HASI | carboncount®

Carbon Confidence in Climate Finance

CarbonCount® 2.0

April 2023

What Is CarbonCount®?

CarbonCount® is a decision tool that evaluates investments in U.S.-based renewable energy, energy efficiency, and climate resilience projects to determine how efficiently they reduce CO2 equivalent (CO2e)[1] emissions per $1,000 of investment. CarbonCount® integrates forward-looking project assumptions, emissions factors, and capital investment to produce a quantitative impact assessment for use by investors, developers, corporate buyers, policymakers, and other stakeholders interested in most efficiently avoiding emissions that contribute to climate change.

HASI initially developed the CarbonCount® methodology to ensure that each investment aligns with HASI's mission to improve our climate future. In 2014, HASI partnered with the Alliance to Save Energy (ASE), a non-profit organization comprised of industry leaders including Southern Company, the Edison Electric Institute, United Technologies Corporation, and the DOW Chemical Company to further advance the methodology. In 2015, Bloomberg New Energy Finance awarded CarbonCount® its Finance for Resilience (FiRe) prize and HSBC praised CarbonCount® for its ability to provide the "single metric" that investors need to "compare the environmental quality of green bonds."

1) CO2 equivalent emissions includes the impact of greenhouse gas emissions beyond CO2 such as methane and normalizes impact in terms of units of CO2 equivalent adjusting for the often higher global warming potential of such other greenhouse gas emissions per metric ton. For instance, one metric ton of methane is equivalent to approximately 30 metric tons of CO2 in terms of global warming potential.

Why Does CarbonCount® Matter?

At its core, CarbonCount® is a capital efficiency metric. Given that carbon counts and capital is scarce, investors should prioritize investments with high-impact CO2e emissions reductions.

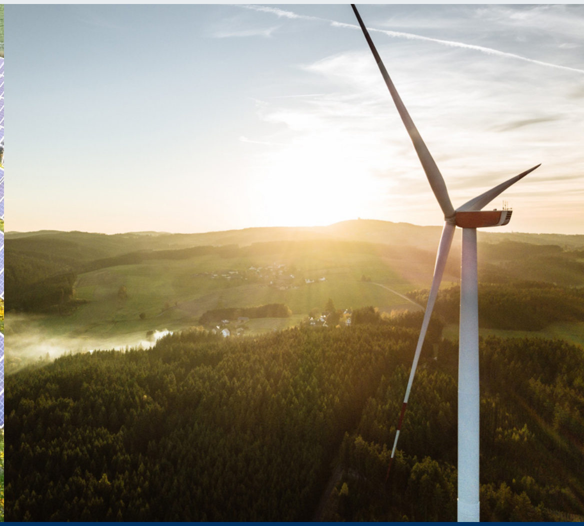
HASI uses CarbonCount® to screen each new investment opportunity to ensure that every investment improves our climate future. Every HASI investment has a positive CarbonCount® (or other tangible positive environmental impact such as reduced water consumption).

CarbonCount® is also a crucial tool for businesses developing net-zero targets and clean energy procurement plans. It is imperative that such businesses use carbon-denominated measurements like CarbonCount® to evaluate procurement and more accurately match emissions generated with emissions avoided. Many existing corporate net-zero targets use megawatt hours (MWh) as the basis for calculating actual and avoided emissions through execution of renewable energy power purchase agreements (PPAs) and renewable energy credit (REC) purchases. However, simply relying on offsetting consumption at a particular time and location with PPAs and/or RECs – often generated at a different time and location – can lead to wide gaps between traditional emissions accounting and actual emissions impact. As a result, many conflate reductions in GHG Protocol Scope 2 market-based inventories with reductions in actual emissions, which is often not the case. Such gaps distort the market signals that influence project siting, power market congestion, and prices and can lead to a sub-optimal allocation of capital.

Why is HASI Updating CarbonCount®?

In early 2022, HASI launched a company-wide effort to reevaluate and modernize the CarbonCount® calculation to improve its granularity and accuracy. CarbonCount® will still be measured in metric tons of CO2e avoided per $1,000 invested, achieving the objective of evaluating the efficiency of investing capital in avoiding emissions. Starting in 2023, CarbonCount® 2.0 now reflects a more sophisticated and accurate assessment of avoided emissions by reporting year-one avoided emissions informed by more granular emissions data.

The primary driver of the update is the availability of more accurate and granular emissions modeling through our partnerships with REsurety and WattTime – leaders in advanced emissions factor modeling. Rather than estimating avoided emissions on an average annual basis (AAB) using the Environmental Protection Agency's (EPA's) eGRID emissions factors, the new CarbonCount® 2.0 methodology assesses avoided emissions using locational marginal emissions (LME) factors that reflect the grid composition specific to each project's location at the time of generation.



Historic CarbonCount® Methodology

Until this update, the historic CarbonCount® methodology had not materially changed since it was developed by HASI in 2014.

$$\frac{\text{Annual Hourly MWh Generation Avoided by Underlying Renewable Energy and/or Efficiency Project(s)} \times \text{Location Specific Hourly Grid Emissions Factor Metric Tons of CO2e / MWh}}{\text{Total Capital Cost of the Projects}} = \text{carboncount}^{®}$$

carboncount®
Metric Tons of CO2e Offset Annually per $1,000 invested

There are three primary components of the historic CarbonCount® calculation:

1	**Annual Hourly Generation Avoided**	For renewable energy and energy efficiency investments, avoided emissions is directly tied to energy generated or saved (as measured by megawatt hours - MWh) by a project. The historical CarbonCount® calculation relied on year-one generation estimates to produce a year-one efficiency metric.
2	**Location-Specific Hourly Grid Emissions Factor**	CarbonCount® has historically relied on the EPA's available eGrid emissions data to determine the number of tons of CO2e emissions avoided per MWh of energy and stationary fuel emissions factors (e.g. CO2e per unit of avoided boiler fuel oil consumption).
3	**Total Capital Cost of Project**	To calculate the tons CO2e avoided per $1000 invested, avoided emissions are divided by the total capital expenditures (capex) of the project.

Limitations of EPA eGrid Estimated Carbon Emissions Data

While eGrid's data is widely used, there are several limitations that make its use less accurate than LME data. The primary issues are:

1 Data is often dated (e.g., in 2022, the eGrid data reflected 2020 average emission data)

2 eGrid data reflects the average of the entire year across an entire state, which results in **several challenges:**

- Renewables often produce most of their production during a limited time period (e.g., solar during the day) so an annual average is not a reflection of the true emissions impact;
- The amount of emissions reduction is impacted both by the project's location in a region and (potentially resultant) transmission constraints, which prevent projects from delivering a portion of the power generated;
- eGrid average data does not reflect renewables purchased and accounted for by an individual consumer so the reported average involves double counting the impact of renewables (the individual user and the overall grid both get credit for the renewable project);
- While historically eGrid data was often the only available data set, newly available locational marginal emissions data allows for significantly better accuracy.

New CarbonCount® Methodology

The CarbonCount® 2.0 methodology more precisely evaluates the efficiency of new investments to avoid carbon emissions. The primary methodological update is improved location-specific hourly grid emissions factors, known as locational marginal emissions factors, instead of relying solely on the EPA's eGRID average annual state-wide emissions factors. Going forward, we will report this year-one CarbonCount based on the location-specific hourly grid emissions factors.

Locational Marginal Emissions

In all situations where locational marginal emissions data is available, CarbonCount® 2.0 will use LME factors to calculate metric tons of CO2e avoided per MWh – replacing the EPA's eGRID state-wide annual average factors. By considering grid composition, project location, and hourly generation profile, LME factors enable more accurate emissions modeling.

In late 2022, LME data became available at the nodal level for two U.S. Independent System Operators (ISOs): Electric Reliability Council of Texas (ERCOT) and Pennsylvania-New Jersey-Maryland Interconnection (PJM). For all other ISOs, LME data is currently available at the balancing authority (BA) level, which incorporates many nodes but is still more granular than a state-wide average. By the end of 2023, REsurety has pledged to make available nodal marginal emissions data across all U.S. wholesale markets, while WattTime has pledged to expand its global data coverage to include parts of two or more additional continents[2].

For projects where hourly generation forecasts are available, projected hourly generation will be matched with hourly LME rates from the trailing 12-month (TTM) period. For projects with only monthly or annual generation estimates, the average hourly LME rate for the appropriate period will be used.

2) REsurety and WattTime to Make Marginal Emissions Data Widely Available to Support More Impactful Climate Action

Locational Marginal Emissions Overview

Locational Marginal Emissions is a measurement of the tons of carbon emissions avoided by generating 1 MWh of renewable energy or avoiding 1 MWh of consumption through energy efficiency, load management, or load shifting measures at a specific location and time[3]. LME is calculated by identifying the specific generation asset that is being replaced by each incremental MWh of renewable energy.

LME is an important tool in assessing individual projects because seemingly identical renewable energy projects can have drastically different impacts on avoided carbon emissions.

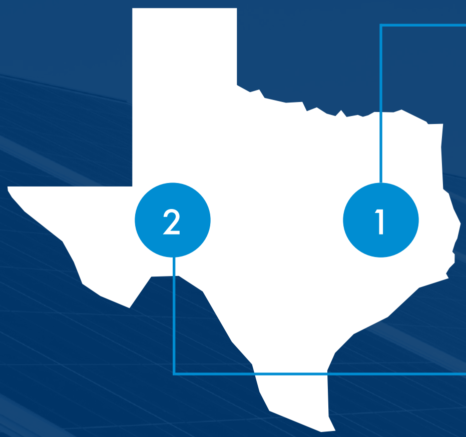
There are two primary drivers of differences in LME across individual projects:

1. The grid's fuel mix varies by location and time of day; and
2. Transmission constraints and congestion limit some projects from delivering power to customers at various times and locations.

Generally, if deployment of a renewable energy project replaces primarily fossil fuel generation (e.g., coal, gas, oil), then such a project will have a relatively higher LME and greater avoided emissions. However, it is possible to deploy renewables in locations where they primarily replace other renewables, resulting in a lower LME and fewer avoided emissions.

3) REsurety-Locational-Marginal-Emissions-A-Force-Multiplier-for-the-Carbon-Impact-of-Clean-Energy-Programs.pdf

To illustrate the impact of the locational fuel mix on emissions, we posit below two hypothetical zones within the same state:



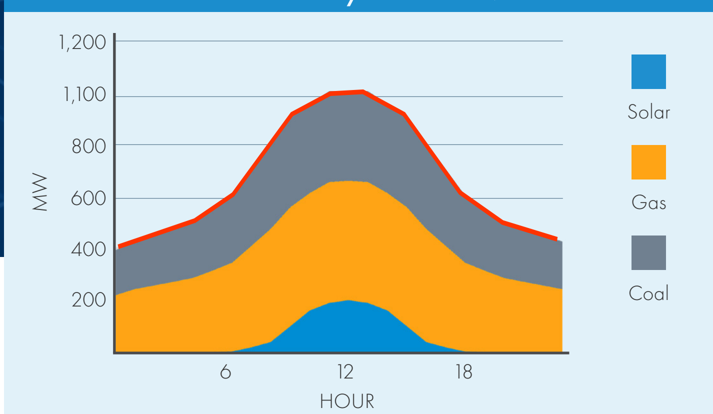
Zone 1

Fuel	Capacity (MW)	Emissions Rate (tons/MWh)
Solar	200	-
Wind	-	-
Natural Gas	500	0.65
Coal	300	1.00

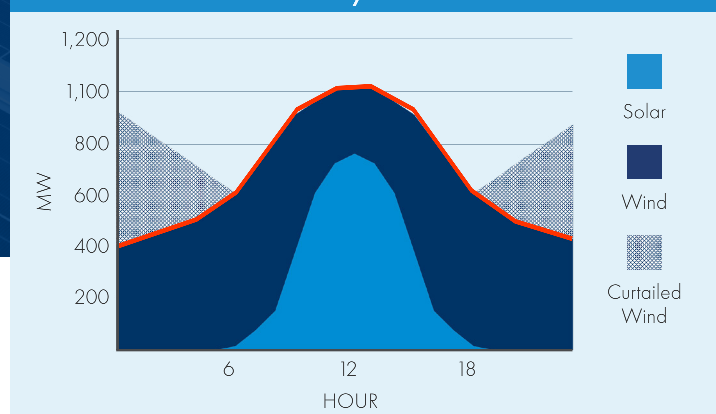
Zone 2

Fuel	Capacity (MW)	Emissions Rate (tons/MWh)
Solar	750	-
Wind	900	-
Natural Gas	-	0.65
Coal	-	1.00

Zone 1 - Daily Grid Fuel Mix



Zone 2 - Daily Grid Fuel Mix

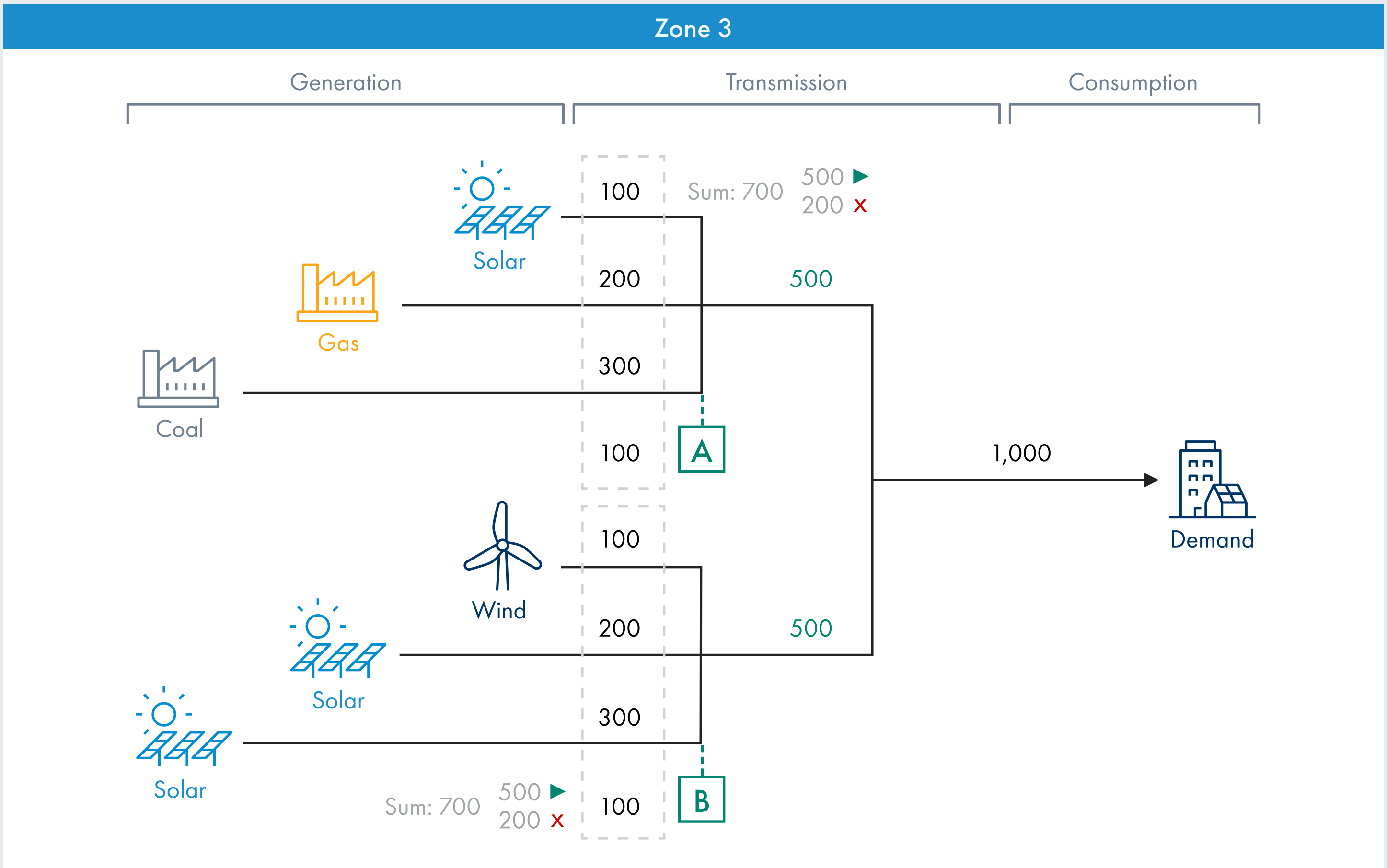


For each hypothetical zone, the graphic displays the mix of generating assets across a given day. In both zones, the red line shows hypothetical demand for energy.

The locational marginal emissions rate for each zone is calculated by identifying the marginal emitter – the generating asset that is to be curtailed by the addition of a MWh of renewable energy. Adding an additional clean energy project to Zone 1 would likely push gas and coal generation to the margins, resulting in positive (and likely significant) avoided emissions. Adding additional clean energy generation to Zone 2 typically pushes existing wind or solar to the margins, resulting in de minimis avoided emissions and a resulting de minimis LME rate.

Yet, relying instead on EPA's eGRID statewide annual average factors results in the view that both projects avoid an identical quantum of emissions.

The subsequent below example posits a third hypothetical zone (Zone 3) to demonstrate how transmission constraints within a single zone can generate a meaningful LME differential even for projects that are geographically proximate. In this example, the transmission lines shown in green have a maximum capacity of 500 MW, with the system curtailing any generation that exceeds the transmission capacity (i.e., congestion). Adding a project to position A on the grid would likely result in greater avoided emissions (and a higher LME) because the additional generation would replace competing natural gas and coal generation. Alternatively, adding a project to position B would result in de minimis avoided emissions as the curtailed generator would tend to be zero-emission renewable generation.



CarbonCount® 2.0 and LME

Calculating avoided emissions on a locational marginal basis enables more accurate near-term carbon reduction scoring than the previous CarbonCount® methodology, which calculated avoided emissions on an average annual basis. In many cases, the use of LME factors will result in a materially lower avoided emissions estimate and year-one CarbonCount due to the current realities of renewables siting constraints.

To demonstrate the difference between LME and annual average emissions factors, we compare the year-one CarbonCount calculation for an operational project in West Texas[4] using both the historical average annual emissions factors with the new locational marginal emissions factors. The project cost $350 million to construct, has a P50[5] year-one production estimate of 600,000 MWh, and has a useful life of 30 years.

As the example demonstrates, relying on an LME rather than an average annual factor can result in materially different but certainly more accurate avoided emissions estimates (235,000 vs. 354,000 metric tons) and resulting CarbonCount metrics (0.67 vs. 1.01).

$$\text{CarbonCount}^{\circledR} \text{ (historical)} = \frac{\text{Project Year 1 Avoided Emissions}}{\text{Project Capital Cost (\$1000s)}} = \text{MT CO2e per \$1000}$$

Year 1 Avoided Emissions = (average annual basis) P50 year 1 production * EPA eGRID emissions Factor = 600,000 * 0.59 = 354,000 MT CO2e

$$\text{CarbonCount}^{\circledR} \text{ (average annual basis)} = \frac{\text{354,000 MT CO2e}}{\text{\$350 m}} * \text{\$1000} = \textbf{1.01 MT CO2e per \$1000}$$

Year 1 Avoided Emissions = (locational marginal basis) $\sum_{h=1}^{8,760} X_h Y_h$ = 235,023 metric tons of CO2e

One Year of Generation

	Hour (h)	1	2	3	4	5	6	7	...	...	8,759	8,760	Total
X	Generation (MWh)	50.06	58.71	37.36	37.58	30.73	16.12	10.32	...	...	53.53	59.34	600,000
Y	LME	0.42	0.43	0.60	0.48	0.43	0.34	0.38	...	...	0.35	0.44	
	Avoided Emissions (X*Y)	21.03	25.25	22.42	18.04	13.21	6.77	3.92	...	...	18.74	26.11	235,023

$$\text{CarbonCount}^{\circledR} \text{ (locational marginal basis)} = \frac{\text{235,023 MT CO2e}}{\text{\$350 m}} * \text{\$1000} = \textbf{0.67 MT CO2e per \$1000}$$

4) Production data measured from 6/1/2020 through 5/31/2021
5) P50 is a statistical level of confidence suggesting that we expect that the predicted resource/energy yield may be exceeded with 50% probability.

CarbonCount® 2.0 Use Cases

By moving from average annual emissions factors to more granular LME factors, CarbonCount® 2.0 aligns with cutting-edge emissionality modeling by industry leaders and repositions CarbonCount® at the forefront of carbon reporting.

CarbonCount® 2.0 can be used by:

1. **Investors** to assess and compare opportunities for quantifiable carbon impact;
2. **Developers** to site projects to maximize carbon impact;
3. **Corporate buyers** to ensure that the projects with which they contract more accurately mitigate the carbon impact of their consumption;
4. **Policymakers** to spur the regulations and infrastructure required to achieve net zero targets; and
5. **Other stakeholders** to detect and prevent greenwashing and hold industry accountable for our quantified carbon impact.

Appendix: Potential Future Refinements

The updated CarbonCount® 2.0 methodology will enable HASI to more accurately communicate the efficiency with which our investments avoid CO2e emissions. Because the goal of CarbonCount® is to report the most accurate avoided emissions calculation possible, we anticipate further refinements to the calculation as additional data sources are developed. Below are specific areas for potential future improvements.

Expansion of LME Data Availability

As of late 2022, nodal LME data is available for just two U.S. ISOs: ERCOT and PJM. For all other ISOs, LME data is currently available at the balancing authority level, which incorporates many nodes but is more granular than a state-wide average. We expect nodal LME data will become available across all U.S. ISOs in the next year. In addition, companies such as REsurety are currently developing long-term LME forecasts.

Reporting Lifetime Avoided Emissions

As forward-looking LME data becomes available for all U.S. ISOs, CarbonCount® 2.0 will also endeavor to report a lifetime assessment in addition to the year-one metric. Because many of our investments have a useful life of 20 years or more and will contribute to avoided emissions for the duration of this useful life, supplementing CarbonCount® 2.0 with reports of the projected cumulative avoided emissions throughout each project's useful life (as verified by independent engineers and/or industry standards) will maintain consistency with how we evaluate the projected economic return of our investments. Eventually reporting lifetime CarbonCount® will provide a more comprehensive assessment of avoided emissions over a project's useful life.

Embedded Emissions

As credible organizations develop estimates related to the embedded emissions inherent to the production, construction, and installation of our assets, we may seek to adopt a consistent methodology to accurately report our share of each project's embedded emissions.

Expansion outside the United States

While granular LME data is not yet readily available outside the United States, we hope the adoption of CarbonCount® 2.0 will help to prompt its development so CarbonCount® can be calculated for renewable energy, energy efficiency, and climate resilience projects located outside the U.S. Recently, WattTime pledged to expand its global data coverage to include parts of two or more additional continents by the end of 2023.

Expansion to Additional Asset Classes

While CarbonCount® 2.0 is currently applicable only for real infrastructure assets, such as renewable energy, energy efficiency, and climate resilience projects, we hope to spur internal and external efforts to develop a similar metric for asset classes beyond real infrastructure.