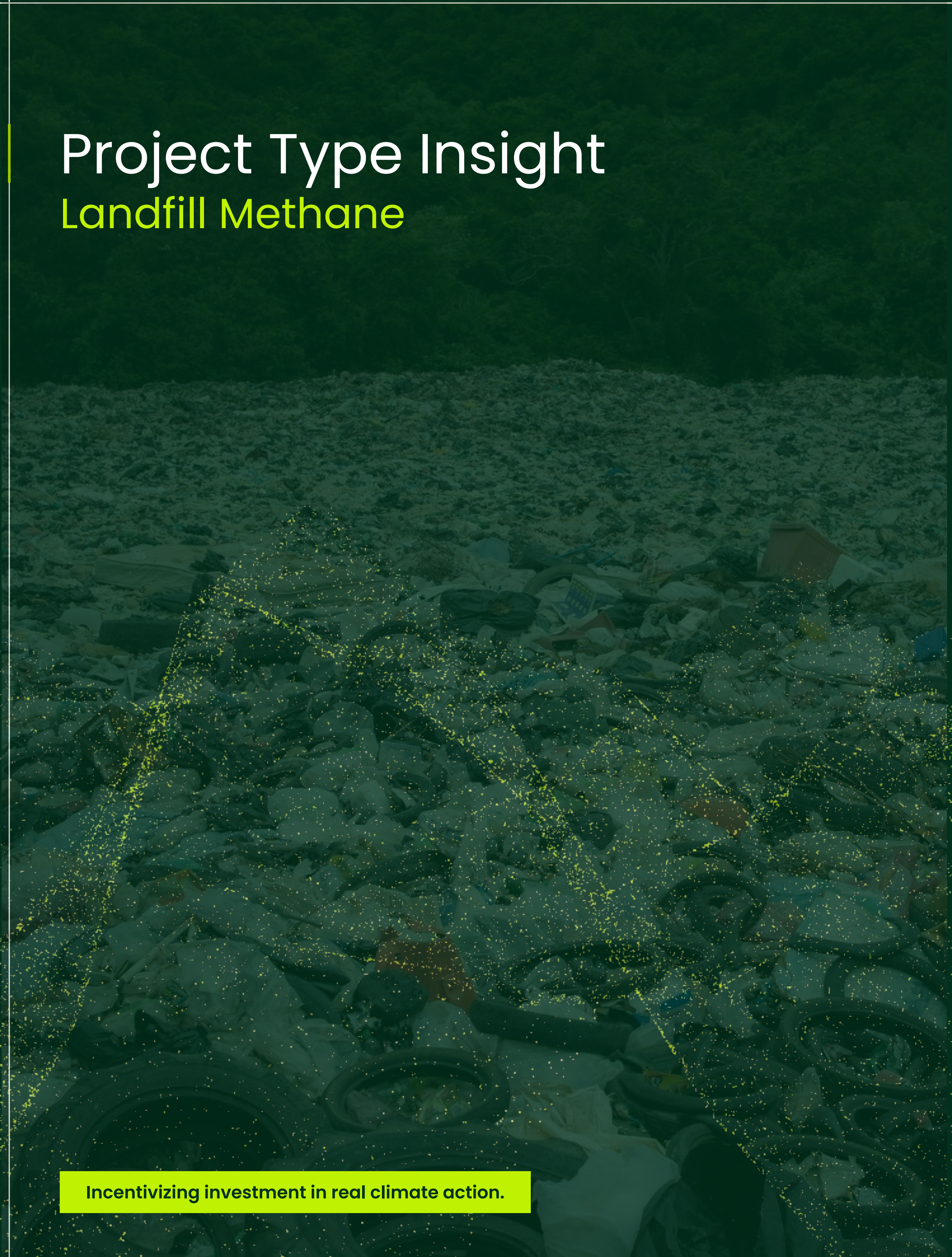
Project Type Insight
Landfill Methane



Incentivizing investment in real climate action.

Key Terms and Concepts

Key concepts and definitions

Landfill Methane (LFM) Projects	Landfill Methane is produced by landfills through decomposition by microorganisms, and is typically 50% methane and 50% CO2 (EPA, 2024). Landfill Methane projects collect this gas, with the purpose of preventing its release into the atmosphere, often either through flaring or energy production.
Baseline emissions	The emissions that would have been generated in absence of the project.
Carbon credit	A tradable unit representing one metric ton of carbon dioxide (CO_2), or an equivalent amount of another greenhouse gas (GHG), avoided or removed from Earth's atmosphere.
CNG Vehicle Fuel	Compressed Natural Gas (CNG) is primarily made up of methane, and can be used as a vehicle fuel.
Flaring Project Type	One method employed at Landfill Methane projects is the burning of captured Landfill Methane. This converts methane into CO2 and water, and is one of the major methods used by projects.
GWP	Global Warming Potential (GWP) values are metrics used to represent the amount of warming caused by emissions of specific gases, over a certain time period. These values are released periodically by the IPCC based on the latest climate science.
LFM Energy Project Type	One method employed at Landfill Methane projects is the creation of energy from burning of the Landfill Methane, and this is another major method used by projects..
MRV	MRV stands for Measurement, Reporting, and Verification in the context of carbon credits. It is a process used to assess and validate the emission reduction or removal activities of carbon offset projects.
Oxidation Factor	The oxidation factor (OX factor) represents the portion of methane that is consumed by methanotrophic microorganisms in the layer covering the landfill, therefore preventing this methane from being released from the landfill.
Over-crediting risk	This refers to the risk that the project has issued credits in excess of what is justifiable against the business as usual scenario.
Project emissions	Emissions associated with ongoing operations of the carbon credit project.
VCM	Voluntary Carbon Market where individuals and organizations can voluntarily purchase carbon credits to offset their own emissions and support projects that reduce greenhouse gas emissions or promote sustainable development.
Vintage	This refers to the year, or timeframe, in which the issued carbon credit was generated.

What is a Landfill Methane project?

Overview of Landfill Methane

When organic matter in landfill decomposes, methane (CH4) is emitted. Methane is dangerous to the local area (it is flammable) and the environment (it has a 27-30 X higher global warming effect than CO2). The quantity of methane gas generated is directly proportional to the organic waste content in the landfill.

Methane at landfills can be **flared,** where the gas is captured and combusted, converting methane into CO2 and water, meaning that the process has a lower global warming effect than if the methane was released into the atmosphere.

Methane can also be **converted into energy** through combustion and used in this way for electricity, heating, or fuel. This approach offers a dual climate benefit: it helps prevent landfill methane emissions and reduces the need for coal, oil, or natural gas that could otherwise be used for this energy supply.

In addition, landfill methane is a harmful pollutant. Capturing the gas improves health conditions and air quality in the surrounding area. Landfills often create unpleasant odors for nearby communities, but capturing and burning landfill gas, either for direct flaring or energy generation, significantly reduces these odors.

Landfill Methane Process

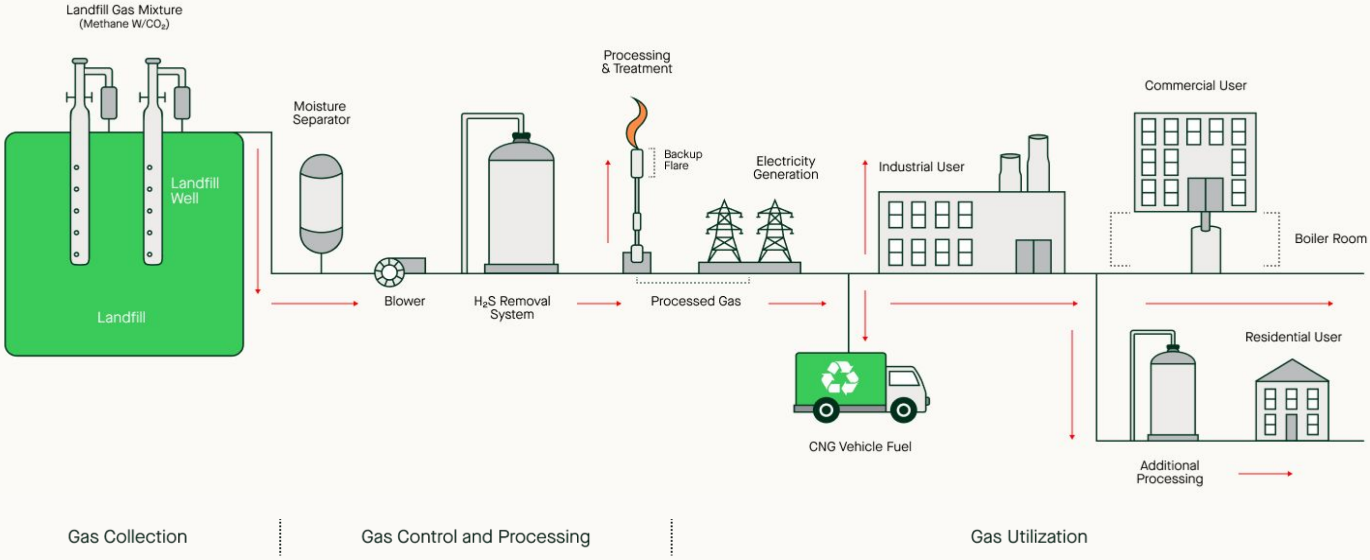


Figure 1: A diagram showing how a Landfill Methane project can operate

To capture methane, the base of the landfill is lined and the top is capped. Methane is then captured and transported through wells and pipes. **A landfill gas collection system can be implemented at any point throughout the landfill's operational period (when the landfill is established, or at any point after that, even when it reaches maximum capacity).** The methane is then either flared to convert it into CO2 and water, or it is burned for energy purposes. For example, this may be to supply electricity to the grid, or as CNG vehicle fuel, amongst other uses.

The majority of Landfill Methane projects are located in the United States, followed by China, Turkey, and Brazil.

Two-thirds of countries have implemented laws to manage solid waste. Financing waste management systems is challenging, and public-private partnerships are crucial. The VCM can provide a solution for reducing the climate impact of landfills through Landfill Methane projects.

Landfill Methane Key Findings

What drives quality in LFM projects?

Key Drivers

Sylvera provides in-depth, holistic assessments of project quality based on rigorous analysis of three key indicators: **carbon** performance, **additionality** and **permanence,** as well as co-benefits and safeguarding provisions. For each project type, there are certain fundamental areas of materiality within these pillars that drive project quality.

In this Project Type Insight, we outline Sylvera's approach to assessing Landfill Methane projects and provide an overview of potential strengths and risks for buyers to consider.

For Landfill Methane projects, we have identified the three following pillars as key drivers of project quality

1. **Carbon Metrics Assessment**
   Carbon metrics are used in the emissions reductions calculations of projects. Their quality should be assessed to understand the accurateness and representativeness of the outputs.

2. **Policy and Regulatory Additionality**
   The policy and regulatory environment that a project operates in affects the degree of additionality of the project.

3. **Financial Additionality**
   Financial additionality is determined by whether the project is viable without revenues generated by the VCM, and therefore this must be assessed to understand the level of additionality of the project.

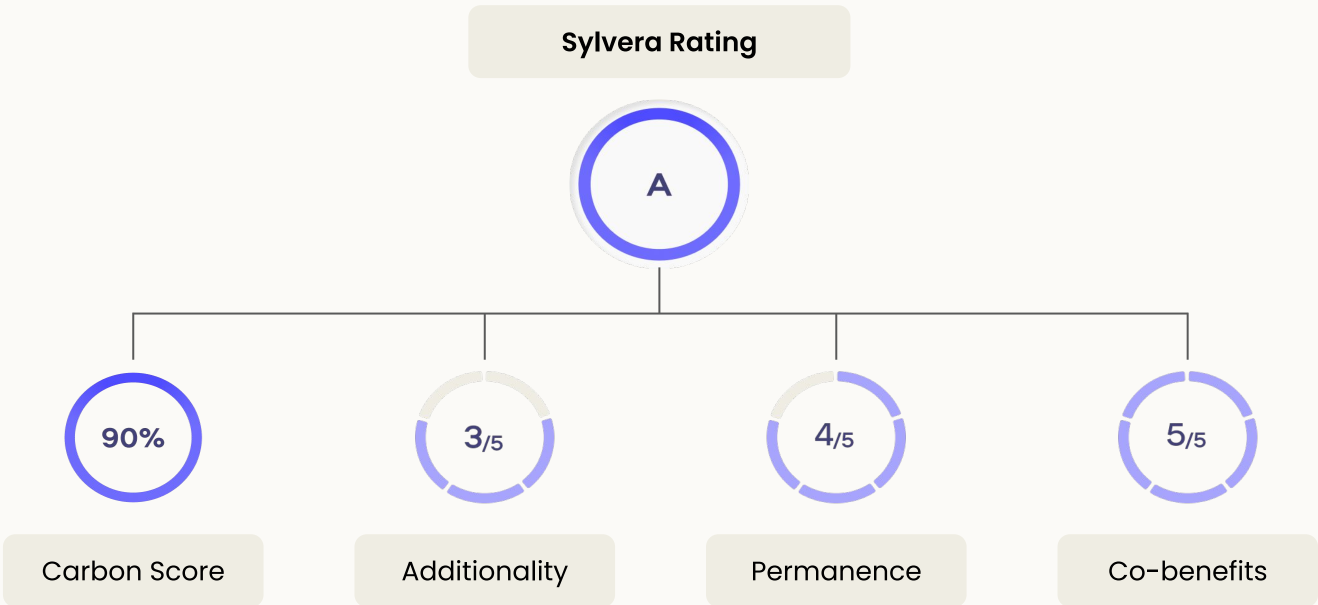


Figure 2: The overall structure of Sylvera's Ratings includes assessments of Carbon Score, Additionality, Permanence and Co-benefits. All of these pillars would be assessed by Sylvera in a Landfill Methane Project Rating. The scores shown are for illustrative purposes and do not represent the quality of a particular project.

Landfill Methane

Project Type Key Findings

Carbon Metrics Assessment

The use of Oxidation Factors, GWP values and electricity emission factors in carbon calculations is a key driver of quality for LFM projects

The calculation of emission reductions from Landfill Methane projects involves the use of various metrics in carbon calculations, which may be pre-defined. There are three main areas of materiality in the use of these carbon metrics that affect the quality of Landfill Methane calculations. This is through the use of Oxidation Factors (OX factors), Global Warming Potential (GWP) values, and electricity grid emission factors.

OX factors represent the fraction of Landfill Methane generated by the landfill that is oxidised by microorganisms in the soil or other material covering the waste. Methanotrophic microorganisms consume the methane produced, before it reaches the atmosphere. Therefore, if a Landfill Methane project used an OX factor of 1, this would represent complete oxidation of methane by microorganisms, whilst an OX factor of 0 represents zero oxidation of methane. Many Landfill Methane projects use a default OX factor of 0.1, which originates from IPCC National Greenhouse Gas Inventory guidelines.

However, the context of what is considered conservative in National Inventory accounting must be examined when compared to Project accounting for carbon credits. In National Inventory accounting, it is conservative to assume that a smaller proportion of methane is oxidised by microorganisms, and therefore a larger volume of methane is released to the atmosphere. This means that countries are less likely to underestimate the methane that is released by their landfills to the atmosphere.

In Project accounting, Landfill Methane projects are credited for the amount of methane that they prevent from reaching the atmosphere compared to the baseline scenario (or the amount of energy they produce from Landfill Methane that is supplied to the grid). Therefore, assuming a low OX factor and therefore a larger volume of methane leads to over-crediting. In the context of Project accounting, a higher assumed OX factor is more conservative.

It has been found that a default OX factor of 0.1 is likely to underestimate the extent of methane oxidation in landfills (Chanton, J.P., Powelson, D.K. and Green, R.B. (2009)). Therefore as a result, there is the potential for extensive, systematic over-crediting from VCM projects using this default.

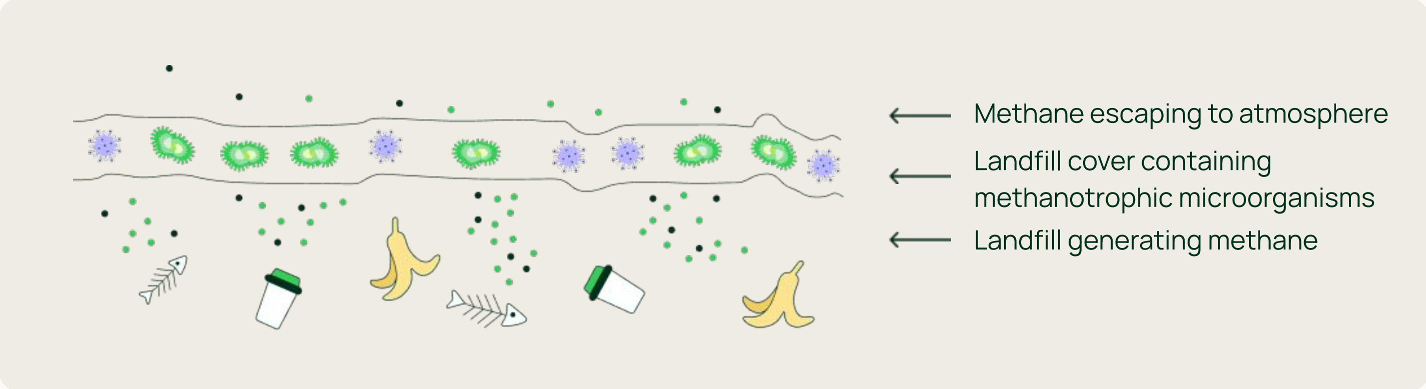


Figure 3: A diagram showing methane generated in a landfill being consumed by methanotrophic microorganisms in the landfill cover, reducing the volume of methane escaping to the atmosphere

Landfill Methane

Project Type Key Findings

Carbon Metrics Assessment

GWP values are metrics used to represent the amount of warming caused by emissions of specific gases, over a certain time period. These values are released periodically by the IPCC based on the latest climate science.

All GWP values are calculated with respect to the GWP of CO2. Therefore, CO2 always has a GWP of 1.

Over a 100-year time period, the GWP of methane is 27-30 as compared to the impact of CO2 over the same time period. The impact of the methane over a shorter time period is higher (EPA, 2024).

As LFM projects are claiming credits based on avoided methane emissions to the atmosphere, any projects using a higher GWP than they should are at risk of over-crediting.

Projects should use the most up-to-date version of the IPCC GWP factor for methane to obtain accurate carbon credit calculations.

Where projects are selling electricity generated by burning the landfill methane to the grid, the **electricity emission factor** (EF) they are using for calculations is also important in calculating the corresponding benefit for the grid. Electricity EFs represent the greenhouse gas (GHG) impact caused by electricity used from a certain source. For example, a grid electricity EF represents the GHG intensity of the electricity mix of that particular grid.

The specificity (e.g. global, country, grid) of the electricity EF used in carbon credit calculations impacts their accuracy.

This is important because the GHG intensity of the grid varies significantly by geography, and over time. Therefore, to understand the real impact of the electricity that is being generated, an accurate emission factor should be used to represent this.

Projects should use the most specific electricity EF possible to ensure accuracy in their calculations.

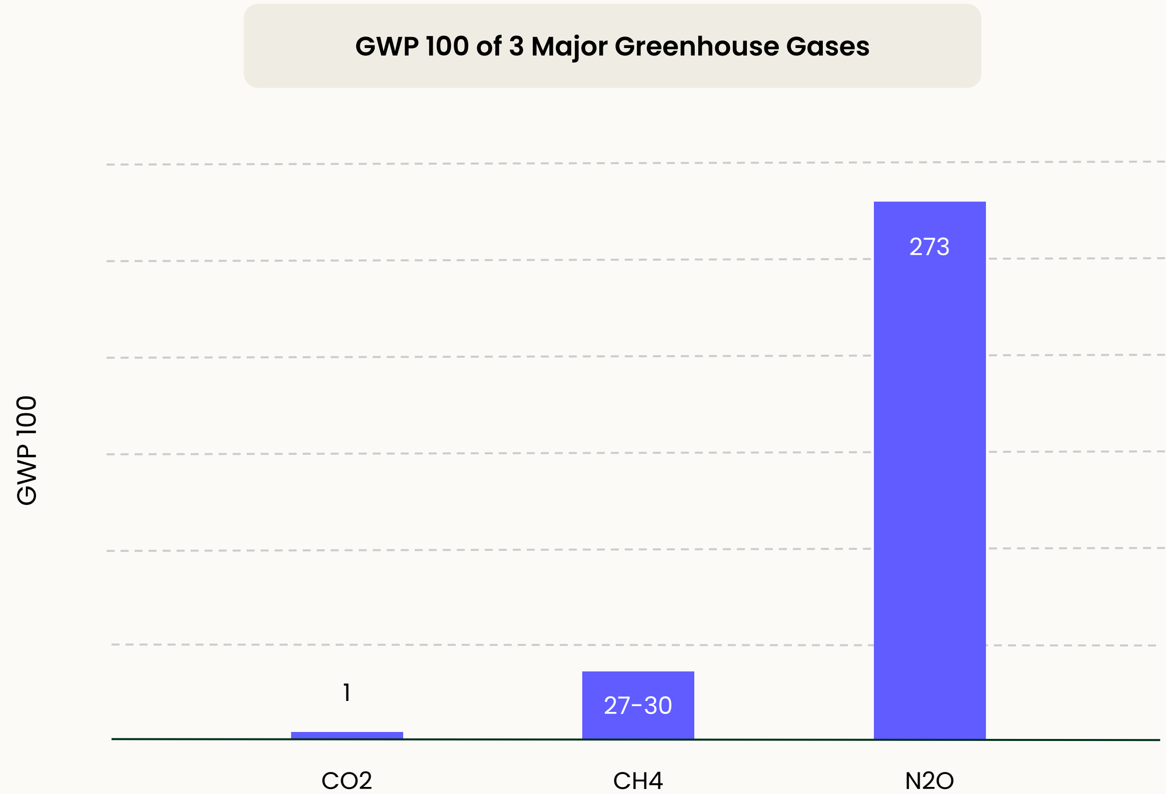


Figure 4: A graph showing the GWP 100 of 3 major Greenhouse Gases, values from EPA, 2024

Landfill Methane

Project Type Key Findings

Policy and Regulatory Additionality

Policy and Regulatory Additionality is a key driver of LFM project quality, especially in flaring projects

Policy and Regulatory Additionality assesses whether there are policies, regulations or laws that would already require the project activities to take place, in absence of the VCM. For example, if Landfill Methane projects were required to flare all generated methane by law then this would not be considered an additional project on the VCM.

The additionality of Landfill Methane projects is affected by the policy and regulatory environment in which they are operating, and this is especially important for flaring type projects.

The policy and regulatory environment varies globally, so these checks should be geographically-specific. There are key pieces of policy and regulation that require landfills to already collect and neutralise the gas generated. This is a moving environment, with updates in requirements and tracking technologies happening all the time.

For example, the US has state and federal rules on flaring of Landfill Methane. These regulations often rely on the capacity of the landfill and Non-Methane Organic Compound (NMOC) emissions, with some states having stricter rules on flaring. The US Environmental Protection Agency (EPA) is also due to revisit its Clean Air Act emission standards for new and existing municipal solid waste landfills.

Satellites have been launched to observe spectrographic data coming from various sources including Landfill Methane. The introduction of new methane tracking technologies will help lawmakers to enforce stricter regulations, which may in turn impact the policy and regulatory additionality of these projects.

Advances in remote sensing of methane emissions will also allow more accurate measurement, reporting, and verification (MRV) of Landfill Methane VCM projects, providing an incentive for higher quality.

Landfill Methane

Project Type Key Findings

Financial Additionality

Financial Additionality is a key driver of LFM project quality, especially in LFM Energy projects

Financial Additionality assesses whether the project would have happened in absence of revenue from carbon credits.

The additionality of Landfill Methane projects is affected by the sale of products produced by the project, including the sale of energy. Depending on the financial situation of the project, this may mean that the projects are viable and attractive without revenues from the VCM. The strength of financial additionality depends on the type of Landfill Methane project.

Landfill Methane projects that generate energy have the potential to be less financially additional than other Landfill Methane projects, as they can profit from selling electricity, and revenue from carbon credits can represent only a fraction of revenue gained from energy sales.

Therefore, financial additionality becomes the priority check, as in this case the proponent likely would have been incentivised to invest in the activities regardless of the VCM. It is worth noting that Sylvera has assessed certain Landfill Methane projects to be financially additional, so each project must be studied on a one-by-one basis. For flaring type projects, this check is not as relevant, as flaring on its own does not generate revenue, and instead the focus should be on policy & regulation.

The financial additionality of Landfill Methane projects has been shown to be an important risk factor recently, with analysis by Carbon Plan showing that certain US Landfill Methane projects experienced years-long gaps in crediting, but maintained operations throughout this gap. This implies that these projects experiencing a gap are financially viable in absence of the revenues from carbon credits, and therefore do not need VCM support to cross the viability gap.

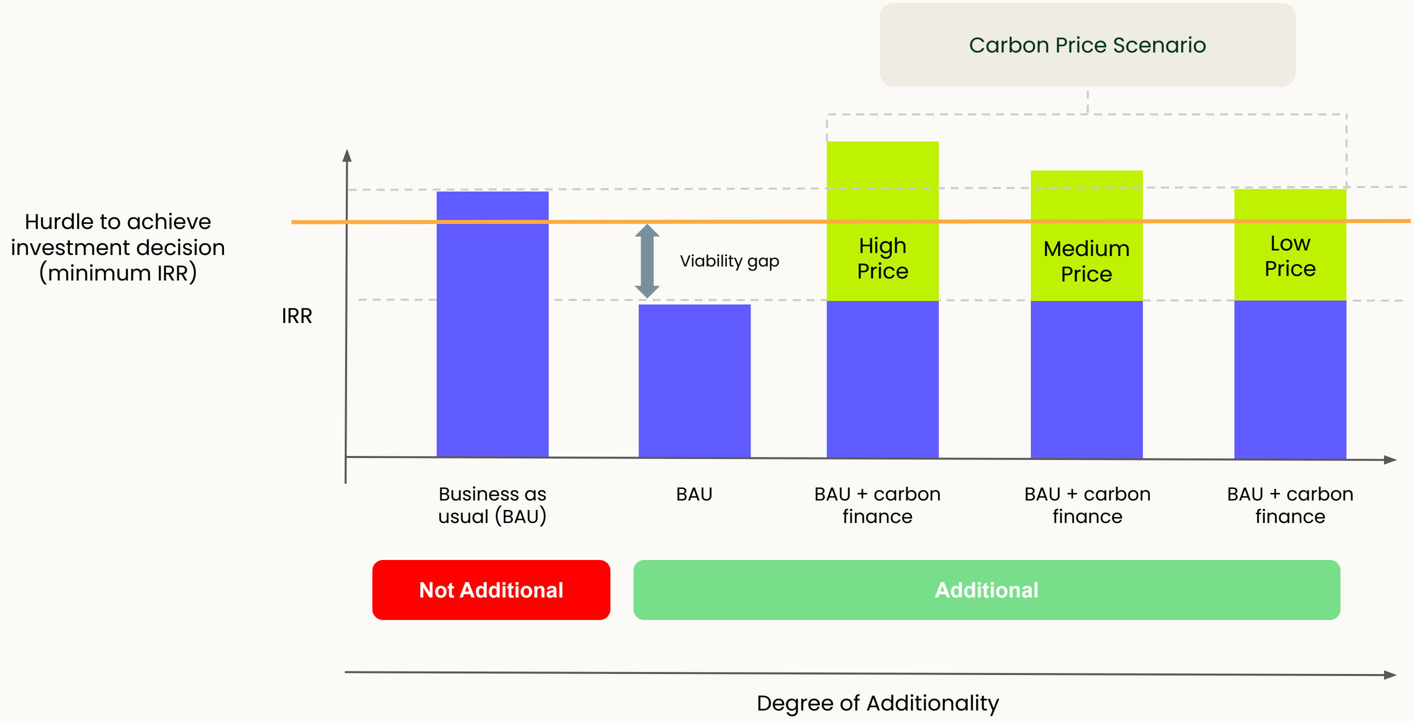


Figure 5: A diagram showing the relationship between degree of financial additionality and crossing the viability gap.

Conclusions

Key Findings on LFM Project Quality Drivers

Our Findings

Many factors affect the quality of Landfill Methane projects, and can be specific to the type of Landfill Methane project, as well as its geographical location.

For Landfill Methane projects, we have identified the three following pillars as key drivers of project quality

1. **Carbon Metrics Assessment**

   The metrics employed by projects in their carbon calculations can have a huge impact on the quality of the project, by affecting the size and uncertainty of their emissions reductions quantifications. It is especially important to assess the OX factor, GWP values and electricity EFs.

2. **Policy and Regulatory Additionality**

   The policy and regulatory environment in which the Landfill Methane project is operating has a material impact on the additionality of the project. For example, if a policy already exists that requires methane flaring, then flaring projects in this area are not additional.

3. **Financial Additionality**

   The financial additionality of projects is a third key quality driver of Landfill Methane projects; projects must be financially infeasible in the absence of revenues from the VCM to be considered additional. The sale of energy often impacts the degree of additionality of LFM Energy projects.

Landfill Methane projects address an important issue for the environment: emissions of a greenhouse gas with a high GWP. Therefore, it is imperative that these projects operate at a high quality, with real climate impact.

Increasing regulations and improved methane tracking abilities in the future will ensure accountability in these areas. Use of the most accurate and transparent values in carbon calculations allows valid carbon credit computations.

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Global corporations, financial institutions, and governments rely on Sylvera to develop and execute their carbon credit strategies, drive measurable progress toward net zero goals, and optimize returns on investment.

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Incentivizing investment in real climate action.