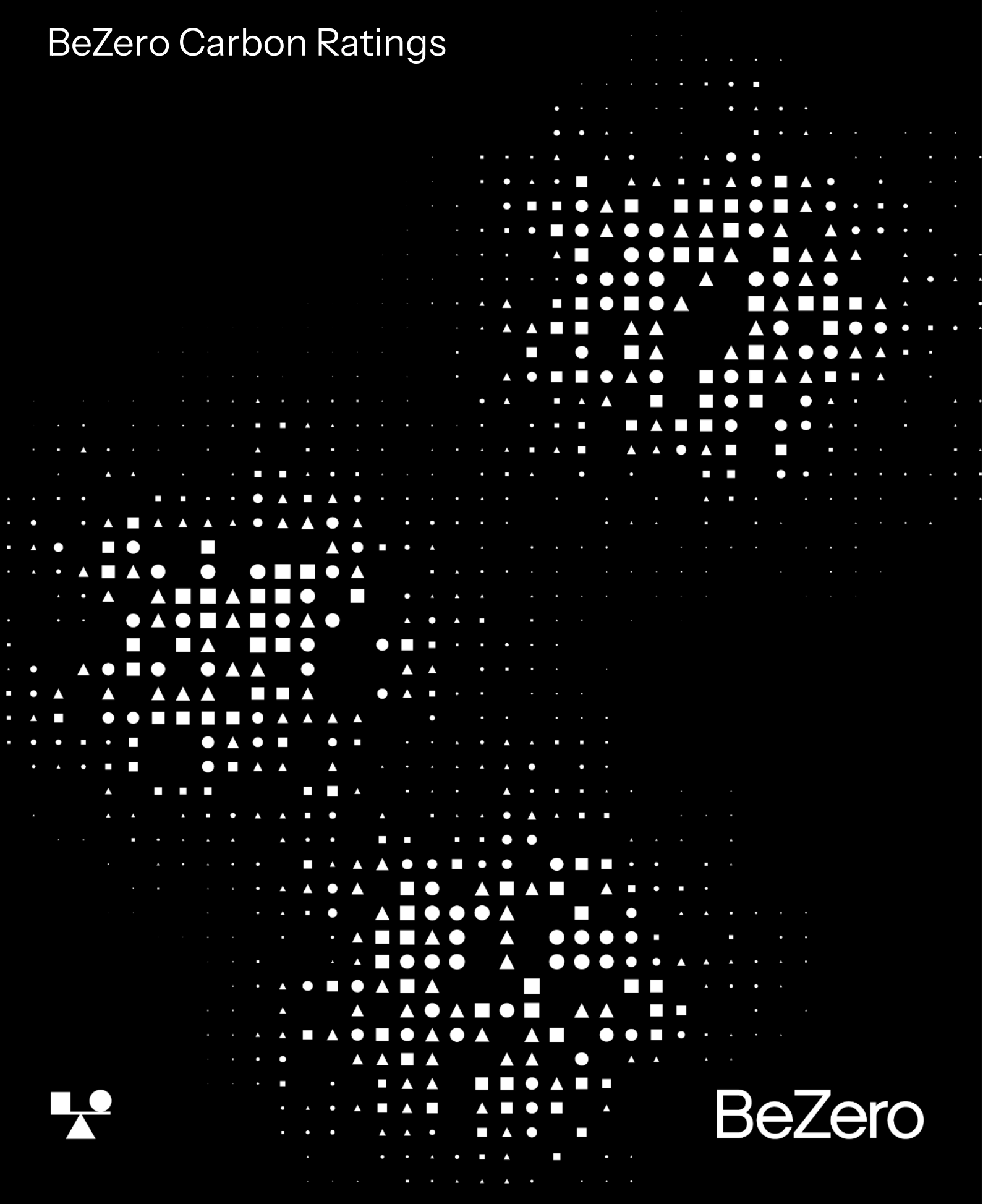
Waste methodology

BeZero Carbon Ratings



BeZero

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Introduction

BeZero Carbon is a global ratings agency for the carbon market (CM). Our ratings provide a publicly available, risk-based framework for assessing carbon efficacy. We rate qualifying carbon credits in all sectors.

We take a research-first mindset, fusing traditional capital markets research practices with expertise in environmental sciences and technology. We think creatively about climate problems and build solutions the whole market can use.

We have developed extensive analytical frameworks to rate carbon credits on their likelihood of delivering on their promised carbon emissions avoidance or removal. These analytical frameworks are deeply sector nuanced and bring to the fore our extensive experience in rating hundreds of projects across dozens of sub-sectors.

Our ratings team is made up of over 60 analysts who create the models and perform the analysis for every rating. They combine expertise in climatic, biological, and Earth sciences, in disciplines from remote sensing, forest ecology, ecosystem disturbance, peatlands and blue carbon through to statistics, machine learning, artificial intelligence, sell-side financial research, industrial engineering, and public policy. They hold over 20 PhDs, have published over 200 academic papers and have been cited over 10,000 times in peer-reviewed, scientific academic literature.

As the market's number one risk metric, our ratings are available on our website and dozens of marketplaces, and alongside extensive analysis and research on our BeZero Carbon Markets platform.

What is included in the Waste sector?

BeZero Carbon's Waste sector methodology is a tool for users of the BeZero Carbon Rating to better understand our multifaceted ratings approach to the sector group.

In the Waste sector group, credit issuance is classified as avoidance only. These credits are issued for avoiding the emissions associated with a range of waste related activities which are further disaggregated at the sector and sub-sector level.

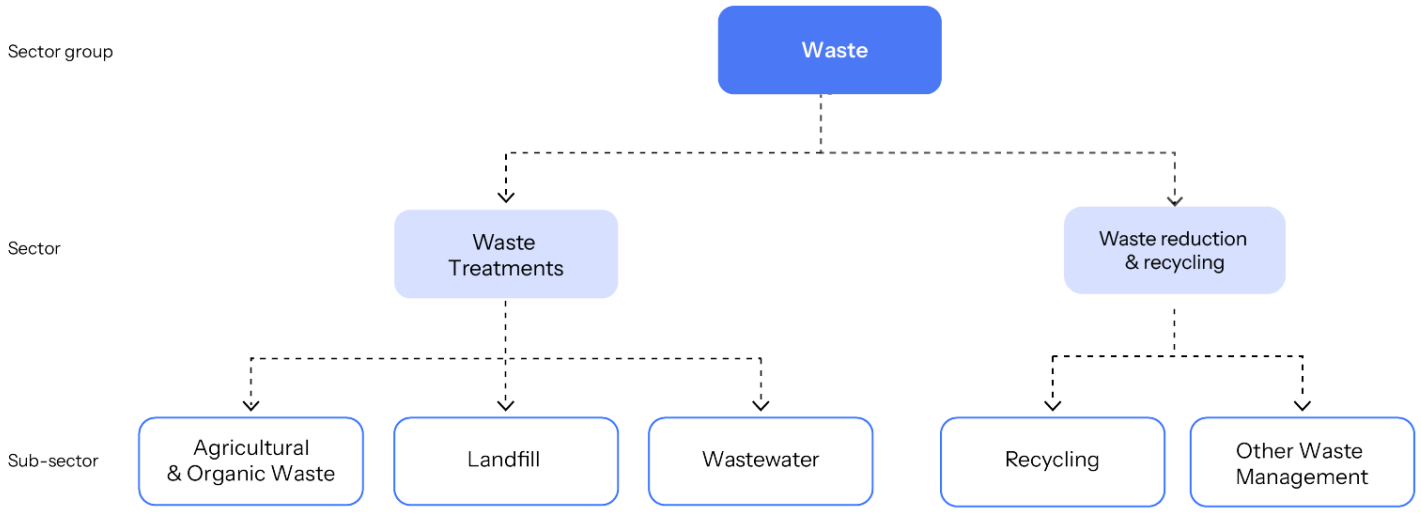


Figure 1. The Waste sector group and sub-sector classifications.

Waste Treatments. Waste treatment projects are typically downstream interventions, acting after the waste has been generated and is already decomposing. The abatement lever is the destruction or utilisation of superpollutant gases that would otherwise be vented to the atmosphere. They typically consist of the sub-sectors below:

- **Agricultural & Organic Waste.** These projects prevent methane from fresh organic material by controlling how it decomposes. On the manure side, open lagoons are covered or replaced with anaerobic digesters that capture the biogas. On the diversion side, food waste, green waste, and agricultural residues are routed to composting or incineration instead of landfill, so anaerobic conditions never form in the first place.

- **Landfill.** These projects capture the methane generated by decomposing organic waste in a landfill and destroy it, either by flaring or by using it as fuel. Collection systems of wells and pipework draw the gas out of the waste mass before it escapes through the cap. Where utilisation is added, the gas generates grid electricity, processes heat, or is upgraded to pipeline-quality biomethane.

- **Wastewater.** These projects convert uncontrolled anaerobic treatment of effluent into controlled systems, typically by covering lagoons or installing enclosed reactors that capture the biogas. The methane released by breakdown of the organic load is collected rather than vented, then flared or burned for heat and power. Industrial effluent from palm oil mills, distilleries, and food processing is the most common application.

Waste Reduction & Recycling. These projects typically intervene upstream, by stopping material from entering the waste stream at all, or by substituting it from virgin production. The abatement lever is displaced manufacturing energy and process emissions, plus avoided methane generation from disposal. Credits represent emissions that are not generated elsewhere, inferred from material flows rather than measured.

- **Recycling.** Projects collect, sort, and reprocess post-consumer or post-industrial material so it re-enters manufacturing in place of virgin feedstock. The most common streams are plastics (particularly PET back into food-grade resin or fibre), metals, paper, and glass. The abatement comes from the manufacturing side rather than the waste site: producing from recyclate avoids the energy and process emissions of extracting and refining virgin material.

- **Other Waste Management.** A residual category covering waste interventions that fit neither anaerobic treatment nor material recovery. These activities include projects which support the diversion of solid waste from typical disposal routes, such as landfilling, to food banks or for internal facility use.

Additional sub-sector qualifiers for Waste projects

To further disaggregate waste projects, we use unique additional qualifiers within sub-sector classifications to enable project labelling and grouping. Below we describe the key features that determine qualifying labels:

Table 1. Additional qualifiers according to the relevant sub-sector.

Additional Qualifier	Sub-sector	Option	Description
Destruction activity in project scenario	Agricultural & Organic Waste; Landfill; Wastewater	Heat displacement	Projects that utilise the biogas to replace heating from fossil fuels
		Electricity generation	Projects that generate electricity in the project activity
		Gas grid injection	Projects that distribute biogas directly into a local gas grid
		Flaring	Projects that flare biogas in the project activity without the generation of electricity
Processing type	Agricultural & Organic Waste	Incinerator	Projects that involve the combustion of municipal solid waste, converting the waste into ash and flue gas
	Agricultural & Organic Waste; Wastewater	Anaerobic digester	Projects that utilise various sources of feedstock materials, such as cattle or swine manure, as a feedstock for biogas production
		Composting	Projects that use naturally occurring microorganisms to convert biodegradable organic matter into nutrient-rich soil amendment
Grouping	Landfill	Grouped	Projects that have sites spanning multiple project areas
		Un-grouped	Projects that have one site or multiple sites within a single project area
Scale	Landfill	Small scale	Project sites with a nameplate capacity of 10 MW or less
		Large scale	Project sites with a nameplate capacity over 10 MW
LFG destruction requirement in baseline	Landfill	Not government mandated	Projects operating in a country where there is no government mandated policy for LFG destruction
		Government mandated	Projects operating in a country where there is a government mandated policy for LFG destruction

Methane in baseline	Landfill	No destruction in baseline	Projects without any destruction device previously at the landfill site. The methane is released to atmosphere
		Combustion with electricity generation in baseline	Projects where LFG destruction with electricity generation was already occurring, to some extent, prior to the project activities
		Combustion without electricity generation in baseline	Projects where LFG destruction without electricity generation was already occurring, to some extent, prior to the project activities
Type of recycled material	Recycling	Oil-Recycling	Projects that recycle process oil types to virgin quality
		Recycling	Projects that recycle plastic, glass and metal products from MSW and avoid the production of their virgin based equivalents
Reduction method	Other Waste Management	Food Rescue	Projects that rescue or divert food/organic waste from waste disposal routes
		Other	Projects that rescue or divert waste disposal routes for other than food/organic waste

BeZero Carbon Rating analytical framework and process for Waste projects

We have designed an approach to assessing the carbon efficacy risk for issued carbon credits. This framework is applicable to any project type in any sector accredited by any standards body, and leverages a blend of qualitative and quantitative factors; financial, environmental, policy assessment techniques; and primary and secondary data sources.

Our BeZero Carbon Rating Methodology details our risk based assessment for understanding and interrogating the efficacy of issued carbon credits of any type, in any sector and country.

The BeZero Carbon ex ante Rating Methodology similarly describes our framework for assessing carbon efficacy of credits yet to be issued from projects of any type, in any sector and country. Ex ante ratings will also consider project execution risk.

Sector methodologies are nested within the overarching ex post or ex ante methodologies. The overall rating definitions, risk factors and risk driver categories are common across all projects while the sector methodologies provide more detail on our sector-specific analytical approach.

This document provides an extension to our overarching rating methodologies. It presents BeZero's detailed analytical framework and process for Waste projects. It showcases the various parameters through which we assess risk to the carbon quality of these credits, and how this sector relates back to our overarching ratings methodologies.

Holistic assessment

The assessment of a carbon credit's efficacy includes a detailed, project-specific, bottom-up, and top-down analysis, to provide a comprehensive assessment of risk. Further details on the risk factor definitions, the rating process, and the overall risk assessment can be found in our BeZero Carbon Rating Methodology. For pre-issuance ratings please consult the BeZero Carbon ex ante Rating Methodology.

Important elements of the BeZero Carbon rating process that are applicable to all project types are described in detail in these documents (but not repeated in this document). These include:

- The steps in the rating process
- The project governance assessment
- Project boundary auditing
- Assessing the risks of double counting
- The integrity of reported issuance
- Assessing rating eligibility (whether projects meet our three primary qualifying criteria)
- The rating assignment process
- The role of the BeZero Carbon Rating Committee
- Ongoing monitoring and 'rating watch' process

Carbon efficacy assessment

Additionality

'The risk that a carbon credit does not lead to a tonne of CO_2e being avoided or sequestered that would not have otherwise happened.'

Table 2 sets out the risk drivers within our assessment of additionality. In the sections that follow we detail the key parameters that factor into each level of risk assessment.

Table 2. Sub-components of additionality assessed.

Risk factor	Risk driver category	Risk driver
Additionality	Activity analysis	Common practice
		Alternatives to the proposed project
	Financial analysis	Prior consideration of carbon finance
		Investment analysis
		Barrier analysis
	Legal and policy	Policy support

Activity Analysis

Common practice

Common practice is a major driver of our additionality analysis for waste projects. Our objective is to determine whether the project's activities would be standard practice in the region in the absence of carbon finance. The assessment is specific to sites and operators of similar size and function, working under similar rules, ownership and market conditions to the project. It considers both the type of activity adopted under the project scenario — capturing and destroying gas, recycling plastic, or diverting waste from disposal — and how far the project takes that activity, since two operators doing nominally the same thing can differ widely in what they achieve.

We establish what constitutes common practice through a review of the literature and of third-party data, identifying comparable waste activities in contexts similar to the project's. Relevant similarities include jurisdiction and the regulations that apply, site size and design, waste type and volume, and the revenue available to the operator from energy or electricity sales. Projects often assess common practice by counting similar carbon projects in the region. We think it is equally important to look at similar activities implemented without carbon finance, since those are the clearest evidence of what would have happened anyway. We leverage our internal markets database to assess the prevalence of other carbon market projects in the area registered on, but not limited to, five major standards bodies: American Carbon Registry, Clean Development Mechanism, Climate Action Reserve, Gold Standard, and Verra. We also draw on national greenhouse gas inventories, permitting and operating registers, and sub-sector databases such as the US Environmental Protection Agency's Landfill Methane Outreach Programme (LMOP) for landfill gas and its AgSTAR database for agricultural and organic waste. Exhaustive literature review is conducted to unearth any programmes or interventions conducting similar activities that may otherwise have been overlooked. Our overall view contextualises these findings with data on national, regional and local trends, and with industry and academic literature on technology costs, policy and market conditions.

Where a meaningful share of similar operators have adopted the same activity without carbon finance, the project's activities likely represent — or fall short of — common practice, which implies they are not additional. Where uptake among operators without carbon finance is low or absent,

project activities likely do not represent common practice, which supports additionality. The size and consistency of that difference informs the strength of our conclusion. We also consider whether uptake was voluntary or required by law, and where a requirement exists but is not consistently enforced, we assess what operators actually do rather than what the regulations alone require.

Our conclusion on common practice therefore reflects both whether the project's activities are commonly applied at similar sites in the region absent carbon finance, and whether we can discern a difference between what the project does and what its peers do. Risk is highest where both point in the same unfavourable direction, and lowest where both point in the same favourable direction.

Supplementary to this analysis, some project activities are considered 'first-of-its-kind' within the region, or at the scale of the intended greenhouse gas impact. This may be due to the age of the project, or because the barriers to implementation were highly significant. We use global datasets, alongside an assessment of government programmes and interventions by non-governmental organisations, to estimate whether the activity is genuinely first of its kind in the project region. Projects that are the first of their kind tend to have high additionality, as it is more likely there were barriers to implementing the activity without the incentive of carbon finance.

Alternatives to the proposed project

This risk driver addresses the most likely counterfactual scenario - regardless of the baseline scenario the project has selected - and establishes what would plausibly have happened to the waste stream, and to the site operator, had the project not been implemented; it also assesses whether the scenario the project has adopted as its baseline is the most plausible of those alternatives. Our assessment may include, but is not limited to, the following conditions.

Alternative arrangements. We compare the project as structured against the arrangements plausibly available to the parties capable of implementing the same activity, drawing on project documents, ownership and concession records, contractual and offtake terms, the technical requirements of the activity, and our own analysis of the costs and savings it would generate for each party. Where the activity would have been economically viable for one of those parties under an alternative ownership, financing or operating arrangement, this implies that the project's reliance on carbon finance stems from the structure adopted rather than from the underlying economics of the activity. Where the project cites a barrier as the reason an alternative arrangement was not adopted — an absence of in-house technical capability, for example — we then assess whether that barrier could reasonably have been overcome under a different arrangement, such as contracting a third party to operate an asset the original party continues to own, because the availability of such an arrangement weighs materially against additionality.

Persistence of the baseline. We assess whether the scenario identified as the baseline would plausibly have continued for the full crediting period, drawing on the regulatory requirements applicable to the site, permitting and licence conditions, the age and condition of the existing infrastructure, and observed practice at comparable sites. Where a constraint would foreseeably have curtailed or replaced the baseline practice before the end of the crediting period — a tightening emissions, effluent or nuisance requirement, or the retirement of existing assets, for example — the baseline is unlikely to hold for the full period and the emission reductions credited against it are correspondingly uncertain.

Our conclusion ranges from a finding that the project activity was economically viable for a party able to implement it under an available alternative arrangement, with no verifiable evidence that carbon finance was necessary to anything other than the structure the project adopted, through to positive and specific evidence that no such arrangement was available to any party holding the relevant decision rights, supported by a baseline that would plausibly have persisted for the full crediting period and is not undermined by regulatory change or other context.

Financial Analysis

Prior consideration of carbon finance

Our objective is to determine whether carbon revenue was taken into account by the party making the investment decision, before that decision was made, and whether it mattered to the outcome. Projects that committed to the activity without carbon revenue forming part of the decision proceeded on a business-as-usual basis, and present high additionality risk. Conversely, evidence that carbon revenue was modelled as a real and meaningful input to the decision, and pursued from that point, supports the case that the project depended on it.

Our analysis has two components. First, we establish when the investment decision was taken, identifying the earliest verifiable point of commitment — usually signature of the main equipment contract, the start of construction, or an irreversible financial commitment. Second, we assess the records generated before that date — board and investment committee papers, feasibility studies and financial models, financing and construction contracts, consultant engagement terms, and any notification filed with the standard body — and determine whether carbon revenue appears as a modelled and meaningful figure or only as a later addition. Risk is elevated where the only evidence is documentation prepared for validation, tempered where carbon revenue is mentioned before the decision but not modelled or is immaterial to the appraisal, and lowest where it is modelled as a meaningful input and followed by continued action towards registration.

Documentation from the time of the decision is frequently incomplete, and a notification filed on time evidences the filing rather than the substance of the decision. Each project is therefore assessed with input from analysts familiar with the relevant mechanism and jurisdiction, and we are explicit where the project start date is a matter of judgement or where prior consideration is unevidenced rather than absent.

Investment analysis

Investment analysis is often a key driver of our additionality analysis for waste projects. Our objective is to determine whether carbon finance was necessary for the project to be a viable investment. If the project would have been knowingly financially attractive without it, then the project activities are unlikely to be additional. The assessment is specific to the project's own cost structure, the revenue streams available to it, relevant cost savings, and the market in which it raised capital, since the same activity can be marginal in one setting and comfortably profitable in another.

We begin by testing whether the numbers underlying the project's investment case are credible. We seek to corroborate them using independent data sources, industry data, peer-reviewed research and in-house expertise. Factors assessed include reported internal rates of return (IRR), reported payback periods, and patterns of investment and capital flow in the sub-sector before the project was implemented. We also screen the methodology itself, as some apply investment benchmarks that are outdated, set too high, or leave significant room for subjective assumptions about future costs. We pay particular attention to assumptions about subsidies and about revenue from selling electricity, gas or recovered materials, since these are the inputs where different assumptions would most likely change the result. Where we cannot corroborate the inputs, we place limited weight on the reported returns.

Methodologies typically require the project's IRR, excluding carbon finance, to fall below a stated benchmark (or hurdle rate) — usually the return available from a conventional alternative. In our view this is a minimum requirement rather than a complete test. We also assess the ΔIRR: the change in return that carbon finance introduces. Taken together, the IRR and the ΔIRR give a better sense of how material carbon revenue was to the investment decision. This matters most where there is doubt about whether the benchmark reflects the true hurdle rate in that market.

Table 3. IRR and ΔIRR scenarios and generic BeZero interpretations.

Scenario	IRR ex. carbon finance vs benchmark	ΔIRR	Generic interpretation
0	Above benchmark	—	The project is an attractive, logical investment regardless of carbon revenue.
1	Materially below	Large	Carbon finance is likely a revenue stream critical to the investment decision and the project's ongoing financial success.
2	Immaterially below	Large	Carbon finance could be a revenue stream critical to the investment decision and the project's ongoing financial success.
3	Materially below	Small	The project is unlikely to depend on carbon finance, though the benchmark may not adequately capture the point at which an investment decision is made.
4	Immaterially below	Small	The project is unlikely to have depended on carbon finance.

Alongside this, we assess how the project earns revenue. For many waste projects, the role of carbon finance is to fund equipment or practices that generate no revenue of their own — capturing and destroying methane, treating waste, or changing how material is handled. Where destruction is the only outcome and there is no saleable product, projects are likely to show a high degree of additionality, as no independent revenue stream exists to cover the cost of installing and maintaining the equipment.

Where a project produces something it can sell — electricity, heat, biomethane, digestate, compost or recovered materials — additionality is less certain. Some countries operate government-backed feed-in tariffs that guarantee a price for renewable energy over the life of the project; China and India have both used these at national and regional level. Projects also commonly sell energy under a power purchase agreement, a private contract rather than a government mandate. Comparable support exists elsewhere in the sector, including renewable fuel credits for biomethane and gate fees for accepting waste. In recycling and material recovery, the value of the recovered material itself is often the primary revenue stream, and carbon finance is more likely to be marginal than enabling.

Our revenue analysis compares the contribution of each income stream available to the project. This informs our opinion on additionality, as it allows us to judge whether the project's activities genuinely depended on carbon finance, or would have been viable without it.

Barrier analysis

Our objective is to determine whether barriers existed that would have prevented or delayed the project activities in the absence of carbon finance, and whether carbon revenue was capable of alleviating them. Projects facing severe, well-evidenced barriers that carbon finance directly addresses are likely to present lower additionality risk. Conversely, additionality risk is elevated where the barriers claimed are not evidenced, are common to the sector without having prevented comparable projects from proceeding, or are of a kind that carbon revenue cannot resolve.

Our assessment takes into account variables impeding implementation that a project may or may not disclose, and that may sit inside or outside the project boundary. It is driven by data, academic literature, industry reports and our own analysis of the market concerned, rather than by the barriers the project elects to present. Not only does our assessment consider the existence of barriers, but also the role of carbon finance in alleviating them. The latter aspect is pivotal, since some barriers are fundamentally unrelated to the benefits afforded through voluntary financing. These challenges are varied, and our assessment is therefore not a prescription.

Our analysis has two components. First, we identify the barriers plausibly bearing on the project and assess whether each is evidenced rather than asserted. In the waste sector these commonly include access to capital and the cost of debt in the host market; the absence of a revenue-generating output where the activity is destruction or avoidance only; the technical capability of the operator to install and run the equipment; the availability of qualified contractors, spare parts and maintenance support; grid connection availability; feedstock security, contamination and composition variability; the absence of a viable offtake for the output; permitting delay; and the distribution of decision rights across site owners, concession holders and offtakers. We assess each against observed practice at comparable sites in the same market, since a barrier that has not prevented similar projects from proceeding is unlikely to have been decisive.

Second, we assess whether carbon revenue was capable of alleviating the barriers identified, and at what scale. Risk is elevated where the barriers cited are structural or regulatory in nature and unaffected by an additional revenue stream, tempered where carbon revenue addresses a barrier only partially or was received too late in the project's development to have done so, and lowest where carbon revenue directly and materially resolved a barrier that comparable projects in the same market did not overcome.

Barriers are frequently presented in general terms, and the practical significance of a given constraint to an individual operator is often not evident from the project documentation. Each barrier identified is therefore assessed with input from analysts familiar with the relevant sub-sector and jurisdiction, and we are explicit where a barrier's existence, severity, or susceptibility to carbon finance is uncertain.

Legal and policy

Policy support

Our objective is to determine the extent to which existing policies, incentives and mandates encourage or require the project activities in the absence of carbon finance. Projects in jurisdictions that benefit from robust, effectively-enforced policy environments which reduce barriers to implementation are likely to present higher additionality risk. Conversely, carbon finance may be essential to a project's successful implementation where relevant policies are weak, poorly enforced, or actively undermine project activities.

Our analysis has two components. First, we identify policies that require or restrict waste management practices in a manner consistent with the project activities, using both our internal policy database and primary research. These may include landfill gas capture and control requirements, landfill bans and organic waste diversion targets, effluent discharge and treatment standards, nutrient management and odour requirements, extended producer responsibility obligations, recycled content mandates, and conditions attached to operating permits or waste collection concessions. We comment on the effectiveness with which those policies are implemented and enforced. Where activities are mandated by policy in a jurisdiction where that policy is effective, additionality risk is high.

Second, we identify government programmes and market mechanisms which could incentivise the project activities without carbon finance, including feed-in tariffs, renewable portfolio and renewable

fuel obligations, capital grants, concessional finance and tax incentives. We establish which mechanisms the project or operator is eligible for, which it is or has been enrolled in, the level of uptake in the region, and the level of support they provide relative to the carbon finance received under the project. Risk is elevated where project activities are heavily supported by such mechanisms, tempered where they exist but the project has not accessed them, and lowest where no supporting mechanisms exist and existing policy actively undermines project activities.

Carbon Accounting

'The risk that the carbon accounting underlying a credit does not fully achieve a tonne of CO_2e avoided or removed.'

Table 4 sets out the risk drivers within our assessment of carbon accounting.

Table 4. Sub-components of our over-crediting assessment.

Risk factor	Risk driver category	Risk driver
Carbon Accounting	Direct accounting	Baseline scenario
		Project scenario
		GHG conversions
	Leakage accounting	Activity displacement
		Market leakage

Reconstructing the project's crediting structure

Our assessment of carbon accounting begins by reconstructing how a project arrived at its net issuance across the rated vintage period, so that the effect of each subsequent finding can be located within that structure.

Using project-reported values, we establish the project's total gross emissions reductions, baseline and project emissions. We then decompose that totals into its components, since each is subject to different risks and different vintage profiles. In most waste projects the dominant component is avoided methane — the emissions assumed in the baseline that the project scenario prevents from reaching the atmosphere. Where the project generates a saleable output, a second component reflects the fossil emissions displaced by that output, whether grid electricity, heat, transport fuel or virgin material. The distinction matters because the two often depend on different evidence: methane destruction is measured at the flare or engine, while displacement is modelled from an emission factor and is rarely measured directly. For the project's own emissions we investigate the comprehensiveness and appropriateness of estimates for components such as energy consumption, methane slip and any unrecovered fugitive losses — together with any leakage deduction and, where projects applied it (usually due to the methodology requirements), any uncertainty or risk-based deduction..

We then construct the equivalent quantity for the total emission reductions on our own terms to obtain our best estimate range for comparison. Where our analysis of the risk drivers below leads us to a different view of the counterfactual, of the baseline parameters applied, of reported project emissions, of destruction and collection efficiency, or of the appropriate leakage deduction, we quantify the emissions reductions that our own assumptions would imply, and arrive at a BeZero view of net emissions reductions for the rated vintages. The proportion of the project's claimed net issuance that our analysis does not support is the central output of our carbon accounting assessment, and the primary determinant of the risk factor score.

Because waste project baselines rest on parameters that can err in opposite directions, we quantify the effect of each parameter separately and report the net position rather than the individual components alone. Where metered data provide an empirical cap on a modelled baseline, we identify which route governs issuance and what the alternative would have implied, since a project adopting the lower of two permitted methods is accounting more conservatively than one that is not.

Three points of method follow from this. First, quantification is attempted wherever the evidence permits it, including where we conclude that a project's accounting is conservative rather than aggressive. Second, non-trivial assumptions are unavoidable, particularly in establishing an alternative counterfactual and in selecting values for parameters that cannot be observed directly. Third, in many cases we also need to consider the range and shape of uncertainty, strength of the scientific consensus that underpins the estimations, the likelihood of other unknowns, and other more qualitative considerations. Where the evidence supports a range rather than a point estimate, we present a range, and in conditions of material uncertainty we prefer to do so.

Direct accounting

Baseline scenario

Our objective is to assess the accuracy of the emissions quantification the project has applied to its selected baseline scenario — the assumptions, data, and calculation methodology underpinning the reported baseline emissions — and to test whether this quantification holds against the most likely counterfactual, quantifying the difference where it does not. This is a major risk driver for waste projects, and typically the most consequential single component of the carbon accounting assessment.

We begin by establishing what the project's baseline represents and how it was determined, the emissions it implies over the rated vintage period, and the proportion of issued credits attributable to each parameter within it. Baseline setting varies materially between waste methodologies and sub-sectors.

Agricultural and organic waste. The baseline represents the emissions from the manure or organic residue management system that would have continued absent the project — most commonly open anaerobic lagoons, storage pits or solid stacking — together with any emissions displaced by the project's output, such as fossil fuel combusted for heat or power. Methodologies typically permit two routes to the baseline: modelling gas generation from feedstock volume, composition and the management system assumed, and metering the biogas actually combusted. Where the lower of the two is required, the metered figure provides an empirical cap on the modelled estimate, and we state which route governs and what the alternative would have implied for issuance. Where the modelled route governs, risk concentrates in the parameters underpinning a Tier 2 estimate: volatile solids excretion, maximum methane producing potential (B_0) and the methane conversion factor (MCF). We assess each against site-specific evidence rather than accepting default values. MCF defaults do not reflect retention time or intra-annual temperature variation, and frequently overstate generation where storage is emptied periodically rather than held continuously. B_0 defaults are diet-dependent and can understate generation at large commercial operations, where published values for comparable high-productivity systems are materially higher. Volatile solids and animal weight defaults drawn from earlier guidance may not reflect the differentiation by production system and animal type introduced in subsequent refinements. Because these parameters can err in opposite directions, we quantify each separately and report the net effect on baseline emissions and on issuance. Monitoring relies on metered biogas flow and methane fraction, feedstock tonnage and characterisation, and digester operating temperature; we assess sampling frequency, the basis of characterisation, and instrument calibration.

Landfill. The baseline represents the methane that would have been generated and released absent the project. It is either modelled using a first-order decay function driven by the site's waste

acceptance history, degradable organic carbon content and decay rate constants, or derived from metered gas flow where a collection system already exists. Three factors are most crucial for accuracy. The first is whether a deduction has been made for methane destruction that would have occurred anyway. Where a destruction device was already installed before the project start, credits should be issued only for the increase in methane destroyed, and we assess whether the deduction applied reflects the capability of the existing system across the crediting period. Where a regulation requires capture and flaring but the operator had not complied, the project may claim only partial baseline emissions, and we assess whether the destruction percentage assumed — including any default applied in the absence of a specified figure — is defensible against observed enforcement in the jurisdiction. The second is the methane oxidation factor, which captures the fraction of methane oxidised by bacteria in the cover layer before it reaches the atmosphere. Methodologies typically permit 0.1 for organic covers such as clay, soil or sandy loam, and zero for synthetic or geomembrane covers. A single default cannot reflect the range of cover thickness, moisture, temperature and gas flux conditions found across sites, and field measurements frequently support rates above 10%; we assess the value applied against academic literature, industry reporting and our own waste factors database, and quantify the effect on issuance where the two diverge. The third is monitoring: gas is collected through a system of wells and headers under vacuum, with flow rate, methane fraction, temperature and pressure recorded continuously by calibrated instruments. We assess the specification of that equipment, the frequency at which readings are logged, and the calibration interval against methodology requirements and industry practice.

Wastewater. The baseline represents the emissions from the treatment configuration and sludge handling that would have continued absent the project. It is driven by the organic load entering the system, expressed as chemical or biochemical oxygen demand, the methane conversion factor applicable to the assumed treatment route, the fraction of that load degraded anaerobically, and the fate of the sludge generated. Risk concentrates in two places. The first is characterisation of the influent load, which is frequently established from limited sampling and may not represent seasonal or production-linked variation in flow and strength — a material concern where the wastewater arises from an industrial process with variable output. The second is the methane conversion factor, which for open lagoons turns substantially on assumed depth, since deeper systems are treated as fully anaerobic; we assess whether the depth and configuration assumed match the system as it actually operated. We also assess whether the baseline treatment route would plausibly have persisted for the full crediting period, given that effluent quality and odour requirements often tighten over time, and whether the same organic load is credited across more than one project boundary. Monitoring relies on metered biogas flow and methane fraction alongside influent and effluent load measurement; we assess sampling regime, laboratory method and calibration.

Recycling. The baseline captures the route the material would have taken absent the project, and the production route for the virgin material the recovered output displaces. On the disposal side, we assess whether the assumed counterfactual — landfill, incineration with or without energy recovery, or export for treatment elsewhere — reflects the routes actually available in the collection area, and whether the material was already being recovered through an existing commercial channel, in which case the project displaces an existing recycler rather than diverting material from disposal. On the displacement side, the baseline depends on the emission factor assigned to virgin production and on the adjustment factors applied for material quality and market effect. Recovered material is rarely a functional one-for-one substitute for virgin feedstock, and increased supply in one market may displace recycled material elsewhere rather than displacing virgin production. We assess whether the factors applied for physical inferiority and market displacement are supported by evidence specific to the material and market, or selected at the end of the permitted range most favourable to issuance, and we compare them against the multipliers a comparable project would face under current methodologies. Monitoring relies on weighbridge records for material received, composition and contamination sampling, yield and reject rates through the process, and sales records evidencing the destination of the recovered output.

Other waste management. The baseline depends on the route the waste would have taken absent the project, and on the generation or fuel supply that the project's output substitutes. On the

disposal side, we assess whether the assumed counterfactual — landfill, open burning, uncontrolled dumping, or an existing treatment facility with available capacity — reflects the routes actually available for that stream, and whether the feedstock was already being combusted, processed, or otherwise diverted commercially, in which case the project redirects material within the residual waste system rather than removing it from disposal. Where the counterfactual is landfill, the credited volume rests on modelled decay of the diverted organic fraction, so the composition assumption carries the same weight here as the substitution factor does in recycling. On the displacement side, the baseline depends on the emission factor assigned to the displaced energy or fuel — grid electricity, fossil heat, or coal and petcoke in cement kilns — together with the calorific value and fossil carbon fraction of the processed waste, and the conversion or thermal substitution efficiency assumed. Combustion of the fossil-derived fraction is itself a project emission, so the net position is sensitive to how the fossil and biogenic split is determined, and a stream characterised as predominantly biogenic on limited sampling can shift the outcome materially. We assess whether the grid or fuel emission factor reflects the marginal source actually displaced rather than a favourable average, and whether efficiency and substitution assumptions are supported by operating data rather than design specification. Monitoring relies on weighbridge records for waste received, composition and calorific sampling with sufficient frequency to capture seasonal and source variability, metered energy export or fuel dispatch, plant availability and throughput records, and offtake documentation evidencing where the output was used and what it replaced.

Project scenario

In waste projects, emissions typically continue to lesser extent or are generated under the project scenario: the project consumes energy to operate its equipment, and depending on the technology, methane escapes the system after the point at which it has been captured. The accuracy of claimed emission reductions therefore partly relies on those quantities being appropriately monitored and reported. Our objective is to determine whether a project is accurately monitoring, reporting and deducting for its own emissions. This risk driver applies to ex post ratings of all waste projects.

The composition of project emissions depends on the methodology project applies, and in particular on whether the baseline is metered or modelled. Where the baseline is derived from methane actually captured and destroyed, gas that escapes collection is excluded from the credited quantity by construction and is not a project emission. Where the baseline is instead modelled from organic load or feedstock characteristics, residual and fugitive methane under the project scenario is an explicit deduction, since the modelled quantity is not otherwise constrained by measurement. We establish which structure applies before assessing what the project has reported.

We then establish the emissions reported under the project scenario over the rated vintage period, drawn from monitoring reports, verification reports and metering records. These commonly comprise grid or fossil-derived electricity consumed by blowers, pumps, compressors and aeration equipment; auxiliary and pilot fuel for flares and boilers; fossil fuel used in on-site handling and, where the methodology places it inside the project boundary, in transporting feedstock, digestate or recovered material; methane slip from upgrading units where biogas is treated to pipeline specification; physical leakage from digester covers, pipelines and gas handling infrastructure; and, under modelled-baseline methodologies, methane from digestate and sludge storage and from residual organic load in discharged effluent. Carbon dioxide arising from the combustion of captured methane is biogenic and is not counted. Where reported values are not provided, they may be inferred from design specifications in project documentation or from the difference between gross and net reductions.

We then compare reported emissions against what the installed system would be expected to consume and lose. Where they are clearly disclosed and consistent with the specification and operating regime of the equipment, reporting is likely accurate. Where they are clearly disclosed but materially below that expectation — on-site energy consumption reported at a fraction of the rated draw of the installed plant, or fugitive losses assumed to be nil across a system with no leak detection

— reporting may be inaccurate. Where a deduction required by the methodology is absent altogether, or where the monitoring record cannot establish that the associated equipment was operating as described, there is material uncertainty as to whether reporting is accurate. In the latter two cases we approximate the emissions associated with the shortfall, using assumptions appropriate to the equipment and site in question, deduct these from the gross emissions reductions reported over the rated vintage period, and express the resulting difference as a proportion of the project's claimed net issuance. Risk rises with the size of that proportion, and is lowest where the monitoring record substantiates the emissions the project reports.

GHG conversions

Our objective is to determine whether the conversion factors a project applies to translate its activities into carbon dioxide equivalent are appropriate, and where they are not, to quantify the effect on issuance. Where project-applied values overstate warming impact relative to the latest reliable third-party estimates, the project is likely over-crediting; where they understate it, the project is likely under-crediting. The same logic applies in either direction, and we quantify both. This risk driver applies to ex post ratings of all waste projects, and is generally minor in magnitude relative to the baseline and project scenario drivers, though we assess it against those in determining the overall carbon accounting position.

Two categories of factors account for most of the risk.

Global warming potentials. We assess against GWP100 values, as this is the market standard and reflects warming over a useful analytical timeframe. The appropriate value is that determined in the latest IPCC Assessment Report, and for methane arising from the decomposition of waste, manure, organic residues or wastewater, the non-fossil derived value applies, as this methane is biogenic. Projects registered in earlier vintages commonly apply values from superseded assessment reports, and because successive reports have mostly revised the methane GWP upward, the practical effect is usually understatement of baseline emissions and therefore under-crediting rather than over-crediting. We establish the value applied across the assessed vintages and its source, substitute the current value, and quantify the resulting change in issuance. Where a project quantifies nitrous oxide — most commonly in manure management and wastewater treatment, where it arises from nitrogen in the feedstock or effluent — we assess that value on the same basis, noting that revisions to the nitrous oxide GWP have moved in the opposite direction to methane and can therefore offset the effect.

Displacement factors. Where a project claims reductions for displacing fossil-derived energy or materials, we assess the factor applied to that displacement. For electricity fed to a grid or consumed on site in place of imported power, we assess the grid emission factor against values in our internal databases, published national and international sources, and academic literature. A material consideration is whether the project applies a static factor held constant across the crediting period or a dynamic factor updated annually, since grids in most markets have decarbonised over time and a static factor set at registration will overstate displacement in later vintages. Where a project displaces fossil fuel directly — biogas substituting for coal, natural gas or oil in a boiler, or biomethane substituting for pipeline gas — we assess the fuel emission factor and the assumed conversion efficiency of the equipment displaced. Where a project displaces virgin material, we assess the emission factor assigned to virgin production against evidence specific to the material and production route concerned.

We rebuild the affected component of the calculation using substituted values, and express the change in issuance attributable to each factor separately. Risk rises with the size of that change. In most waste projects the displacement component is small relative to avoided methane, and the associated risk is correspondingly limited; where displacement forms a substantial share of total reductions, as it may in projects generating energy for export or recovering material at scale, the factor applied carries proportionately greater weight.

Leakage accounting

Our objective is to determine whether the project has caused emissions outside its boundary that offset the reductions claimed within it, and where the project's own deduction does not capture those emissions, to quantify the difference. Leakage in the waste sector arises through two distinct mechanisms, which rest on different evidence and are assessed separately. This risk driver applies to ex post ratings of all waste projects, and its materiality varies substantially by sub-sector: it is generally limited where the project treats a waste stream already arising at a fixed location, and can be substantial where the project alters where waste is generated, collected or processed.

Activity displacement

Activity displacement occurs where the project moves an emitting activity outside its boundary rather than eliminating it. We first establish whether the project's intervention is capable of displacing activity, by reference to whether the waste stream, the treatment operation or the material recovered could relocate in response to the project.

We assess the following pathways.

Diversion of feedstock from an existing use. Where a project draws organic residues, manure, food waste or recyclable material that was previously being treated, recovered or used elsewhere, the emissions associated with the displaced use continue at the alternative location, or are replaced by a higher-emitting substitute. This is the dominant displacement pathway in agricultural and organic waste projects competing for feedstock, and in recycling projects drawing material from established commercial recovery channels.

Relocation of waste receipt. Where a project alters the gate fee, capacity or acceptance conditions at a site, waste may be diverted to or from other facilities. Where waste is drawn away from a site with gas capture toward one without it, or vice versa, the net effect falls partly outside the project boundary.

Displacement of downstream handling. Where a project produces digestate, compost, sludge or reject material, the emissions associated with transporting, storing and applying those outputs may arise beyond the point at which the methodology draws the boundary.

Substitution effects at the point of use. Where a project supplies energy or material that a user would otherwise have sourced elsewhere, the displaced supply may be consumed by another user rather than withdrawn from the market.

We assess whether the methodology requires a deduction for each applicable pathway, whether the project has applied one, and whether the value applied is supported by evidence specific to the market concerned. Where a pathway is material and no deduction has been applied, we quantify the emissions we consider attributable to it, deduct them from the reductions reported over the rated vintage period, and express the resulting difference as a proportion of claimed net issuance. Risk rises with the size of that proportion, and is lowest where the project treats a waste stream that arises at a fixed location, has no alternative use, and generates no output capable of relocating.

Market leakage

Market leakage occurs where the project changes prices or supply in a market such that emissions elsewhere adjust in response, without any physical activity relocating. It is assessed separately because it operates through market response rather than through the movement of material, and because the evidence supporting it is economic rather than operational.

We assess the following mechanisms.

Incomplete displacement of virgin production. Where a project supplies recovered material, an increase in supply may reduce the price of that material rather than reduce virgin production one for one. Recovered output is rarely a functional substitute for virgin feedstock, and additional supply in one market may displace recycled material elsewhere. We assess the adjustment applied for market effect against evidence specific to the material, the market and the period concerned.

Rebound in the market supplied. Where a project supplies energy or material at below prevailing cost, consumption in the supplied market may increase rather than substitute, such that a portion of the claimed displacement does not occur.

Effects on waste generation. Where a project's presence reduces the cost of disposing of or treating a waste stream, the volume of that stream generated may increase, offsetting part of the reduction achieved per tonne.

Price effects on competing treatment routes. Where a project changes the economics of treatment or recovery in a regional market, capacity elsewhere may be brought forward, deferred or retired, with consequences for emissions outside the boundary.

We assess whether the methodology requires a market leakage deduction, whether the project has applied one, and whether the factor applied reflects the elasticity conditions in the market concerned rather than a default selected at the end of the permitted range most favourable to issuance. Where the evidence supports a range rather than a point estimate, we present a range. Risk rises with the extent to which the project's output enters a market capable of adjusting in response, and is lowest where the project's reductions arise from destroying methane at source with no output entering any market.

Permanence

'The risk that the carbon avoided or removed by the project will not remain so for the time committed.'

Table 5. Sub-components of permanence assessed

Risk factor	Risk driver category	Risk driver
Permanence	Technical risks	Reversal risk

Reversal risk

In the case of Waste projects, there is no risk of reversal from a technical perspective. This is because the emission of greenhouse gas is avoided, not removed, and the gas or the source carbon is not collected and stored by a project, thus it cannot later be released.

Appendix I: Additional reading

Check out the ratings resources page on our website to find links to all of our published methodologies, in addition to our series of risk factor assessment frameworks, our frameworks for assessing project methodologies and country-level risks, deep dives on factors influencing the carbon efficacy of projects in various sectors, and more.

Appendix II: Methodology review policy

All BeZero methodologies are live and current, with versioning logs at the end of each document. The ex post rating methodology is comprehensive and holistic and is not knowingly subject to major or structural shortcomings.

The methodology is subject to periodic review, and at least once annually. The need for revisions will consider a range of factors including:

- Methodology review and evaluation. BeZero continuously reviews emerging data and research on the carbon market. BeZero will assess any evidence indicative of structural weaknesses in the framework or systemic risks that are not appropriately captured.
- Evolution in the market dynamics and scientific best practice. Evolutions in the scientific consensus and market infrastructure that underpin carbon markets may warrant methodological revisions (e.g. the definitions or conventions used for vintages).
- External regulatory and asset framework shifts where relevant. Shifts in the legal basis, regulatory architecture or accounting conventions that underpin carbon markets may warrant methodological revisions (e.g. the definitions or conventions used for risk concepts such as additionality or permanence).
- Periodic review. All active frameworks are reviewed periodically (at least annually) to ensure continued robustness and effectiveness and to make analytical refinements.

Revisions to the methodology will be deemed material or non-material.

Non-material changes typically refer to minor updates such as administrative fixes, editorial clarifications that do not alter the underlying analysis. Other potential non-material changes may reflect an elaboration or expansion of the risk assessment framework. Non-material revisions are published routinely as needed.

Material changes typically refer to a fundamental shift in the analytical framework, scoring models, rating scope and definitions, or key rating assumptions that could reasonably alter an existing credit rating outcome. BeZero will undertake an impact assessment when material revisions are proposed. Impact assessments will evaluate the expected portfolio-wide impact, estimating the proportion of ratings that might migrate (upgrade or downgrade) as a result of the revised criteria.

Any change to the rating methodologies are led by our Lead Analytical Officer and approved by a formal Analytical Committee composed of senior personnel from the analytical team. We also consult with our external advisory board on such matters as required.

Changes to methodologies are tracked and logged. The version history of this methodology is available at the end of this document.

Stakeholder consultation

BeZero engages regularly with a wide range of market stakeholders. Feedback is welcome and will be considered as part of the periodic review process. BeZero in some cases may consult with stakeholders via ‘request for comment’ or equivalent processes when considering material methodology revisions.

Updates and reviews

Version number	Date	Description
1.00	21/12/23	Initial release
1.01	31/01/24	Formatting updates
1.02	03/10/24	Formatting updates and clarification on additionality as a limiting factor
2.0	25/03/25	Updated risk factor framework
3.0	27/10/26	Consolidation of four separate Waste sector and sub-sector methodologies into one Waste Sector Group methodology. Removing case studies of project assessments. Revision of applicable risk drivers. Formatting updates, edits and revisions to align with ESMA regulatory requirements.

Disclaimer

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