CarbonCount™

Quantitative Carbon Scoring System for "Green" Bonds

ALLIANCE
TO SAVE ENERGY

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The *Alliance to Save Energy* wishes to thank the U.S. Environmental Protection Agency (EPA) for developing and making freely available the AVoided Emissions and geneRation Tool (AVERT), a computer model that forecasts reductions in emissions of criteria air pollutants, including carbon dioxide, from U.S. electric power plants, based on user-defined scenarios for increased energy efficiency and renewable generation. Special appreciation is due Ms. Robyn De Young, manager of the EPA's State and Local Climate and Energy Program, for graciously explaining the workings of AVERT, advising on its suitability for inclusion in the *CarbonCount*™ methodology, and validating the applications described in this paper. AVERT is a powerful resource for anyone looking to gauge the emissions impacts of reduced reliance on fossil-fueled facilities for generating electricity. Without AVERT, the *Alliance*'s task would certainly have been more difficult, and the findings less compelling.

This paper introduces *CarbonCount*™, a metric that evaluates bond investments in U.S.-based energy-efficiency and renewable-energy projects based on the expected reduction in carbon dioxide (CO_2) emissions resulting from each $1,000 of investment. *CarbonCount*™ was developed by the *Alliance to Save Energy* (the *Alliance*), a leading U.S. nonprofit organization that promotes energy efficiency to achieve a healthier economy, a cleaner environment, and greater energy security. A primary *Alliance* strategy is to reduce informational barriers that hamper market-driven solutions. *CarbonCount*™ operationalizes this strategic direction, recognizing that investors will not—indeed, cannot—properly value carbon impacts until they are confident that those impacts have been estimated impartially and consistently. *CarbonCount*™ addresses this challenge by combining forward-looking project data already used for credit ratings, sophisticated emissions modeling software, and clearly documented assumptions to produce a quantitative score tailored for finance professionals. Building carbon confidence through wide use of *CarbonCount*™, the *Alliance* aims to increase financial flows toward, and justify favorable capital pricing for, projects that promise superior climate benefits.

Quantifying "Green"

Nearly 40% of self-labeled green bonds issued in 2013 and 2014 lacked any independent review of their climate impacts.[1] Some prospective investors have expressed concerns that self-labeling without credible, independent oversight may disrupt the green bond market before it firmly takes root.[2] Rigorous monitoring and verification systems are not without their own disadvantages, however, as they can burden green issuances with costs not incurred by projects lacking green aspirations. And perhaps more detrimentally, complex and comprehensive taxonomies designed to set minimum impact standards and capture only <u>net</u> green benefits will inevitably take time to develop and gain acceptance. Pausing to craft a fully comprehensive solution—perhaps one that outstrips the information needs of some investors—could cause the green bond market to fall off its current steep growth path.

Opting for the middle road between unguided self-labeling and prescriptive taxonomic systems, the International Capital Market Association unveiled voluntary Green Bond Principles (GBP) in early 2014.[3] Initially drafted by Bank of America, Merrill Lynch, Citigroup, Crédit Agricole, and JPMorgan Chase, the GBP have rapidly gathered support from investors, underwriters and issuers, with 73 such institutions joining the effort as Members in just one full year.[4] Non-financial institutions are eligible for Observer Membership, and the *Alliance* is privileged to enjoy this status.

The GBP represent a significant demonstration of industry commitment to transparency, but they were clearly not intended to evaluate the impacts of individual bonds. Instead, these guidelines identify broad green project categories, and make high-level recommendations regarding the disclosure of use of funds, project selection processes, the management of proceeds, and the modalities of reporting. They are not designed to provide a quantitative metric that investors could rely upon when evaluating the climate impact of individual green bond offerings, but they do "recommend" the use of such a metric, where practicable.

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1 "Bonds and Climate Change: The State of the Market in 2014," *Climate Bonds Initiative* (July 2014), 6.
2 Bridget Boule and Sean Kidney, "How standardization can help ensure that the green bonds market delivers on its potential," *ri insight* (November 2014): 25-27.
3 "Green Bond Principles, 2014: Voluntary Process Guidelines for Issuing Green Bonds," *International Capital Market Association* (13 January 2014).
4 See http://www.icmagroup.org/Regulatory-Policy-and-Market-Practice/green-bonds/membership/, last accessed on 14 January 2015.

***CarbonCount*™**

CarbonCount™ is an effort to provide this type of metric, satisfying what the *Alliance* believes to be a pressing need for enhanced investor information to further accelerate the growth in green capital. By intention, *CarbonCount*™ is an exercise in rapid prototyping; it was developed over the course of several months with the expectation that it would benefit from being exposed to the critical judgment of the market—the sooner, the better. Over the long term, *CarbonCount*™ can stand on its own as a measure of an investment's carbon efficiency, or be incorporated within more comprehensive green bond rating systems should they emerge.

For testing purposes, the *Alliance* is seeding the market with *CarbonCount*™ scores for bonds selected to sample a variety of technologies, project types, and financing structures. We have begun with the following five instruments:

- Continental Wind LLC Senior Secured Bond, an already issued bond financing utility-scale wind-power projects and with a $635 million total face value;
- Southern California Public Power Authority's Milford Phase One Revenue Bond, an already issued bond financing utility-scale wind-power projects and with a $240 million total face value;
- SolarCity Series I LMC 2013-1 Bond, an already issued bond financing distributed solar-power projects and with a $54.4 million total face value;
- Topaz Solar Farms LLC Series A Senior Secured Bond, an already issued bond financing a single large utility-scale solar-power project and with an $850 million total face value; and,
- Hannon Armstrong Sustainable Yield Bond, a representative example of an estimated $101 million face value bond secured by governmental energy savings performance contract (ESPC) projects undertaken by energy service companies (ESCOs).

Details of these bonds, and their *CarbonCount*™ scoring results, are provided in Appendix A.

Resources permitting, the *Alliance* pledges to evaluate any bond brought to us by issuers in 2015 and certify that projected CO_2 savings have been modeled consistently, utilizing comparable energy generation and savings forecasts.

Initially, only U.S.-based renewable-energy and energy-efficiency projects can be covered, because of the limitations of the rigorous analytical framework adopted. Extending our approach to cover international markets is entirely feasible, however, subject only to the availability of required data.

Investment Grade Audits and Independent Engineers' Estimates

CarbonCount™ builds upon quantitative forecasts for power generation and energy savings that investors and analysts already use to judge the financial merits of bond offerings. In other words, in seeking to enhance carbon confidence, we have used the same underlying data that others use to establish the creditworthiness of their investments.

In the case of renewable-energy projects, a report from an independent engineering consultant (IE) detailing the predicted monthly energy generation output is customarily included as part of the standard financial underwriting package. The IE's role is to provide an impartial assessment on the projected output of the proposed project under a variety of scenarios. Projected generation is quoted in terms of exceedance probabilities that are the product of Monte Carlo simulations.

P-90 production, a level often used for underwriting purposes, implies a 90% probability that generation will exceed the modeled amount.

To further conservatively bias the analysis, we have chosen to employ P-99 production values for our CO_2 impact analysis. Where a P-99 value is not provided, we discount the usually available P-90 value using a degradation factor derived from the known drop-off between P-90 and P-99 values of a similar project. We granularize annual P-99 estimates by allocating projected energy production over the 8,760 hours in a year using technology- and region-specific distribution tables developed by the National Renewable Energy Laboratory (NREL).

Infrequently, neither an independent engineering analysis nor other project production data are available. In such cases, we take the nameplate generating capacity of the project and estimate annual production hours using the state- and technology-specific capacity factors found in the U.S. States Renewable Energy Technical Potentials study prepared by NREL in 2012.[5] Since the resultant generation estimates represent a maximum achievable technical potential, they must be discounted to ensure that annual generation per unit of capacity derived in this fashion does not exceed the Monte Carlo-simulated P-99 value for a similar project we have rated.

In the case of energy-efficiency projects, the involved ESCO usually provides the customer with a detailed analysis of estimated energy savings in the form of an Investment Grade Audit (IGA). An IGA is generally required for adherence to standards set by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) for evaluating the energy savings associated with particular energy conservation measures (ECMs).[6] An IGA establishes the current baseline energy consumption of a facility and provides projections on energy consumption after the installation of a proposed set of ECMs. Forecasted savings are presented by relevant fuel/energy type, e.g., electricity in kilowatt hours (kWh), natural gas in million British thermal units (MMBtu), and fuel oil in gallons. Such projects are modeled based on the savings contractually guaranteed by the ESCO to the facility owner/operator. Since this guarantee represents a financial risk to the ESCO, a conservative bias is assumed. One recent study of ESPCs entered into by the federal government found that ESCOs guarantee only 96% of engineering estimates.[7] Unless hourly load impacts are explicitly identified in an IGA, the *Alliance* has allocated annual savings evenly across the 8,760 hours in a year.[8] From a methodological perspective, there is no barrier to matching savings to specific hours, provided such information is available; it has not been available in the IGAs viewed by the *Alliance* to date.

[5] "U.S. Renewable Energy Technical Potentials: A GIS-based Analysis," *National Renewable Energy Laboratory* (July 2012), available at http://www.nrel.gov/gis/re_potential.html.
[6] Additional information on ASHRAE standards and energy audit protocols are available at: https://www.ashrae.org/resources--publications/bookstore/procedures-for-commercial-building-energy-audits.
[7] John Shonder and Bob Slattery, "Reported Energy and Cost Savings from the DOE ESPC Program: FY 2013," *Oak Ridge National Laboratory* (December 2013), esp. 2-3 and 7, available at http://info.ornl.gov/sites/publications/files/Pub47781.pdf.
[8] The hourly profile of building energy consumption varies significantly by building type. Hospitals, for instance, are usually characterized by round-the-clock activity, 365 days per year. College dorms and classrooms are often in steady use from early morning to late evening, but activity is concentrated during the nine-month school year, with a much lighter load during the summer. Even in commercial office buildings where usage peaks during the 9am-to-5pm period, significant energy services are often provided during hours when most occupants are absent. DOE has published prototypical building load profiles; see "Commercial and Residential Hourly Load Profiles for all TMY3 Locations in the United States" at http://en.openei.org/doe-opendata/dataset/commercial-and-residential-hourly-load-profiles-for-all-tmy3-locations-in-the-united-states. Nevertheless, without access to specific profiles, we have opted for a consistent distribution across all hours in the year.

It is not possible to demonstrate that the assumptions for energy-efficiency and renewable-energy projects are equally conservative. However, consistency has been strictly maintained within each overarching category.

Quantifying Electricity-Sector CO_2 Impacts—Leveraging EPA's AVERT

EPA's AVoided Emissions and geneRation Tool (AVERT), released in February 2014, is a publicly available model intended primarily to help state air and energy officials evaluate the impact of proposed energy-efficiency and renewable-energy policy initiatives.[9] AVERT underwent a peer review and beta testing prior to its release. The *Alliance* has leveraged the model's capabilities to measure electricity-sector impacts for *CarbonCount*™.

AVERT uses Air Market Program Data (AMPD) from the EPA's Clean Air Markets Division (CAMD). Under this program, every fossil-fueled electric generating unit (EGU) located within the lower 48 United States with over 25 megawatts (MW) of capacity must report various hourly performance data, including gross generation, heat inputs, as well as emissions of sulfur dioxide (SO_2), oxides of nitrogen (NO_X), and CO_2. In simplest terms, AVERT analyzes historical usage patterns of fossil-fueled EGUs, recorded by the hour and grouped into ten regions, to predict future EGU behavior and, thus, emissions. The AMPD data document when a particular facility operated in the past, how much it generated, and with what resulting emissions at that level of operation (i.e., efficiency of operations will vary at differing generation levels). Then, employing Monte Carlo analysis and other statistical methods, AVERT estimates how each EGU will operate under future regional load scenarios. Finally, on the basis of user-defined load reductions for a particular year, achieved either through efficiency or non-fossil generation, AVERT estimates avoided metric tons of CO_2 for the modeled year. AVERT also calculates avoided SO_2 and NO_x, but these are not factored into the *CarbonCount*™ calculation of climate benefits. Appendix B discusses the capabilities of AVERT at greater length.

Additional CO_2 Impacts

The AVERT model cannot directly capture the CO_2 impacts of fuel-oil or natural-gas usage offset by onsite energy-efficiency improvements, but these are easily calculated using EPA Emissions Factors for Greenhouse Gas inventories.[10] These savings can then be added to the results from the AVERT model for a total CO_2 impact.

Finalizing the Metric

The final steps in generating the *CarbonCount*™ involve apportioning CO_2 impacts for the fraction of project capital provided by bonds and then scaling to a common investment size.

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[9] "AVoided Emissions and geneRation Tool (AVERT) User Manual Version 1.2," *U.S. Environmental Protection Agency* (October 2014).

[10] Emissions from fuel oil and natural gas combusted onsite do not vary by location or time of use; see http://www.epa.gov/climateleadership/documents/emission-factors.pdf.

[11] See "Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants," *Energy Information Administration* (April 2013), available at http://www.eia.gov/forecasts/capitalcost/pdf/updated_capcost.pdf; and "Financing, Overhead, and Profit: An In-Depth Discussion of Costs Associated with Third-Party Financing of

If the total project cost is known, this is a matter of dividing the total issuance by the total project cost and multiplying the CO_2 savings by this fraction. If total project cost is not known (generally only an issue on select renewables investments), an estimate must be developed using generally accepted unit installed costs or, alternatively, the present value of projected cash flows.[11] The CO_2 emissions attributable to the green bond share of the underlying project are then divided by the face value, in dollars, of the bond offering and multiplied by 1,000. Results are expressed in metric tons of CO_2 (CO_2e) offset per $1,000 of the bond.

How *CarbonCount*™ Works

- Obtain Investment Grade Audit or Independent Engineer's Analysis for bond's underlying project[s].
- Estimate hourly load impacts for a full-year (8,760 hours), allocated to each relevant region among the ten regions in EPA's AVERT model,

  --energy savings for efficiency projects (even distribution, unless hourly info available), and
  --generation for renewables projects (distributed according to NREL data).
- Run AVERT to estimate electric-sector CO_2 emissions reductions for one year.
- Use EPA Emission Factors to calculate CO_2 impacts for non-electric energy savings (e.g., thermal components of energy-efficiency projects).
- Calculate the share of total project capital funded through the bond offerings and associate these with proportional share of CO_2 impacts.
- Derive *CarbonCount*™ → annual carbon savings per $1,000 (face value) bond investment.

Given the design of AVERT, we use only one of CO_2 savings when assessing the bond, even though the capital basis covers the full lifetime of the project. To be clear, ***CarbonCount*™ *is not an effort to predict lifetime carbon savings*** for particular investments. Rather, it is a metric built upon ***estimated carbon savings over one year evaluated against capital deployed***. Instead of pushing the AVERT model beyond the near-term range where it is most accurate, we suggest thatinvestors seeking to gauge carbon impacts over an extended period cautiously extrapolate *CarbonCount*™ values to reflect time-to-maturity, degradation/improvement in project performance, and changes in the relevant generation mix.

CarbonCount™ is designed to permit near-term impact comparisons of various carbon-reducing investment opportunities. Whether the market will share our preference for a robust one-year metric over softer life-time projections remains to be seen; in this regard, we note that the German development bank KfW recently employed a similarly conservative approach when it scored its own U.S. dollar-denominated green bonds.[12]

Residential and Commercial Photovoltaic Systems," *National Renewable Energy Laboratory* (October 2013), available at http://www.nrel.gov/docs/fy14osti/60401.pdf.

[12] "Green Bonds – Made by KfW," (September 2014); see http://www.sec.gov/Archives/edgar/data/821533/000119312514346549/d792167dfwp.htm.

The *CarbonCount*™ results for the bonds studied to date, in metric tons of CO_2 offset annually per $1,000 bond, are as follows:

Continental Wind	Milford Wind	SolarCity	Topaz Solar	Hannon Armstrong
~1.037	**~0.392**	**~0.161**	**~0.198**	**~0.522**

Detailed reports on these bonds are included in Appendix A. Anyone using *CarbonCount*™ is advised to examine these reports closely. In particular, it is important to carefully evaluate the primary drivers of the resulting metric—project cost (which may include items that do not directly contribute to power generation or energy savings) and regionally specific emissions situations—as these may lead to markedly different scores for apparently similar projects.

	Continental Wind	Milford Wind	SolarCity	Topaz Solar
Total Project Cost	$1,140,000,000	$505,000,000	$198,428,000	$2,592,300,000
Derived Cost Per MW	$1,709,145	$2,481,572	$4,520,000	$4,423,720
Plant Capacity (MW)	667	203.5	43.9	586
P99 Capacity Factor	30.2%	25%	16.1%	22.4%
P99 MWh per year	1,765,000	445,919	61,756	1,152,694
Effective Emissions Factor (tCO2/MWh)	0.670	0.444	0.517	0.446
Face Value of Bond	$635,000,000	$240,000,000	$54,425,000	$850,000,000
Bond Contribution to Project Cost	55.7%	47.5%	27.43%	32.8%

In the above comparison of renewable-generation investments, for example, consider the cases of Continental Wind and Milford Phase One. Both are utility-scale wind projects, but with *CarbonCount*™ scores that differ significantly—Continental delivers 165% more impact than Milford (1.037 versus 0.392 metric tons per $1,000 bond). This disparity merits attention, precisely, because it helps reveal the strength—and the limitations—of *CarbonCount*™.

The derived cost per MW for Milford Phase One is 45% higher than for Continental Wind, in part because the former project includes an 88-mile transmission line build out. Factor out this cost, at an estimated $500,000 per mile of constructed line, and Milford's derived cost per MW declines to $2,265,000, 33% greater than Continental's, while the *CarbonCount*™ gap falls to 0.61. That remaining difference is partly explained by Continental's higher capacity factor, which has been estimated at a level approximately 21% higher than Milford's. Were Milford the equal of Continental in underlying resource potential, its *CarbonCount*™ score would rise accordingly, though a gap between the two projects would still remain.

Project design and resource quality are not the only factors that influence carbon impacts, however. Carbon-avoiding investments that impact power generation in relatively carbon-intensive regions yield greater carbon savings than similar investments made in regions where the power sector has begun to decarbonize. For example, Continental—whose turbines are located in several states—is designed to supplant fossil-fueled generation in regions of the country where the power sector is heavily reliant on coal. In contrast, Milford—while sited in Utah, a state whose own electricity demand is satisfied disproportionately by coal generation[13]—sells its

[13] See http://www.eia.gov/state/?sid=UT - tabs-4.

output into the California market, thus displacing generation there. California has already eliminated all the coal-powered generation from its dispatch fleet. Renewable power sold into the relatively low-carbon California system (largely powered by natural gas, nuclear, hydro and other renewables) necessarily results in fewer avoided carbon emissions than renewable power routed into a coal-reliant market.

Ultimately, *CarbonCount*™ treats projects as they are presented, accepting that developers, seeking to optimize returns, are the best judges of the scope of their own capital needs. Capacity factors and transmission needs are likely rooted in a complex calculus that weighs resources, location, demand, incentives, and technology, among other variables.[14] *CarbonCount*™ is designed to reveal how such matters affect the efficiency of carbon reduction over a relatively limited time horizon. Its one-year snapshot of carbon reductions is not intended as a short-cut around the multivariate analysis that should precede any investment decision. But it does offer investors an important basis for comparing carbon impacts across varying technologies, locations, and project designs.

Conclusion

CarbonCount™ is an intentionally simplified solution to a complex problem, but we believe it achieves what it was designed to accomplish:

- Provide a quantitative measure of CO_2 emissions reductions/offsets per unit of investment that U.S. bond buyers can use today to evaluate the carbon impacts of specific projects;
- Leverage information that is already included in standard offerings that issuers provide to credit ratings agencies and potential buyers; and
- Offer a transparent methodology that can be vetted and accessed by third parties.

In sum, investors told the *Alliance* that a quantitative metric of climate benefits could help accelerate the market for green bonds. In response, we designed *CarbonCount*™. Now let's see whether our efforts have produced a tool that will help accelerate capital flows toward green investments. At the end of the day, that's the only measure that counts.

[14] For example, transmission costs almost certainly need to be included for bonds backed by offshore wind projects.

Appendix A: Detailed Bond Reports

Continental Wind LLC Senior Secured Bonds

~1.037 Metric Tons of CO_2 Offset per $1,000 Bond

Issuer: Continental Wind LLC, subsidiary of Exelon Corp.
Bond Face Value: $635,000,000
Issue Date: September 2013
Location: ID, KS, MI, NM, OR, and TX
Notable Features: Geographically diverse but with dominant (60%+) exposure in MI

Inputs and Assumptions:

Total Project Cost	$1,140,000,000
Derived Cost Per MW	$1,709,145
Plant Capacity (MW)	667
P99 Capacity Factor	30.2%
P99 MWh Per Year	1,765,000
Effective Emissions Factor (tCO2/MWh)	0.670
Face Value of Bond	$635,000,000
Bond Contribution to Project Cost	55.7%

Bond Overview:
The Continental Wind LLC Senior Secured Bonds were used to refinance the construction cost of a 13 project wind portfolio with a total capacity of approximately 667 MW distributed across the United States. The projects achieved commercial operation between 2009 and 2012 for a total capital cost of $1.13 billion. The projects are located in Michigan (4), Idaho (4), Kansas (2), Texas (1), New Mexico (1) and Oregon (1). The projects are owned by Exelon Generation Co., LLC, and the electricity generated is purchased under long-term PPA contracts with eight different investor-owned, cooperative, and municipal utilities. Given that the bond investor's funds are exclusively used to refinance the underlying wind projects, the associated grid electricity offset and the corresponding quantity of greenhouse-gas emissions reduced are attributed to the bond investor based on their bond purchase amount.

Energy Offset Assessment
DNV KEMA Renewables Inc. (DNV) served as the independent engineer responsible for evaluating the wind resources at the various project sites and provided stress tested electricity generation output projections for the projects. The annual generation output estimates are based on Monte Carlo stress testing and a P-99 distribution, which means in any given year, there is a 99% probability that actual generation will exceed the modeled amount. DNV estimated that the projects will generate approximately 1,765,000 MWh of electricity under the P-99 scenario for an effective capacity factor of 30.2%. This scenario was used by Moody's Investors Service and Standards & Poor's Financial Services in order to determine a credit rating for the portfolio of projects. This P-99 generation output estimate was also used to determine the associated environmental impact. Below is an estimate of the MWh by site as provided in DNV's independent engineer's report included as part of the bond offering memorandum.

Project	State	MW Capacity	IE P99 1yr production data
Harvest II	MI	59.4	169,000
Beebe	MI	81.6	179,000
Michigan Wind 2	MI	90.0	262,000
Harvest	MI	52.8	118,000
Tuana Springs	ID	16.8	28,000
Cassia	ID	29.4	59,000
High Mesa	ID	39.9	83,000
Mountain Home	ID	42.0	81,000
Greensburg	KS	12.5	39,000
Shooting Star	KS	104.0	377,000
Whitetail	TX	91.2	242,000
Wildcat	NM	27.3	80,000
Echo II	OR	20.0	48,000
Total		**666.9**	**1,765,000**

Environmental Impact Assessment
The U.S. Environmental Protection Agency's AVERT was utilized to evaluate the annual emissions impact of the underlying projects' generation of zero emissions electricity and the impact of offsetting CO_2 intensive generating units serving the electricity grid. AVERT models U.S. emissions impacts of new renewable-energy and energy-efficiency projects given 10 different geographic subregions, the respective electricity generating load profiles, and the associated emissions intensity per MWh of each generating unit over 25 MW in capacity serving the grid. The MWhs generated by the projects were summed by the 5 relevant subregions in which the projects are located. In order to model the impact of the MWh generated by the project on CO_2 emissions, the annual P-99 MWh was first distributed on an hourly basis across a 365-day calendar year to reflect average wind variability in the 5 specific subregions as reported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy. The hourly MWh distribution was then input into AVERT. The impact by subregion and total for the portfolio of projects is listed below.

EPA AVERT Model US Subregion	Metric tons of CO2 Offset Annually
Northwest	185,610
Southwest	40,914
Texas	142,156
Great Lakes/Mid-Atlantic	507,298
Lower Midwest	306,538
Total	**1,182,516**

Environmental Impact Attributable to Bond Investor Funds
Given that the bond proceeds refinanced approximately 55.7% of implementation costs of the underlying project, the estimated impact attributable to the bond issuance equals 55.7% of the total annual offset associated with the underlying projects or 658,682 tCO2. The impact per $1,000 bond equals the offset attributable to the bond issuance divided by the face value of the bonds. **Per $1,000 bond, emissions will be reduced by approximately 1.037 tCO2 annually.**

Southern California Public Power Authority's
Milford Phase One Revenue Bonds
~0.392 Metric Tons of CO_2 Offset per $1,000 Bond

Issuer: Southern California Public Power Authority
Bond Face Value: $240,000,000
Issue Date: January 2010
Location: UT
Notable Features: Selling into low-carbon CA market (90%+ ownership by Los Angeles Department of Water and Power); project includes an 88-mile, 1,000-MW transmission line

Inputs and Assumptions:

Total Project Cost	$505,000,000
Derived Cost Per MW	$2,481,572
Plant Capacity (MW)	203.5
P99 Capacity Factor	25%
P99 MWh Per Pear	445,919
Effective Emissions Factor (tCO2/MWh)	0.444
Face Value of Bond	$240,000,000
Bond Contribution to Project Cost	47.5%

Bond Overview
The Milford Phase One Revenue Bonds were used to fund the prepayment by Southern California Public Power Authority of the electricity to be generated by a 203.5 MW wind farm over the 20-year delivery term of the project's power purchase agreement (PPA). The prepayment structure and associated bond proceeds were used to finance approximately 48% of the project's installed cost of approximately $505 million.[15] A portion of this project cost funded the construction of an 88-mile, 1,000-MW transmission line. The 97-turbine wind farm located near Milford, Utah, approximately 200 miles southwest of Salt Lake City, reached commercial operation in November 2009 and has met the annual generation output estimates guaranteed under the PPA for the years 2009-2013. First Wind developed and currently operates and maintains the project. Given that the bond investor's funds were exclusively used to finance the underlying wind projects, the associated grid electricity offset and the corresponding quantity of greenhouse-gas emissions reduced are attributed to the bond investor based on their bond purchase amount.

Energy Offset Assessment
Moody's Investors Service estimated the annual generation output of the Milford Phase One project to be approximately 445,919 MWh zero emissions electricity. This annual generation output estimate is based on Monte Carlo stress testing and a P-99 distribution, which means in any given year there is 99% probability that actual generation will exceed the modeled amount. This P-99 generation output estimate was used to determine the associated environmental impact.

[15] First Wind Holdings Inc. Form S-1., p. 117; see http://www.nasdaq.com/markets/ipos/filing.ashx?filingid.

Environmental Impact Assessment

While the wind farm is located in Utah, the electricity generated by the project is transmitted to California. The zero emissions electricity generated by the project offsets approximately 0.44% of the annual electricity previously supplied by existing electricity generating units serving the California electricity grid. In order to model the impact of the MWh generated by the project on CO_2 emissions, the annual P-99 MWh was first distributed on an hourly basis across a 365-day calendar year to reflect average wind variability in California as reported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy. The hourly MWh distribution was then input into the U.S. Environmental Protection Agency's AVERT. AVERT models U.S. emissions offsets given 10 different geographic subregions, the electricity generating load profiles, and the associated emissions intensity per MWh of each generating unit serving the grid over 25 MW. Given that the electricity generated by the Milford project offsets more CO_2 intensive generating units on the California electricity grid, the California-specific AVERT element was used to estimate that the project will offset annual emissions by approximately 197,857 metric tons of CO_2 emissions.

Environmental Impact Attributable to Bond Investor Funds

Given that the bond proceeds financed approximately 48% of implementation costs of the underlying project, the estimated impact attributable to the bond issuance equals 48% of the total annual offset associated with the underlying projects or 94,031 tCO_2. The impact per $1,000 bond equals the offset attributable to the bond issuance divided by the face value of the bonds. **Per $1,000 bond, emissions will be reduced by approximately 0.392 tCO_2 annually.**

SolarCity Series I LMC 2013-1 Bonds
~0.161 Metric Tons of CO_2 Offset per $1,000 Bond

Issuer: SolarCity Corp
Bond Face Value: $54,425,000
Issue Date: November 2013
Location: various, but 90% of portfolio in AZ, CA, and CO
Notable Features: distributed generation

Inputs and Assumptions:

Total Assumed Project Cost	$198,428,000
NREL Assumed Cost Per MW for Residential Solar	$4,520,000
Total Portfolio Capacity (MW)	43.9
Assumed Capacity Factor	16.1%
MWh Per Year	61,756
Effective Emissions Factor (tCO2/MWh)	0.517
Face Value of Bond	$54,425,000
Bond Contribution to Project Cost	27.43%

Bond Overview:
The SolarCity Series I LMC 2013-1 Bonds are asset-backed securities supported by 5,033 operational rooftop and ground-mounted solar PV systems. The systems have a total capacity of 43.9MWs distributed across the United States and represent a total collateral value of approximately $198,428,000. Residential systems make up approximately 90% of the total collateral value, with commercial systems making up the remaining portion. The electricity output from the underlying PV systems is purchased through solar lease contracts and power purchase agreements. The payments from such contracts support the principle and interest payments due to bond investors. The overcollateralization, the difference between the bond face value and the total collateral value, is a risk enhancement used to make the bond more attractive to bond investors. This issuance was the first distributed solar PV ABS of its kind and SolarCity has subsequently issued two similar, larger ABS offerings. Given that the bond investor's funds are exclusively used to refinance the underlying solar assets, the associated grid electricity offset and the corresponding quantity of greenhouse gas emissions offset are attributed to the bond investor based on their bond purchase amount.

Energy Offset Assessment
To estimate the electricity generation output of the portfolio, the total MW capacity located in a particular state was multiplied by the National Renewable Energy Laboratory's state specific average rooftop solar capacity factors and the number of hours in a year. The total estimated annual output of the systems was approximately 61,755 MWh, for an approximate portfolio capacity factor of 16.1%. The table below illustrates how this output was distributed across United States subregions.

US Subregion	Approximated Annual MWh	% of Total MWh
California	28,979	47%
Southwest	18,963	31%
Rocky Mountains	6,730	11%
Mid-Atlantic	3,377	5%
Northeast	1,821	3%
Hawaii	1,378	2%
Northwest	508	1%
Total	**61,756**	

Environmental Impact Assessment

The U.S. Environmental Protection Agency's AVERT was utilized to evaluate the annual emissions impact of the underlying projects' generation of zero emissions electricity and the impact of offsetting CO_2 intensive generating units serving the electricity grid. AVERT models U.S. emissions impacts of new renewable-energy and energy-efficiency projects given 10 different geographic subregions, the respective electricity generating load profiles, and the associated emissions intensity per MWh of each generating unit serving the grid over 25 MW. The MWhs generated by the projects were summed by the 6 relevant subregions in which the projects are located. The annual estimated MWh output for each subregion was then distributed on an hourly basis across a 365-day calendar year to reflect average solar variability in the 6 specific subregions as reported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy. The hourly MWh distribution was then input into AVERT. Given that the state of Hawaii is not included as part of the AVERT, the EPA eGRID annual CO_2 emission rate for non-baseload generating units was used to determine the impact of the solar PV systems located in Hawaii. The impact by subregion and total for the portfolio of projects is listed below.

US Subregion	AVERT tCO2 Offset Estimate	eGRID tCO2 Offset Estimate	
California	12,973		
Southwest	9,525		
Rocky Mountains	4,899		
Mid-Atlantic	2,268		
Northeast	907		
Northwest	363		
Hawaii		1,012	
Total	**30,935**	**1,012**	**31,947**

Environmental Impact Attributable to Bond Investor Funds

Given that the bond proceeds financed approximately 27.4% of implementation costs of the underlying project, the estimated impact attributable to the bond issuance equals 27.4% of the total annual offset associated with the underlying projects or 8,762 tCO_2. The impact per $1,000 bond equals the offset attributable to the bond issuance divided by the face value of the bonds. **Per $1,000 bond, emissions will be reduced by approximately 0.161 tCO_2 annually.**

Topaz Solar Farms LLC Series A Senior Secured Bonds
~0.198 Metric Tons of CO_2 Offset per $1,000 Bond

Issuer: MidAmerican Energy Holdings
Bond Face Value: $850,000,000
Issue Date: February 2012
Location: CA
Notable Features: thin-film modules

Inputs and Assumptions:

Total Project Cost	$ 2,592,300,000
Derived Cost Per MW	$ 4,423,720
Plant Capacity (MW)	586
P99 Black & Veatch Assumed Capacity Factor	22.4%
P99 MWh Per Year	1,152,694
Effective Emissions Factor (tCO2/MWh)	0.446
Face Value of Bond	$ 850,000,000
Bond Contribution to Project Cost	32.8%

Bond Overview
The Topaz Solar Farms LLC Series A Senior Secured Bonds were used to refinance the construction cost of a 586 MWac solar PV power project in San Luis Obispo, California. Construction on the project began in December 2011 and achieved commercial operation ahead of schedule in November 2014. The Topaz project is the largest commercially operational solar PV project in the world and comprises 9 million thin-film solar panels spread across 9.5 square miles. The project was developed by First Solar, is owned by MidAmerican Energy Holdings, and the output generated by the project will be purchased by Pacific Gas & Electric under a 20-year power purchase agreement. Given that the bond investor's funds are exclusively used to refinance the underlying solar project, the associated grid electricity offset and the corresponding quantity of greenhouse gas emissions reduced are attributed to the bond investor based on their bond purchase amount.

Energy Offset Assessment
Black & Veatch, the Independent Engineer for the project, estimated the annual generation output of the Topaz project to be approximately 1,152,694 MWh zero emissions electricity. This annual generation output estimate is based on Monte Carlo stress testing and a P-99 distribution, which means in any given year, there is 99% probability that actual generation will exceed the modeled amount. This P-99 generation output estimate was used to determine the associated environmental impact.

Environmental Impact Assessment
The zero-emissions electricity generated by the project offsets approximately 1.14% of the annual electricity previously supplied by existing electricity generating units serving the California electricity grid. To model the impact of the MWh generated by the project on CO_2 emissions, the annual P-99 MWh projection was first distributed on an hourly basis across a 365-day calendar year to reflect average solar radiance variability in California as reported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy. The hourly MWh distribution was then input into U.S. Environmental Protection Agency's AVERT. AVERT models

U.S. emissions impacts of new renewable-energy and energy-efficiency projects given 10 different geographic subregions, the respective electricity generating load profiles, and the associated emissions intensity per MWh of each generating unit serving the grid over 25 MW. Given that the generating output of the Topaz project offsets more CO_2 intensive generating units on the California electricity grid, the California-specific AVERT element was used to estimate that the project will offset annual emissions by approximately 514,283 metric tons of CO_2 emissions.

Environmental Impact Attributable to Bond Investor Funds
Given that the bond proceeds financed approximately 33% of implementation costs of the underlying project, the estimated impact attributable to the bond issuance equals 33% of the total annual offset associated with the underlying projects or 168,630 tCO_2. The impact per $1,000 bond equals the offset attributable to the bond issuance divided by the face value of the bonds. **Per $1,000 bond, emissions will be reduced by approximately 0.198 tCO_2 annually.**

HASI Sustainable Yield Bond—Representative Example

~0.522 Metric Tons of CO_2 Emissions Offset per $1,000 Bond

Issuer: Hannon Armstrong
Representative Bond Face Value: $101,000,000
Location: CA, CO, DC, KS, MD, MO, NM, PA, TX, VA, and WI
Notable Features: diverse technology/project portfolio

Inputs and Assumptions:

Total Project Cost	$112,486,462
Effective Emissions Factors:	
tCO2/MWh	0.634
kg CO2/mmbtu of nat gas	53.06
kg CO2/mmbtu of coal	94.27
kg CO2/mmbtu of district steam	66.33
kg CO2/gallon of fuel oil	10.21
Face Value of Example Bond	$101,237,815
Bonds Contribution to Project Costs	90%

Bond Overview

The HASI Sustainable Yield Bond (SYB) is a representative example of an estimated $101 million face value bond secured by governmental energy savings performance contract (ESPC) projects. The sample bonds analyzed below are backed by 13 different energy efficiency projects in 11 different states across the United States each averaging approximately $8.6 million in upfront capital costs, for a total collateral value of approximately $112 million. The projects employ a variety of different energy conservation measures (ECMs) including LED lighting, high efficiency chillers, HVAC variable-speed motors, low-flow water fixtures, automated building controls, and switching from fuel-oil to natural-gas heating systems. Assuming a 90% advance rate on the capital costs, the amount financed would be approximately $101 million. The associated savings in electricity, natural gas, fuel oil, and coal consumption and the corresponding quantity of greenhouse gas emissions reduced are attributed to the bond investor based on their bond purchase amount.

Energy Offset Assessment

The energy service companies (ESCOs) that designed and engineered the ECMs to be implemented at the 13 projects develop Investment Grade Audits (IGA) that present estimates of the amount of electricity, natural gas, and other commodities that will be saved through the implementation of a proposed project. There is a high degree of engineering analysis that goes into the development of such IGAs and the estimation methodologies have been standardized under what is known as the ASHRAE standard.[16] In addition, as part of the value proposition to customers, the ESCOs developing the project guarantee the savings presented in these IGAs. The data from the IGAs detailing annual energy savings estimates serve as the basis of the bond's environmental impact assessment. The data input into the emissions modeling software are 96% of the total savings estimated by the ESCOs and the amount guaranteed by ESCOs under the

[16] Procedures for Commercial Building Audits. American Society of Heating, Refrigerating and Air-Conditioning Engineers; see https://www.ashrae.org/resources--publications/bookstore/procedures-for-commercial-building-energy-audits.

typical ESPCs.[17] As compared to the baseline usage of the site prior to implementation, the underlying ECMs at the 12 projects will approximately reduce annual consumption of:

Electricity by	46,004	MWh
Natural Gas by	387,914	MMBtu
Fuel Oil by	86,108	gallons
Coal by	37,323	MMBtu
Heating Steam by	69,510	MMBtu

Environmental Impact Assessment
The U.S. Environmental Protection Agency's AVERT was utilized to evaluate the annual emissions impact of the underlying projects' electricity savings. AVERT models U.S. emissions reductions given 10 different geographic subregions and associated generating load profiles. The MWhs saved for the projects were summed by subregion and input into the relevant AVERT regional elements to determine the associated metric tons of carbon dioxide emissions (tCO_2) reduced annually. Given that the natural gas, fuel oil, coal, and steam savings are localized at the specific project sites and the emissions are not impacted by region electricity grid load curves, the EPA's 2014 Stationary Combustion Emission Factors were used to determine the associated tCO2 offset.[18] The table below provides detail on impact by source.

	tCO2 Offset Annually
MWh Impact	29,175
NG Impact	20,583
Fuel Oil Impact	879
Coal Impact	3,518
Steam Impact	4,611
Total Annual Offset Associated with the 12 Projects	**58,766**

Environmental Impact Attributable to Bond Investor Funds
Given a hypothetical advance rate of 90% of implementation costs of the underlying projects, the estimated impact attributable to the bond issuance equals 90% of the total annual offset associated with the underlying projects or 52,889 tCO_2. The impact per $1,000 bond equals the offset attributable to the bond issuance divided by the face value of the bonds. The water savings attributable to the bond issuance are calculated in the same manner. **Per $1,000 bond, emissions will be reduced by approximately 0.522 tCO_2 annually**.

[17] John Shonder and Bob Slattery, "Reported Energy and Cost Savings from the DOE ESPC Program: FY 2013," *Oak Ridge National Laboratory* (December 2013), esp. 2-3 and 7, available at http://info.ornl.gov/sites/publications/files/Pub47781.pdf.

[18] EPA Emissions Factors for GHG Inventories, updated 4 April 2014; see http://www.epa.gov/climateleadership/documents/emission-factors.pdf.

Appendix B: Emissions modeling with AVERT

Methods for estimating displaced emissions vary considerably in complexity. For example, a very basic method relies on average annual emissions rates for electricity produced by the non-baseload electric generating units (EGU) in particular regions. Annual output or savings associated with renewable-energy or energy-efficiency projects are then multiplied by the relevant emissions rate in order to estimate the amount of emissions avoided. The eGRID model developed by the U.S. Environmental Protection Agency (EPA) operates in this fashion.[19] While the eGRID approach is appealing in its simplicity, its drawbacks are substantial. It fails to account for the transmission of electricity between states and does not capture how the intra-day timing of efficiency savings and renewables production impacts emissions.

At the opposite end of the complexity spectrum are elaborate simulations that are employed to predict individual EGU dispatch, commitment, and emissions levels.[20] These simulations forecast production at the site level based on complex functions that capture operational costs as well as transmission constraints. Such fidelity to operational and economic realism is data intensive and costly to achieve, and the required inputs are often proprietary.

EPA's AVoided Emissions and geneRation Tool (AVERT) exceeds eGRID in forecasting power, while avoiding the data availability and cost issues inherent in the use of proprietary grid operator dispatch models.[21] AVERT uses Air Market Program Data (AMPD) from the EPA's Clean Air Markets Division (CAMD). Under this program, every fossil-fueled EGU located within the lower 48 United States with over 25 megawatts (MW) of capacity must report various hourly performance data, including gross generation, heat inputs, as well as emissions of sulfur dioxide (SO_2), oxides of nitrogen (NO_X), and CO_2.

In simple terms, AVERT analyzes historical usage patterns of fossil-fueled EGUs, recorded by the hour and grouped into ten regions, to predict future EGU behavior and, thus, emissions. The AMPD data document when a particular facility operated in the past, how much it generated, and with what resulting emissions at that level of operation (i.e., efficiency of operations will vary at differing generation levels). Then, employing Monte Carlo analysis and other statistical methods, AVERT estimates how each EGU will operate under future regional load scenarios. Finally, on the basis of user-defined AVERT load reductions for a particular year, achieved either through efficiency or non-fossil generation, AVERT estimates avoided metric tons of CO_2 for the modeled year. (AVERT also calculates avoided SO_2 and NO_x, but these are not factored into the *CarbonCount*™ calculation of climate benefits).

Like all models based on historical data, AVERT should only be relied upon to predict behavior in a future where generally similar conditions prevail. In other words, AVERT is useful for estimating the impacts of marginal changes, but it cannot be expected to provide meaningful results when critical facts, such as the makeup of the generation portfolio, fuel costs, or electricity prices, have altered significantly. These factors are external to the model, and their basic consistency must be ensured by users. Internally, AVERT provides diagnostic tools (e.g., scatter plots) to evaluate the statistical validity of results, and these are especially important when testing

[19] See http://www.epa.gov/cleanenergy/energy-resources/egrid/.
[20] See Trieu Mai et al., "Resource Planning Model: An Integrated Resource Planning and Dispatch Tool for Regional Electric Systems," *National Renewable Energy Laboratory* (January 2013), available at http://www.nrel.gov/docs/fy13osti/56723.pdf.
[21] "AVoided Emissions and geneRation Tool (AVERT) User Manual Version 1.2," *U.S. Environmental Protection Agency* (October 2014).

smaller projects. EPA does not identify a threshold lower bound where AVERT use is not advisable, but validity does decline as the modeled generation changes decrease in size.

In clear distinction to proprietary dispatch models, AVERT does not develop generation trajectories over time for individual EGUs; rather, it forecasts each hour discretely and, as a result, misses the impacts (e.g., on efficiency or operational reliability) of ramping and rapid cycling of the plant. AVERT's regional structure is also a major simplification of reality, since it assumes that each region is an independent island and that transmission within each region will be unaffected by new load profiles.

In sum, the AVERT model couples plant-specific generation and emissions information with load reduction profiles—hour for hour. It is available to the public at no charge, runs on Microsoft® Excel, and uses data that are submitted annually to EPA for every major U.S. EGU outside of Hawaii and Alaska. In addition, the EPA is committed to updating and enhancing AVERT on a periodic basis. And while AVERT cannot account for major changes in dispatch due to unforeseen shifts in fuel prices, emissions allowances, or demand for electricity, under relatively stable conditions it has good predictive value over the near term (through not more than five years from the base year data, according to EPA).[22]

[22] *Ibid*., 10.