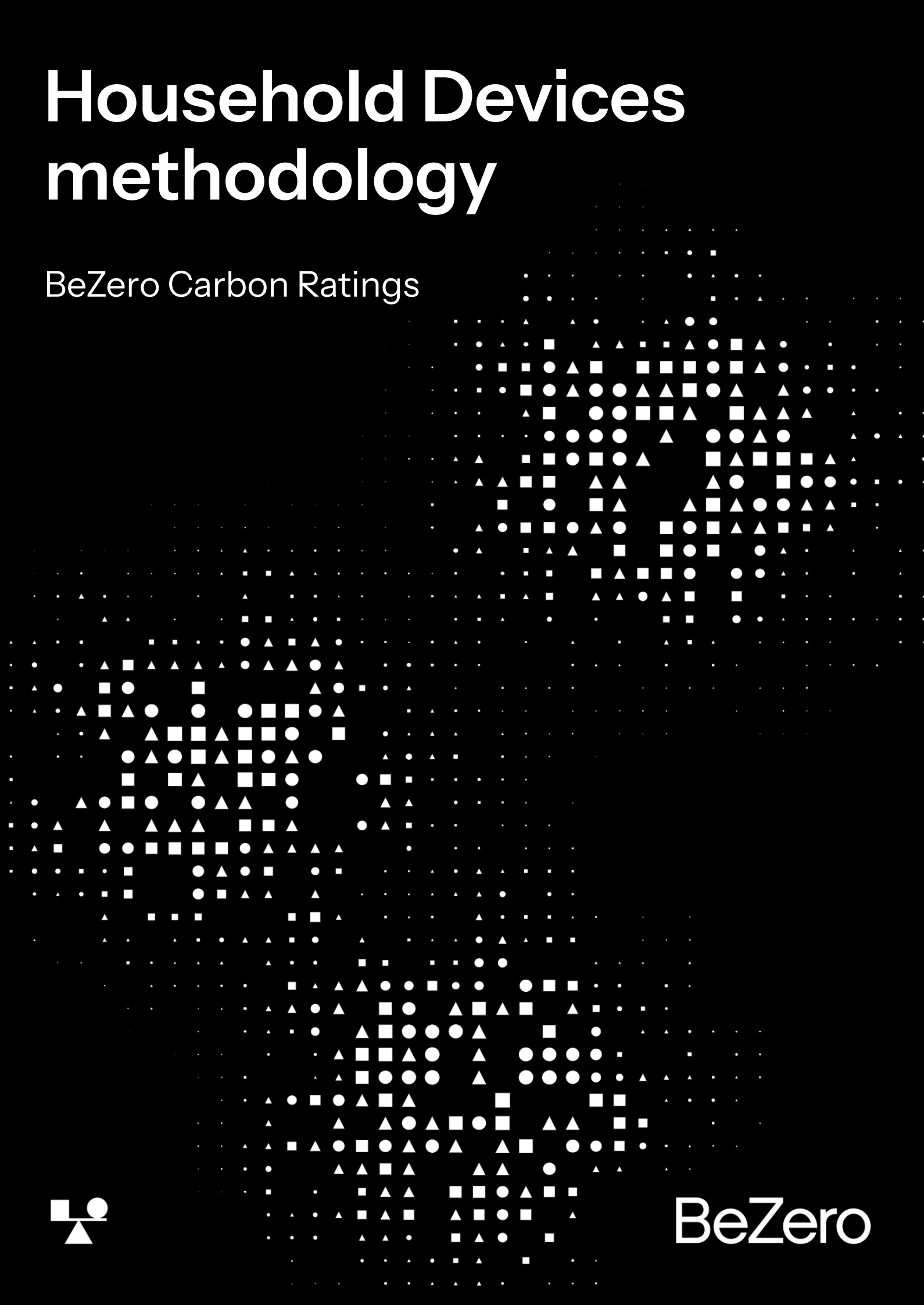
Household Devices methodology

BeZero Carbon Ratings



BeZero

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Introduction

BeZero Carbon is a global ratings agency for the voluntary carbon market (VCM). 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, Geospatial, Data, and Research teams are made up of dozens of climate and data scientists, geospatial experts and financial market analysts. They bring with them the highest academic and industry credentials, a tenacious approach to scientific inquiry and a dedication to climate action through science. They hold PhDs and qualifications in disciplines from remote sensing, forest ecology, ecosystem disturbance, peatlands, and blue carbon to statistics, machine learning, artificial intelligence, financial research, industrial engineering, and public policy. And they have published hundreds of academic papers and have been cited tens of thousands of 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 are Household Devices projects?

Household devices projects aim to reduce GHG emissions by distributing for free or at a discounted price devices such as cookstoves, lighting, heaters that are more efficient and cleaner that the ones that would be used otherwise. BeZero Carbon's Household Devices methodology is a tool for users of the BeZero Carbon Rating to better understand our multifaceted ratings approach to the sector group.

Household Devices projects issue avoidance credits by reducing emissions from the combustion of polluting fuels, or from the anaerobic decomposition of organic waste, relative to a baseline scenario in which the project does not occur. These project types rely on the introduction of cleaner or more efficient technologies for domestic use, delivered at household or community scale. They differ from projects under our Energy Efficiency sector, which instead focus on energy systems in commercial and industrial bodies.

In the BeZero Sector Classification system, Household Devices is one of six sector groups, containing two sectors and five sub-sectors. The two sectors are **Energy Efficient Devices**, whose projects develop and distribute energy-efficient or fuel-switching technologies that displace higher-emission household equipment, and **Water**, whose projects aim to improve water access, usage and/or sanitation — through the distribution of technologies such as filters, or through the development of clean infrastructure such as boreholes and desalination plants, all of which serve domestic users.

The device types covered by this document are:

- **Cookstoves** — improved-efficiency and fuel-switch cooking devices.
- **Domestic biodigesters** — household-scale anaerobic digesters that capture methane from animal or organic waste and supply biogas for domestic use.
- **Domestic lighting** — off-grid lighting products, typically solar, displacing fuel-based lighting.
- **Residential heating and cooling** — devices and measures addressing domestic space and water heating, and cooling, including efficient heating stoves and low-pressure boilers, and fabric measures such as insulation.
- **Water** — household water treatment devices, and community or network-level clean water infrastructure.

Credit issuance across the sector group is exclusively **avoidance**: no project type within Household Devices issues removal credits at this time. Emission reductions arise through three mechanisms, and the mechanism — not the device — determines much of the analysis that follows:

1. **Improved efficiency:** the baseline fuel is retained, but less of it is required.
2. **Fuel switch:** the baseline fuel is displaced by a lower-emission fuel or energy source.
3. **Avoided methane release:** organic waste that would decompose anaerobically is instead captured and combusted.

Additional sub-sector qualifiers for Household Devices

Household Devices encompasses a broad range of project activities delivering different energy or water services to households. The specifics of the technology, and of the service it displaces, largely determine how we assess each risk factor. To determine our approach at the most basic level, we use unique sub-sector qualifiers, which enable project labeling and grouping. For Household Devices, these qualifiers are **intervention type** and **delivery model**. Below we describe the key features that determine qualifying labels:

Intervention type

- **Improved efficiency:** Projects that improve the energy efficiency of the device. The baseline fuel is maintained across project technologies, but due to improved efficiency, less fuel should be required in the project scenario.
- **Fuel switch:** Projects involving a switch from non-renewable biomass or other polluting fuels to cleaner energy sources. The baseline technology is replaced with advanced fuels and technology that use a lower-emission fuel type, such as bioethanol, electricity from renewable sources, liquefied petroleum gas (LPG), biogas, or solar.
-

Delivery model

- **Household device distribution:** Projects that supply a device to individual households, whether free, subsidised, sold at retail price, or financed through installments or pay-as-you-go arrangements.

- **Institution and commercial unit device distribution:** Projects that supply a device to institutions (schools and hospitals) or commercial units (restaurants), whether free, subsidised, sold at retail price, or financed through installments or pay-as-you-go arrangements.
- **Community or network infrastructure:** Projects that construct and operate shared assets serving domestic users, such as boreholes, water kiosks and treatment plants.

BeZero Carbon Rating analytical framework and process for Household Devices

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 arenested 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 Household Devices projects. It showcases the various parameters through which we assess risk to the carbon quality of these credits, and how this sub-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

Geospatial and Earth Observation

Geospatial evidence informs our analysis of Household Devices projects in two specific ways. Its role is bounded by the nature of the activity: the emission reductions claimed are not tied to a delineated project area, and projects rarely disclose the location of participating households or of fuelwood collection.

The first, and most consequential, is spatial modelling of the fraction of non-renewable biomass, described under GHG conversions below. Our implementation of the MoFuss model estimates fNRB for sub-national administrative units, drawing on global datasets of biomass growth rates and land cover change, which allows us to test a project's applied national value against conditions in the areas it plausibly serves.

The second is contextual land cover, settlement and infrastructure data, used where a project discloses distribution locations at district or regional level, to corroborate claims about the population served and about local fuel availability.

Where the quality of the underlying data, or the absence of disclosed project locations, is insufficient to support a conclusion, we say so and weigh the remaining evidence accordingly rather than relying on it.

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.'

Our view of a project's additionality can fundamentally limit the rating we assign to credits issued by that project. Additionality is fundamental to any project being eligible for a rating, and poor additionality constrains the overall carbon rating, reflecting its pre-eminence in our analytical framework.

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
		Project effectiveness
	Financial analysis	Prior consideration of carbon finance
		Investment analysis
		Barrier analysis
	Legal and policy	Land and carbon rights
		Policy support

Activity analysis

Common practice

Common practice is a major driver of our additionality analysis for Household Devices projects. Our objective is to determine whether the technology or practice disseminated by the project would be adopted as standard in the project region in the absence of carbon finance. If it would, then the project activities are unlikely to be additional. The assessment is specific to households comparable to those the project targets, and in geographies comparable to the project's context, and considers both the baseline practice and the project scenario.

We approach this from two directions.

First, we establish what constitutes common practice through a review of the literature and of third-party data, identifying household technology and fuel use in contexts similar to the project boundary. Relevant similarities include geography, rural or urban setting, income level, and the energy or water service in question. We leverage our internal markets database to assess the prevalence of other voluntary carbon market projects in the area registered on the major standards bodies, and we draw on international datasets — including the World Health Organization on primary household fuel use and the International Energy Agency on energy access — together with national-level data on fuel trends and household technologies. An exhaustive literature review is conducted to unearth any programs or interventions conducting similar activities that may otherwise have been overlooked, including government, donor and non-governmental programs implemented without carbon finance. This last point matters: projects tend to assess common practice solely by reference to other carbon projects, which systematically understates how common the activity is.

Second, we interrogate both sides of the project's claim. We look for evidence that the proposed baseline practice is genuinely common within the project boundary, since if it is not, end users may already have access to cleaner technology; and we assess whether technologies similar to those the project disseminates are already accessible to end users, which would indicate that the project scenario is itself already common practice.

A related consideration is **how the project itself demonstrated additionality**. A large share of projects in this sector group qualify through automatic routes rather than project-specific analysis, most commonly by implementing an activity on a standards body's positive list. Available routes include low penetration of the activity relative to its maximum adoption potential; demonstration that activities are not financially viable without carbon finance, typically via a standardised investment analysis tool; an absence of significant revenue other than carbon revenue, which for device projects generally also requires distribution at no cost to the end user; the economic classification of the host country, such as Least Developed Country, Landlocked Developing Country or Small Island Developing State status; project scale below the applicable micro-scale threshold; and low adoption of the technology among target users. Because an automatic route substitutes a categorical test for an assessment of the counterfactual, we conduct our own activity, financial and policy analysis regardless, and we test whether the premise of the categorical test — typically low penetration or low adoption — is supported by independent evidence. Where a project asserts a penetration or adoption figure without disclosing its source or scope, we say so. Because scale thresholds apply at the level of the individual project activity, several micro- or small-scale activities within a programme may each claim automatic additionality even where the programme as a whole operates at a scale that would require full testing; we do not regard this as best practice, and we consider additionality testing appropriate even where the methodology does not require it.

Two further parameters inform our view.

Location. Location is a first-order determinant of common practice. At national level, the economic status of the country, average incomes and infrastructure quality shape barriers to accessing improved devices and clean water. Within countries, we find the likelihood of additionality is generally greater for rural than urban populations: carbon revenue may be the only financing route where there is no self-sustaining commercial market, awareness of the technology's benefits is lower, and infrastructure for cleaner cooking, electricity and clean water tends to be prioritised in urban areas

regardless of carbon finance. Higher incomes and education levels, concentrated in urban areas, are positively associated with adoption of improved devices. We draw on WHO data on primary fuel use at rural, urban and national levels, World Bank data on the urban and rural split of a population and on national income, census data and government reports.

Project technology. The quality, durability and efficiency of the technology distributed also bear on common practice. Technologies relying on less robust local materials such as mud, clay and dung may be less additional, since these materials are affordable to households and resemble traditional devices, increasing the likelihood that the household would have built or acquired an equivalent regardless of the project. Durable manufactured technologies typically must be purchased, and are correspondingly less likely to have been acquired absent the project. This is contextual, and in different regions the effectiveness and availability of a given technology differ.

The evidence base and the shape of the question differ by sub-sector:

- For **cookstoves**, we assess penetration of improved stoves and of clean cooking fuels among the relevant population, and the history of improved-stove programmes in the country, some of which are long-established and have distributed devices at very large scale.
- For **water**, the analysis is not one practice-penetration question but two. Household treatment practices co-exist and compete — boiling, filtration, chlorination, straining — so the question is which prevail in the project area and how heterogeneous they are between regions. Prior penetration of filtration technologies is the relevant analogue to improved-stove penetration.
- For **domestic biodigesters**, common practice requires its own diffusion history, independent of cooking fuel: household biogas has been promoted at national scale for decades in some markets, with periods of rapid growth, stagnation and renewed state investment. National installation counts and the direction of subsidy programmes are the primary evidence, and a shift of support from household-scale to industrial-scale systems is material to the counterfactual.
- For **domestic lighting**, we map the number and market share of off-grid solar distributors operating nationally, and the reach of donor and multilateral market-development programmes, since the off-grid lighting market in many geographies is well established and competitively served.
- For **residential heating and cooling**, we assess penetration of improved heating devices and of state-led mass deployment programmes, which in this sub-sector are frequently large, urban and explicitly air-quality motivated.

Risk is highest where the project technology or an equivalent is already widely available in the project region, adoption is rising independently of the project, and comparable non-carbon-financed programmes are operating; and lowest where the baseline practice is demonstrably dominant, adoption of alternatives is low and static, and no comparable programme exists.

We recognise the limits of this analysis. Project boundaries in this sector group are frequently national, while household technology use is strongly regional and differs sharply between rural and urban populations. Where a project's boundary is materially broader than the population it actually serves and it does not disclose where devices were distributed, we state that limitation and weigh national evidence accordingly rather than treating it as decisive.

Alternatives to the proposed project

This risk driver addresses the most likely counterfactual scenario — regardless of the baseline scenario the project has selected — and asks whether that counterfactual would involve household technology and fuel use emitting more than the project scenario. If so, this implies additionality. Our assessment has three components.

Likelihood of autonomous transition. We assess the likelihood that the target population would continue to rely on emissions-intensive practices absent the project, against the likelihood that it would transition to cleaner or more efficient technology anyway. Populations with high and rising primary reliance on improved devices, or on cleaner fuels such as LPG and electricity, are more likely to transition independently of carbon finance, driven by exogenous factors such as improving access and rising incomes. Populations with consistently high reliance on traditional technologies and polluting fuels face greater barriers, indicating that carbon finance may be necessary. Because the transition is dynamic, we evaluate it across the rated vintages rather than at the point of registration, in contrast to the point-in-time assessments often performed for accreditation.

Baseline technology and fuel. For a project to be additional it must address the technology and fuel actually in use by the targeted end users. Where the project targets a baseline fuel or technology that most targeted end users do not use, the project may be less additional, since the project technology or an equivalent may already be in use. Mixed baselines are the norm rather than the exception: households commonly use multiple fuels for different tasks, and a static single-fuel baseline applied across a long crediting period is frequently at odds with the evidence. Where the stated baseline is unrepresentative, additionality risk is elevated, and the same finding carries into our carbon accounting assessment of the baseline scenario.

First-of-a-kind claims. Where a project asserts that its activities are first-of-a-kind in the region or at the scale of the intended greenhouse gas impact, we test that claim against global datasets, government programmes, and interventions by charities and non-governmental organisations. Genuinely first-of-a-kind activities tend to support additionality, since barriers to implementation absent carbon finance were likely material; claims that do not survive contact with the historical record weaken the project's case.

Sub-sector nuances are material to the counterfactual:

- For **water** projects, the counterfactual concerns the water source as well as the treatment practice. The analysis separates *access* to an improved water source from the *safety* of the water that source delivers: rising access does not consistently eliminate the need for household-level treatment, and the deciding evidence is compliance with national drinking-water quality standards rather than access statistics alone. Where an improved source exists but does not reliably deliver water safe to drink untreated, household treatment retains its counterfactual role; where source water is safe and reliably supplied, additionality risk is elevated.
- For **domestic biodigesters**, the counterfactual is shaped by feedstock and livestock ownership as much as by fuel markets. Households require sufficient livestock and manure, and sufficient water, to operate a digester at all, and shocks to livestock populations — disease outbreaks being the clearest example — act as systemic barriers to sustained operation. The relevant baseline is also dual: both a domestic fuel baseline and a manure management baseline.

- For **domestic lighting**, the question is whether grid arrival or grid extension would have displaced fuel-based lighting within the crediting period regardless of the project, and whether households already grid-connected but subject to frequent outages form part of the target population.
- For **residential heating and cooling**, the heating fuel mix must be established separately from the cooking fuel mix, since the two frequently differ and heating transitions more slowly. A fuel used only to start a fire, with a different fuel sustaining it, is not the heating fuel and should not be treated as one.

Our conclusion ranges from a finding that the targeted population was already transitioning to equivalent technology on its own trajectory, with no verifiable evidence that the baseline practice would have persisted absent carbon finance, through to positive and specific evidence that the baseline practice was dominant, static, and unlikely to change over the crediting period.

Project effectiveness

The extent to which project activities are effectively implemented is a component of our additionality assessment for Household Devices projects, and applies to ex post ratings. If devices have not been adopted, retained and used as intended, then it is unlikely that the project has had an additional impact beyond a without-project scenario. This driver is material in this sector group because the intervention operates through household technology choice and behaviour: distribution is a necessary but not sufficient condition for an emission reduction.

Our objective is to determine whether the project has, in practice, delivered the intervention it set out to deliver. We assess evidence of adoption and sustained use; of after-sales service, maintenance, spare-part provision and technician training where the technology requires them; of user education and awareness activity, and its reach; and of the project's own response where its monitoring, or third-party research, has identified ineffective implementation in an earlier period. Where a project has identified a problem in one crediting period and demonstrably addressed it in the next — for example by funding usage-compliance campaigns after external research found widespread non-compliance with operating instructions — that is reflected in a vintage-differentiated view rather than a single project-level conclusion.

Effective implementation looks different by sub-sector: for **biodigesters** it means digesters still operating and serviced; for **lighting**, devices still functional and in use, with warranty and repair channels available; for **water**, devices still in place and used as the household's treatment method; for **heating**, appliances operated correctly across a full season rather than a single meal.

Risk is highest where evidence indicates devices were distributed but not adopted, or were adopted and then abandoned, with no project response; and lowest where sustained adoption is corroborated by evidence independent of the project's own reporting, and where the project has demonstrably acted on problems it identified.

Financial analysis

Prior consideration of carbon finance

Our objective is to determine whether carbon finance was contemplated before implementation began, and whether the project's activities were already underway, and already commercially viable, before carbon revenue entered.

This risk driver is material for Household Devices projects because many project proponents are established commercial distributors of the device in question. Where a distributor was already operating at scale, across multiple markets, before registration, the analysis addresses what carbon revenue changed: whether it enabled entry into markets or customer segments that were not commercially viable, or whether it supplemented the economics of a business that was already running. Relevant evidence includes the proponent's operating history and geographic reach before and after registration, the date at which carbon finance was first contemplated relative to first distribution, and whether the areas and customer segments served changed once carbon revenue was available.

Risk is highest where a project's activities and geography are indistinguishable before and after carbon finance; and lowest where carbon revenue demonstrably opened a market segment that the proponent's own commercial model could not reach.

Investment analysis

Our objective is to determine whether the project's implementation depends on carbon finance. If the project's activities are financially attractive in the absence of carbon finance, then it is reasonable to assume that the project is not reliant on carbon finance, and the project is unlikely to be additional.

For Household Devices projects the analysis is framed around the **unit economics of the device and the role of carbon revenue within them**. Constructing this comparison requires the cost to manufacture, import and distribute the device; the price at which it is supplied to the end user, and whether that price sits at, below or above cost; the payment structure where instalment or pay-as-you-go financing is used; the incremental costs of carbon project development, including registration and monitoring, reporting and verification; carbon revenue based on the project's achieved or targeted credit price; and any other revenues, including grants, donor funding and government subsidy. Where a project bundles more than one product tier — a single lamp versus a multi-light system, or a digester supplied together with a stove — each tier carries its own economics and is assessed separately.

Investment analysis should demonstrate how carbon revenues overcome the barriers the project identifies: subsidising the device to reach lower-income households, funding awareness and education campaigns, building local manufacturing and supply chains, or funding maintenance and after-sales service. Where a project discloses the allocation of carbon revenue across those uses over time, we can assess directly whether the barriers it claims to address are in fact being addressed.

Market longevity forms part of this assessment. Creating a sustainable market for improved technologies is fundamental to attaining long-term emission reductions in this sector group. Projects following a donor-led approach of simple dissemination without follow-up tend to be less successful over time than projects providing follow-up visits, maintenance programmes and durable supply and distribution channels. Projects that build such channels may have increased additionality; the same evidence reduces carbon accounting risk by supporting device functionality, and we record the finding in both risk factors without double-counting it. This is particularly consequential for **biodigesters**, whose continued operation depends on a funded service model, and for **lighting**, where warranty coverage and repair channels determine whether devices remain in service.

We are explicit about the limitations of this work. Most projects in this sector group do not transparently document an investment analysis at all, and rarely disclose the quantum of carbon finance applied to any particular barrier. Where the role of carbon finance cannot be assessed on disclosed evidence, we treat that uncertainty as a risk rather than resolving it in the project's favour, and we confine ourselves to a directional conclusion.

Risk is highest where the project appears able to operate as a conventional commercial business on device revenue alone, with no disclosed alternative use of carbon finance; and lowest where the device is supplied free or heavily subsidised to a population that demonstrably could not afford it, and the project discloses how carbon revenue funds that subsidy and the activities supporting it.

Barrier analysis

Our objective is to determine which barriers prevented the target population from adopting the technology absent the project, and whether carbon finance was used to remove them. Barrier analysis is a central driver for Household Devices projects, because the obstacles to household adoption are not only financial. Projects that use carbon finance to overcome one or more genuine barriers may have improved additionality.

Financial barriers. For the majority of projects in this sector group, the largest barrier is a lack of available income for users to purchase the technology, especially in low-income rural areas. We assess average household income and poverty levels in the project region, drawn from national datasets and government reports, against the price at which the device is supplied and the willingness to pay evidenced in peer-reviewed literature and industry reports. Projects supplying technologies free of cost or heavily subsidised tend to have higher additionality, as there is a lower likelihood that households would purchase them outright. Projects that do not subsidise and require the end user to purchase at full retail price tend to have lower additionality, suggesting either that financial barriers do not exist or that they have not been surmounted — particularly where the retail price is high relative to local affordability, which suggests either that the barrier persists unaddressed or that the population actually served is not the population targeted. We note that free distribution is not unambiguously favourable: it supports additionality but is associated with lower sustained usage, which is a carbon accounting risk, and the two findings are recorded in their respective risk factors. Where instalment or pay-as-you-go financing is used, the analysis addresses whether the structure genuinely removes the affordability barrier or defers it.

Operational barriers. These vary greatly by technology and geography. Fuel-switch technologies may face limited availability or distribution of the new fuel, which can be a severe constraint in markets where that fuel has no established supply chain; improved-efficiency devices retaining the baseline fuel avoid that constraint but may face distribution barriers arising from poor transport infrastructure. For **biodigesters** the operational barrier is ongoing rather than upfront: limited technical support, inadequate follow-up maintenance and insufficient user knowledge of correct operation are recurring constraints, and the existence of a funded after-sales service model — safety and performance checks, user advisory services, spare parts, certified technicians — is directly relevant to whether the barrier has been overcome. For **water** infrastructure delivery models, the operational barrier is the construction and continued operation of the asset itself.

Social barriers. Awareness of the technology and its benefits, knowledge of how to use it correctly, and cultural acceptability. Projects may introduce technologies into communities with little prior consumer experience of them, which can produce poor uptake or incorrect use that erodes the

device's efficiency in practice. Activities addressing these barriers include marketing campaigns, radio and television advertising, community events, local-language materials and educational workshops. Disclosure of how carbon finance funds these activities, and of the number of people reached, is material; projects that are not transparent about how they address social barriers incur greater risk.

Technical barriers. Safety, durability and maintenance requirements vary greatly across the sector group. For cookstoves, design factors bearing on long-term adoption include base material, mobility, weight, size and protection from weather. For water projects, requirements range from individual filters and straws through to boreholes and desalination plants, with correspondingly different durability profiles; the brittleness and breakage risk of particular filter media is a documented constraint. For lighting, device lifetime, battery degradation and adherence to recognised off-grid product quality standards are the analogous considerations. For biodigesters, construction quality is the dominant technical variable, particularly where digesters are self-built from low-cost materials. We assess these barriers in the context of carbon finance, as they affect the long-term viability and additionality of the project, rather than solely as a matter of end-user experience.

Risk is highest where no material barrier can be identified, or where identified barriers persist unaddressed despite carbon revenue; and lowest where genuine barriers are evidenced, carbon finance is demonstrably applied to them, and adoption evidence indicates they were overcome.

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 supporting the project activity 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.

Policy support is a material risk driver in this sector group, because clean cooking, household air quality and clean water sit high on government and multilateral agendas in most of the geographies where these projects operate. Our approach focuses on those policies which directly bear on household technology and fuel choice, or on the delivery of the relevant service. Broader policy considerations are addressed in our overarching rating methodology and, where they affect double counting, through the separate assessment of that risk described there.

Our analysis has four components.

Government schemes and major policies. We identify government schemes, national programmes and multilateral or donor initiatives related to the project activity, using our internal policy database and primary research. Household device programmes have long histories in many markets, and successive national programmes may have distributed devices at very large scale before the project began. Instruments relevant here include distribution and subsidy programmes, fuel-price subsidies, fuel bans, electricity tariff interventions, product standards, and building energy performance requirements. Where similar activities were being delivered through government-funded or donor-funded programmes, additionality risk is elevated. We also analyse how successful the policy or initiative has been: if it is deemed to have been successful, based on whether targets have been

achieved, this suggests high risk to additionality, whereas an ineffective policy favours project additionality.

Effectiveness. The existence of a supportive policy is not sufficient; what matters is whether it works. We evaluate the effectiveness of government policies at national, regional and local level, encompassing the presence of well-defined and comprehensive legislative frameworks, and the implementation, enforcement and overall effectiveness of policy regulations and initiatives, contextualised with independent measures of government effectiveness. Where activities are effectively supported or mandated by policy in a jurisdiction where policy is effective, additionality risk is high. Where supportive programmes exist but have demonstrably failed to deliver, risk is tempered. Risk is lowest where no supporting programmes exist and existing policy actively hinders project activities.

Regulatory surplus. We interrogate whether existing laws, regulations, statutes, legal rulings or other regulatory frameworks require the implementation of project activities, directly or indirectly. In this sector group this typically involves regulations relating to clean cooking, household fuel use, air quality, water sanitation, building energy performance, and product quality standards. Where regulations mandate project activities in combination with high levels of government effectiveness, additionality risk is elevated.

Wider policy and market backdrop. We consider the national climate and green investment landscape, including tax relief, grants and subsidy mechanisms available to projects or to end users, the market potential for household devices projects in the country, and the direction of state investment; the host country's Nationally Determined Contribution, and specifically any targets and initiatives bearing on residential energy use, clean cooking or water; the government's interaction with the carbon market, including the extent of its participation domestically and internationally, the alignment of that participation with international standards, and the robustness of its monitoring, reporting and verification arrangements; and the country's national classification, which informs the barriers project activities plausibly face — we would typically consider less risk to be associated with Least Developed Countries, and greater risk with high-income countries where alternatives to carbon finance are more likely to exist.

Sub-sector nuances are material. For **biodigesters**, national domestic-biogas construction programmes have their own subsidy histories, distinct from cookstove programmes, and the distributional evidence matters: where subsidy schemes have been captured by wealthier households while lower-income households remained unable to meet the residual cost, a project serving the latter may retain additionality notwithstanding an apparently supportive policy environment. For **residential heating and cooling**, the relevant policy is often macro and air-quality-driven — raw fuel bans, briquette subsidies, subsidised night-time electricity tariffs, national commitments to fuel conversion — and may point away from device efficiency and towards fuel switching, which changes the counterfactual for an efficiency project. For **lighting**, the relevant instruments are national electrification policy and dedicated off-grid solar funds, and the absence of binding national adoption mandates reduces regulatory-surplus risk. For **water**, national rural water strategies and investment targets must be assessed against the implementation gap between coverage and compliance with drinking-water quality standards.

Policy language is frequently obtuse, and the practical significance of a given instrument to an individual household is often not evident from its text. Each policy identified is therefore assessed with

input from analysts with experience of the relevant jurisdiction, and we are explicit where a policy's status or effect on household technology choice is uncertain.

Carbon Accounting

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

Table 3 sets out the risk drivers within our assessment of carbon accounting.

Table 3. Sub-components of our carbon accounting 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 emission reduction calculation as the project has constructed it: the baseline emissions implied by the assumed baseline device, fuel and consumption; the project emissions implied by the project device, its efficiency and its assumed level of use; the parameters applied to convert fuel quantities into greenhouse gas emissions; and the adjustments applied for usage, stacking, physical leakage and leakage. Because emission reductions in this sector group are typically the product of a chain of independently estimated parameters, rather than a single measured stock change, the structure matters, for example, an error in one multiplicative parameter propagates through the whole calculation.

Separately, we construct the equivalent quantities 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 device use, of a conversion parameter, or of the appropriate leakage deduction, we quantify the emission reductions that our own assumptions would imply, and arrive at a BeZero view of net emission 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.

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 — the use of a superseded parameter, for instance, frequently works in the project's

disfavour, and we say so. Second, non-trivial assumptions are sometimes unavoidable. 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 examine the accuracy or conservativness of the assumed, estimated or calculated emissions in the project's applied baseline scenario. This is a major risk driver for Household Devices projects, and typically among the most consequential components of the carbon accounting assessment.

We begin by establishing what the project's baseline represents and how it was determined. Baseline setting varies materially between methodologies, and the baseline is built from several independently estimated parameters.

Baseline fuel consumption. Projects estimate baseline consumption in several ways: combining device thermal efficiency with assumed useful energy demand; surveys of household consumption; in-situ measurement through Kitchen Performance Tests (KPTs) or Controlled Cooking Tests (CCTs); or literature and national default values. These approaches are not equivalent. Methods deriving consumption from assumed efficiencies and fixed ratios do not measure fuel use at all and may not reflect reality. National defaults may not capture regional variation. CCTs and KPTs are conducted in situ and are more likely to reflect performance under local conditions, but remain subject to external variables including household size and income, wood availability, climate, and the presence of observers. We compare project-reported values against government reports, peer-reviewed literature and standardised baselines where they exist. A higher baseline consumption assumption produces higher estimated emission reductions, and therefore carries accounting risk.

Suppressed demand. Particularly for projects in the Water sub-sector, the baseline may be constructed on a suppressed demand basis. Where project beneficiaries are deprived of a reasonable level of human development needs, suppressed demand permits the baseline to correspond to a hypothetical satisfied demand level rather than to the pre-project situation: the assumption is that more households would boil water in the baseline scenario if they had the means to acquire fuel to do so, and that their use of the project technology should therefore be incorporated into emission reductions. There is a sound development rationale for the concept — without it, under-developed regions that have historically emitted less would have to increase emissions before they could raise carbon revenue, which is an undesirable pathway. But it creates clear scope for over-crediting, because emission reductions are claimed in respect of households that did not previously boil or otherwise treat water, meaning no woody biomass has been saved and no emissions avoided. Our assessment establishes what proportion of the target population conducted the baseline activity before the project, using independent household survey and census evidence rather than project assertion alone; the extent to which the baseline relies on a suppressed demand assumption, and whether that extent is disclosed at all; and whether the assumed satisfied-demand level is plausible for the population and period in question.

Sub-sector specific baseline analysis. The baseline question differs materially by sub-sector, and in four cases requires its own treatment:

- **Water.** Baseline emissions rest on two stacked assumptions: reliance on biomass or other polluting fuel for boiling, and the prevalence of boiling itself. Both require independent verification and both vary regionally within a single country. Additional parameters include household size and water consumption per person per day, with the further nuance that not all household water consumption requires treatment — water consumed outside the home, or already boiled in preparing hot beverages, does not represent additional avoided fuel use. The choice of baseline fuel emission factor requires its own scrutiny where more than one fuel could plausibly be displaced.
- **Domestic biodigesters.** The baseline is dual. Alongside a domestic fuel baseline, digester projects claim reductions against a **manure management baseline** — methane that would otherwise be released from uncontrolled or anaerobic storage of animal waste, typically open pits. This requires the baseline storage system, its retention period and its climatic context to be established, since these determine the methane conversion factor applied. The two baselines are quantified separately and carry different risks.
- **Residential heating and cooling.** Heating fuel use must be disaggregated from cooking fuel use. Baseline consumption is anchored to a defined **heating season** rather than to year-round use, which makes seasonality a first-order baseline parameter rather than a monitoring detail, and raises the question of whether out-of-season use is occurring and accounted for. Dwelling typology and building fabric are material stratifiers, since heat retention and therefore fuel demand differ structurally between building types.
- **Domestic lighting.** The baseline is fuel-based lighting, and the central parameters are the baseline lamp type, its hourly fuel consumption, its daily hours of use, and the emission factor of the fuel. Lamp type materially affects consumption rate, so an undocumented baseline lamp type undermines the verifiability of the whole calculation. Where a single project device is credited against more than one displaced baseline lamp, that replacement ratio requires independent support from baseline survey evidence on household lamp ownership. Households with grid connections that use the project device only during outages are poorly represented by a full-displacement baseline default.

Where the project's baseline implies greater emissions than our counterfactual, the project is likely over-crediting, and we characterise the extent of that overestimation in proportion to the difference between the two. Where the project's baseline is consistent with our counterfactual, we state that the baseline is appropriate and quantification of an alternative is unnecessary.

Several limitations bear on this analysis and are disclosed where they apply. Our ability to construct a robust counterfactual depends on the granularity of disclosed distribution locations and on the availability of sub-national household survey data. Where a project's boundary is national and its distribution undisclosed, we are comparing a project-specific claim against national-average evidence, and we say so.

Project scenario

Our objective is to assess the accuracy of the emissions quantification and the level of device use claimed in the project scenario. In this sector group the project scenario, not the baseline alone, is where the largest quantum of unsupported issuance typically arises, because emission reductions are conditional on devices being adopted, functional and used as intended over the crediting period.

Project fuel consumption and device performance. KPTs and CCTs can be used to determine project-scenario fuel consumption, and projects may alternatively rely on the thermal efficiencies of baseline and project devices. As above, methods deriving consumption from assumed efficiencies depend on fixed ratios that may not reflect reality, so in-situ measurement is the more robust approach, though not without uncertainty: household size, climatic conditions, income and compliance of device use all generate variance, particularly where a project applies a static value across all households. Water Boiling Tests (WBTs), commonly used to establish thermal efficiency, are conducted in laboratory settings and may not reflect household conditions; because project device efficiency can be used to estimate both baseline and project consumption, an overstated efficiency can inflate claimed reductions at both ends of the calculation. We assess reported efficiencies against peer-reviewed literature, industry reports, and reported efficiencies for the same or comparable device models tested elsewhere, and we consider the conditions of actual use — outdoor cooking, exposure to wind and rain, and device age all bear on real-world performance. Baseline device efficiency defaults are assessed in the same way, and we note where methodological defaults diverge from published evidence and from more recent recommendations by standard setters.

Efficiency losses over time. Device efficiency declines with age. Methodologies permit projects to monitor efficiency directly, to apply a default schedule of decline to a terminal efficiency, to apply a default annual loss factor, or to rely on manufacturer guidance, literature or industry standards. We assess which approach has been applied, whether it is supported, and whether reported trends are plausible: efficiency reported as increasing over a device's life, or as varying between monitoring periods without explanation, requires scrutiny — particularly where efficiency is sampled at programme level across many device models but applied to a project activity deploying only a few. The analogous degradation parameter for lighting is battery capacity loss.

Usage, adoption and functionality. Reported usage rates in this sector group are consistently high, while the peer-reviewed evidence points to adoption declining over time as devices break, fail to meet user needs, or prove unsuited to local practice. High usage is not inherently implausible — it can indicate a project that has genuinely met user needs — but it is highly context dependent and we assess it against the evidence rather than accepting it as reported. Three distinct questions sit inside this analysis, and conflating them is a common source of overstatement: whether the household possesses the device, whether the device is functional, and whether it is used, and at what intensity. A survey instrument establishing only possession, or establishing functionality through a single binary question, cannot support a quantitative usage parameter. Barriers to sustained use recur: cultural fit, including the ability to cook traditional dishes or cater for large households; lack of training on correct operation; and durability and maintenance, including the availability of repair channels, missing or broken parts, and user modification of the device. Delivery model matters and cuts against additionality: where devices are distributed free, sustained usage tends to be lower, since end users may value the device less and have fewer resources for support and maintenance.

Sub-sector nuances: for biodigesters the analogous parameter is digester functionality — the proportion of installed units still operating — assessed as its own line item, separately from fuel-switching behaviour, and benchmarked against the published evidence on operational decline in household biogas systems; for water devices, the fraction of functional units, with device breakage and the absence of monitoring for broken or abandoned devices as the technology-specific risks; for lighting, device functionality, battery degradation, hours of use, and attrition of dropped or decommissioned devices, and whether a default full-usage assumption applied for a period after

distribution can be verified by the monitoring instrument at all; for residential heating and cooling, usage stratified by dwelling type and bounded by season.

Stacking and partial displacement. Stove stacking — the concurrent use of multiple devices or fuels — is common in the regions undergoing energy transitions where these projects operate, and means the baseline technology has not been fully displaced, so project-scenario emissions are higher than assumed. Devices with a single cooking surface are frequently insufficient for larger households; devices designed to retain heat within a combustion chamber provide less radiant warmth, prompting continued use of open fires for space heating; and where the project device is unsuited to particular dishes, the baseline device is retained for those. Our assessment covers both the robustness of monitoring for stacking — paired in-situ testing versus survey self-report, sample size, stratification, frequency and seasonality — and the measures the project has in place to mitigate it, such as removal of baseline devices. Where a project reports that end users retained baseline devices but makes no deduction for their continued use, that is a quantifiable accounting gap. Analogous partial-displacement risks arise across the sector group: lighting devices used as a complementary rather than substitute light source; water households that continue to boil in addition to using the treatment device; biogas households that revert to solid fuels in cold periods, when heating demand rises and biogas production falls; and heating projects where a single appliance served both cooking and heating in the baseline, so displacing it for heating does not displace it for cooking.

Monitoring and sampling. Because every parameter above is established by sampling a small fraction of a large distributed population, sampling design is central to our assessment rather than incidental to it.

- *Sample size.* Surveying is costly and projects have an incentive to sample the minimum permitted. Methodologies set the confidence and precision requirements that determine sample size, and permit lower confidence levels for more frequent sampling. We find no justification for the lower of the permitted confidence levels: the social and environmental sciences adopt a higher minimum, which increases precision and reduces error propagation, and the lower level is generally appropriate only for small populations with minimal variance. Given the very large populations across which these programmes operate, we assess the sampled fraction relative to the distributed population and treat low sampling rates as increasing uncertainty in every parameter derived from them.
- *Stratification.* A majority of projects in this sector group operate at national scale, distributing devices across multiple demographics; even locally scoped projects encounter end-user populations with distinct characteristics affecting adoption. Best practice is a stratified design capturing that heterogeneity. Where a project assumes a homogeneous population, or samples only a subset of the districts in which it distributed devices, parameters derived from that sample are unlikely to represent the whole, and we assess the direction of the resulting bias where the evidence permits. Relevant stratifiers vary: poverty and rural or urban status for cookstoves and water; dwelling type for heating; livestock holding and productivity system for biodigesters; device tier for lighting.
- *Survey method.* In-person surveys are more robust than remote methods, since enumerators can inspect the device, photograph it, and corroborate reported use; telephone interviews leave room for inaccuracy with no physical verification. Question design matters: the sector group is particularly vulnerable to recall bias, which specific and time-anchored questions mitigate better than open-ended ones, and to social desirability bias, including the Hawthorne effect, which tends to inflate reported use of a socially desirable technology. Methodologies

differ widely in what they require, from a single question on continued use through to mandatory kitchen observation, interviews with the primary cook, photographs of the cooking area and GPS coordinates. Triangulation across methods provides an additional layer of validation, and publicly disclosed supporting evidence adds transparency.

- *Survey frequency.* Adoption typically declines over time and disadoption can occur at any point after distribution. More frequent sampling tracks if and when devices fall out of use; infrequent sampling extrapolates an early observation across a period in which the underlying parameter has moved.
- *Seasonality.* Seasonal patterns affect both fuel use and device use. Some devices cannot burn wet or cold fuel, or take longer to heat, prompting reversion to baseline devices; cooking habits change with the seasons; heating demand and biogas production both vary with temperature. Monitoring conducted in a single season may not represent the year. For residential heating the crediting period is itself season-bounded, and for biodigesters production and stacking are both seasonal.

Project emissions. Where the project scenario involves combustion of a project fuel, those emissions are accounted for using the relevant emission factors. Two sub-sector-specific sources require particular attention. **Physical methane leakage from digesters**: household digesters, particularly where self-built from low-cost materials to non-standardised designs, can vent or leak methane directly, so the project technology is itself emitting and offsetting the reductions claimed; methodologies permit a default deduction, and we assess whether it is commensurate with the published range and whether construction quality, standardisation and installation by trained technicians support the value applied. **Manufacture, import and distribution emissions**: generally minor but non-zero, and their exclusion is non-conservative; local manufacture and sourcing reduce them.

Risk is lowest where device performance, usage and stacking are established by robust, well-stratified, in-situ monitoring at a meaningful sampling rate, and where reported parameters are consistent with independent evidence; and highest where a high usage rate rests on a minimal sample, a binary survey question and an assumption of population homogeneity, with no deduction for retained baseline devices.

GHG conversions

This risk driver addresses the parameters that convert fuel quantities and waste volumes into greenhouse gas emissions. Individually these are technical; collectively they can move claimed issuance substantially, and because they are multiplicative, errors compound.

Fraction of non-renewable biomass (fNRB). For projects with a biomass baseline, net reductions are realised only to the extent that the biomass saved is non-renewable. Where an area is harvested at a rate exceeding its annual growth, the harvest is non-renewable and produces a net decline in biomass stocks; where harvest does not exceed growth, regrowth offsets the emissions from combustion and there is no net climate impact. Projects therefore apply an fNRB value representing the proportion of wood harvested that would not naturally regenerate.

Calculating fNRB is difficult and is a recurring source of accounting risk. The country-specific defaults on which the sector once relied have expired and are no longer permitted for CDM projects; projects now apply either a global default value or calculate fNRB using the CDM's TOOL30. We note that for projects rated by BeZero, fNRB values remain high even with the use of TOOL30. Our bottom-up

analysis interrogates the quality of the data sources used, and the inputs and assumptions applied, to assess whether the claimed value is appropriate and conservative.

We also apply BeZero's implementation of the **MoFuss (Modelling Fuelwood Savings Scenarios)** spatial model. MoFuss takes a bottom-up, spatially explicit approach, allowing fNRB to be estimated for sub-national administrative areas — states, provinces and districts — and incorporating current global datasets on growth rates and land cover change. This matters because fNRB derived from national assumptions can conceal wide sub-national variation in harvest pressure and regrowth, and projects with national boundaries frequently apply a single national value to distribution that is geographically concentrated. Where our spatial analysis indicates that the appropriate value for the areas actually served differs materially from the value applied, we quantify the effect on claimed issuance.

Emission factors. Emission factors convert fuel use into greenhouse gas emissions and are required for each fuel in both the baseline and project scenarios. Most projects in this sector group draw on the IPCC Guidelines for National Greenhouse Gas Inventories. Our assessment considers whether the project has applied the most recently published appropriate values, and whether national inventory reports or peer-reviewed literature indicate country- or fuel-grade-specific factors that differ from the defaults applied — factors differ across coal grades, and between charcoal and the wood from which it was produced. Where the applicable factor is lower than the one used, accounting risk is elevated; where it is higher, the project's approach is conservative and we say so. Where a project displaces or consumes grid electricity, the applicable grid emission factor and its vintage become material, and the direction of the resulting risk depends on whether electricity is displaced or consumed.

Fuelwood-to-charcoal conversion. Projects with charcoal in the baseline or project scenario apply a conversion factor determining how much firewood is required to produce a given weight of charcoal. The default applied by most projects in the VCM has recently been revised downwards. A higher conversion factor implies more firewood consumed in the baseline and therefore higher baseline emissions. The ratio is highly dependent on regional conditions and on kiln technology and efficiency, and methodologies permit projects to calculate it or draw on literature. We compare the value applied against the published evidence for the relevant region and production method.

Digester and manure parameters. Biodigester projects rely on a distinct set of conversion parameters, most drawn from IPCC defaults and occasionally calculated by the project: global warming potentials, methane conversion factors, volatile solids factors, and methane production potential. Volatile solids excretion requires stratification by livestock type and productivity system. Methane conversion factors are specific to climatic region and to manure storage duration, so the actual retention period in the baseline storage system must be established rather than assumed. Global warming potential is particularly consequential for a methane-destruction project, and we assess whether the value applied corresponds to the IPCC assessment cycle in force for the crediting period, noting that the use of a superseded value is frequently conservative rather than aggressive.

Risk is lowest where every conversion parameter is current, regionally appropriate, and consistent with published evidence, or is conservative relative to it; and highest where a national or global default conceals material sub-national variation, as with fNRB in a geographically concentrated project, or where superseded values inflate the reduction claimed.

Leakage accounting

Leakage occurs where emissions avoided by a project are pushed outside the project boundary. Household devices projects typically face limited leakage risk, since they are not exposed to the activity displacement and market dynamics that arise where a project constrains supply of a land-based commodity. It is not, however, negligible, and within the non-nature-based sector groups Household Devices carries somewhat higher leakage risk than sector groups with no displaceable activity at all.

Some methodologies apply a **default leakage discount factor**, deducting a fixed proportion of total emission reductions to account for non-renewable woody biomass consumed by non-project households as a consequence of fuelwood savings within the project boundary. Projects may either determine their own deduction through monitoring or apply the methodological default. We find the default helps temper leakage risk as a conservative measure, but it substitutes for a project-specific assessment rather than constituting one, and a calculated deduction reflecting regional conditions is more informative. Projects that apply no deduction at all, on an assumption of negligible leakage, face higher leakage risk unless that assumption is independently supported.

Activity displacement

Our objective is to determine whether the activity or the fuel displaced within the project boundary reappears outside it. If it does, activity displacement is likely occurring, and the project is over-crediting to the extent that this is unaccounted for.

Baseline device reuse and resale. Where baseline devices are not removed from circulation, they may continue in use, be transferred within the household, or be sold on. Risk depends on the device: fixed baseline technologies such as three-stone fires and mud stoves, which make up the majority of baseline devices, have minimal market value and cannot readily be relocated, so reuse risk is low; portable devices, manufactured stoves, and devices with residual resale value carry greater risk. For distribution models where the displaced device is not surrendered — common in lighting and water device programmes — the presence or absence of a buy-back, collection or disposal arrangement is the relevant control, and we assess whether the project has one and whether evidence indicates baseline devices were in fact retired.

Other uses of the displaced device. Baseline devices frequently serve functions beyond the one the project addresses: space heating, lighting, and smoke as an insect repellent. Households in cold seasons or at high altitude may need heat that an efficient enclosed device does not radiate, and may therefore burn more fuel in the project device, acquire an additional device, or continue using an open fire. Where smoke serves a pest-control function, its removal may prompt substitution. We examine peer-reviewed literature to assess whether the areas a project targets are subject to heating requirements, whether the project accounts for continued device use for those purposes, and whether monitoring conducted outside the relevant season could have captured the effect at all. Projects rarely account for this form of leakage, though its effects are likely minimal in warm climates.

Rebound effects. Efficiency gains reduce the cost of the energy service, which can increase consumption of it — the Jevons paradox. Households realising fuel savings may use the device more, or purchase more fuel, particularly where fuel is also subsidised. In the limit this can absorb the whole of the intended reduction. Projects in this sector group do not generally account for rebound effects, which introduces leakage risk, and the effect is most likely to be material in heating applications, where the energy service is thermal comfort and baseline provision is often inadequate.

Upstream and downstream emissions. Manufacture and transport of project devices, addressed above as project emissions where they fall inside the boundary, constitute leakage where they fall outside it — most obviously where devices are manufactured in and imported from another country. Projects using local manufacturing companies and materials face lower risk.

Enteric emissions and bio-slurry. In the Domestic Biodigester sub-sector, digester capacity is designed around the manure available from the livestock a household owns. Where the availability of biogas creates an incentive to keep additional animals, additional enteric methane may be released outside the accounting boundary. We assess whether the livestock holding assumed by the project is typical for the project location, and whether the design capacity of the digester creates a genuine incentive to expand the herd — where the digester is sized to existing holdings and operates at optimal loading, that incentive is limited. Conversely, digestate exiting the digester is frequently applied to cropland as a fertiliser, displacing synthetic fertiliser and the emissions associated with its manufacture and use; where this occurs it is a source of positive leakage. We assess it where the evidence supports it, and note that positive leakage findings do not offset unquantified negative leakage elsewhere.

Risk is highest where displaced devices retain value and no collection or disposal arrangement exists, where the project region has documented heating or pest-control reliance on the baseline device, and where no deduction has been made; and lowest where baseline devices are immobile and valueless, the climate removes the space-heating channel, and a conservative deduction has been applied.

Market leakage

Market leakage occurs when project activities alter the supply and demand equilibrium for the displaced fuel, shifting market dynamics such that emissions avoided by a project are offset by consumption elsewhere. Reduced household demand for a traded fuel — charcoal, kerosene, coal, LPG — may lower its price and stimulate consumption by other users or in other end uses.

Fuel deficit. Our assessment takes into account any woodfuel deficit, whereby the biomass saved by project activities is used to satisfy fuel demand that is not otherwise being met. We examine peer-reviewed literature to identify whether the country or region in which the project operates has a documented discrepancy between demand and supply of fuel. Leakage risk may exist where demand outweighs supply and the likelihood of non-project end users obtaining the saved fuel is high.

Fungibility and market conditions. The effect is more likely to be material where the freed-up fuel is fungible across end uses, where it is traded at regional or national scale rather than gathered locally, and where the project operates at sufficient scale relative to the market to move it. For fuels with export markets, competing external demand for the same saved volume is a further channel.

Attributing market leakage to any individual project is extremely difficult. Our assessment therefore addresses whether any degree of market leakage is likely to be occurring as a result of project activities, whether the project has recognised it, and whether any deduction applied is sufficient to account for it. Conclusions that market leakage is negligible are reserved for cases where the evidence supports them, not assumed from the sector group.

Finally, we note an inverse relationship between additionality and leakage. Where a project is found to present high additionality risk, leakage risk is often low, since there is little activity to displace and little

impact on market supply and demand. In such cases we would generally consider a project's leakage deduction to be a conservative measure in carbon accounting terms.

Permanence

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

Our analysis considers the permanence of climate benefit as it relates to the contractual commitment of a given project and its credits. Within the Household Devices sector group, projects which reduce biomass use compared to the baseline scenario could face risk.

We acknowledge that Household Devices projects could ultimately lead to biomass growth in the project boundary which is not captured in carbon methodologies. However, the risk that areas of forest could be clear-cut due to other drivers of deforestation outweighs the potential benefits of biomass growth, in our view, given long growth timelines. Furthermore, as woodfuel collection is more closely associated with forest degradation, rather than deforestation, it is likely to have minimal impact upon total biomass growth and carbon stocks. Therefore, anthropogenic and natural forests could deplete biomass stocks where savings would have occurred due to project activities, and we consider this across the vintages which are being rated.

It is worth noting that monitoring is near impossible, particularly for projects operating across a national scale, and we acknowledge this in our assessment. Scale can be important, where evidence may point towards higher or lower risk in project boundaries which may be small. We also consider the fuel mix in the baseline, and this weighs into our analysis. For example, where the baseline is fossil fuels, risk is non-existent, given that there are no reversal risks.

Table 4. Sub-components of permanence assessed.

Risk factor	Risk driver category	Risk driver
Permanence	Technical risks	Carbon stock integrity

Technical risks

Carbon stock integrity

Carbon stock integrity refers to the relative permanence of the carbon stocks saved or sequestered by the project activity: where a project conserves carbon stored in an impermanent form, natural phenomena may reverse the benefit.

For most Household Devices projects, no carbon stock is conserved in a form that could reverse. Where the project activity captures and combusts methane, as in domestic biodigester projects, the abatement is realised at the point of combustion and is not capable of subsequent release. Where the activity displaces a fossil fuel — LPG, kerosene, coal — no biogenic stock is implicated at all.

The driver is therefore relevant principally to projects whose baseline is non-renewable biomass, where the notional stock saved is standing biomass whose harvest is avoided. Assessing that stock is a nuanced process carrying a much higher degree of uncertainty than for land-based projects, for reasons of disclosure rather than of ecology. It is rare for projects in this sector group to disclose the locations of participating households or of fuelwood collection sites, even at district or regional level, and project boundaries are frequently national. There is consequently no way to determine definitively which biomass resource supplies the baseline fuel, nor which trees are preserved by the project activity, and therefore no way to monitor whether the saved stock persists over the rated period. Where a project does disclose the biomass resource on which its baseline depends, we assess the credibility of that resource and any evidence of pressure on it.

Our assessment considers two main factors, being the anthropogenic and natural risks. Typically, anthropogenic risks pertain to expanding agriculture or logging, whilst natural impacts are forest fires or drought.

We acknowledge the potential for reversal of biomass preserved by fuel-avoidance projects. In the absence of data on the location of household-level fuelwood collection before and after a project, however, the permanence of those saved stocks cannot be monitored, and we assess this risk driver as low for Household Devices projects — a conclusion that reflects the nature of the activity and the limits of disclosure rather than positive evidence of durability. Where the biomass resource is identified and material pressure on it is evidenced, risk is higher.

Updates and reviews

Version number	Date	Description
1.00	07/07/23	Initial release
1.01	07/09/23	Format and structure updates
1.02	22/02/24	Content and format updates in response to Project Developer Forum and internal methodological improvements
1.03	03/10/24	Clarification on additionality as a limiting factor
1.04	07/11/24	Updates in response to developer feedback
2.0	04/03/25	Updated risk factor framework
3.0	27/10/26	Formatting updates, edits and revisions to align with ESMA regulatory requirements. Consolidated master Household Devices sector methodology, with sub-sector coverage extended across cookstoves, domestic biodigesters, domestic lighting, residential heating and cooling, and water.

Disclaimer

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