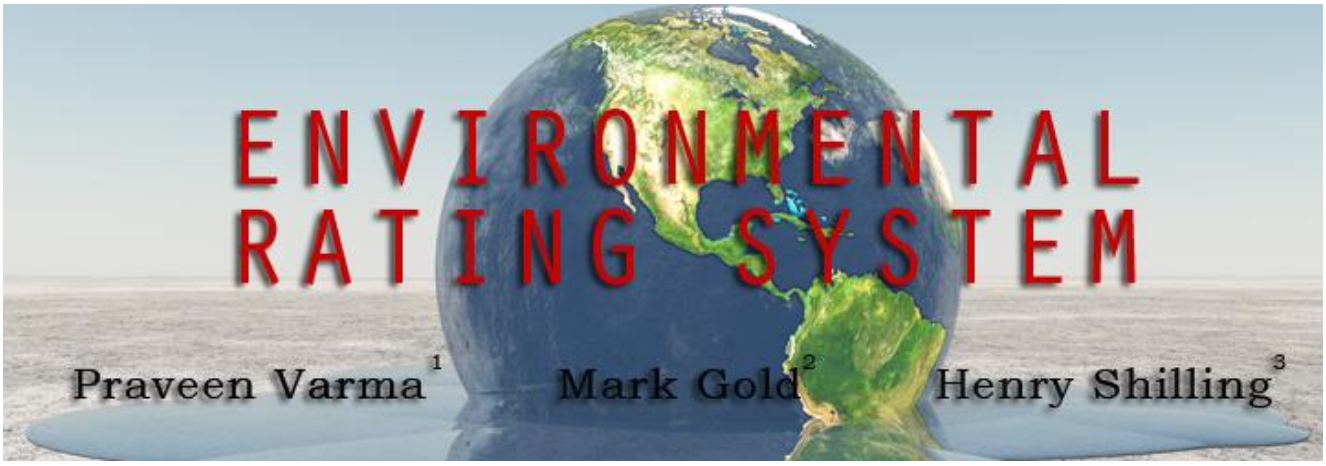
ENVIRA®



We propose an environmental rating system in which public companies are rated based on the amount of unremedied pollution they produce. The objective of this rating system is to more fully account for externalities which are created when companies pass a portion of such costs for society to bear. Efforts to transfer such externalities back to producers like carbon taxes, Cap-n-Trade and even some efforts by ESG rating agencies, have not been very successful. Our proposed ratings could be used to introduce such costs into the system of, for example, market prices via a ratings-based surcharge on security issuance which would be remitted as a tax to the government. The rating system has an easy to understand scale that goes from Aaa (best) to C (worst)

Our rating system can be used in many ways by:

- Policymakers and regulators, who can use these ratings to impose regulation that requires companies to internalize costs of externalities based on our ratings.

- Credit rating agencies as a direct input to their credit analysis. Since the proposed rating system quantifies the cost of externalities in monetary terms, credit rating agencies can use Environmental Ratings to calibrate financial data to appropriately reflect the environmental costs companies might be forced by regulation to internalize.

- Asset managers and investors interested in investing in companies that are creating less environmental damage to society. Our proposed ratings delineate the best from the worst offering investors clear and easy to understand choices.

- Companies themselves, in performing a self-assessment and identifying ways to improve their ratings and executing strategies to do so.

Envira, LLC. ©All rights reserved

54 West 40th Street, New York, NY 10018

Please send all your questions and comments to Praveen.Varma@EnviroRatings.com

- Environmentally conscious consumers, who may choose to buy products from companies that are rated higher on the proposed rating scale.

- Various corporate and financial organizations that may wish to adapt the proposed rating system to create benchmarks for evaluation purposes, investment products and structure various financial instruments linked to pollution reduction initiatives.

The system proposed here is simple and easy to understand and can be applied to companies globally without being distorted by policy or politics.

While markets facilitate the efficient allocation of resources, they do so imperfectly and therefore end up creating problems of sub-optimal allocation. One of such recognized problems is that of externalities—costs of commercially productive activity which are not included and recovered in the system of input and output market prices. The great examples of externalities are unrecovered costs of pollution and environmental degradation as a result of business activity. A particularly important case is that of greenhouse gas (GHG) emissions. As Nobel laureate William Nordhaus has put it: "The economics of the greenhouse effect is a classic case of a public good, in which emissions of GHGs involve global externalities."[1] GHGs have been linked to global warming with associated consequences of rising sea levels, increased numbers and severity of extreme weather events and natural disasters, heat-stressed ecosystems, and other economically adverse effects. Historic levels of carbon dioxide and other greenhouse gas emissions have been quantified by a number of recently issued scientific reports updating previous

assessments[2]. Soil and water pollution are other important but not yet fully quantified examples of global externalities.

These unrecovered costs can be considerable. The impact of chemical and particulate air pollution on health has been estimated at $5.11 trillion in welfare losses globally for 2013.[3] Climate change is also having significant adverse effects.[4] The Interagency Working Group on the Social Cost of Carbon established by the Obama administration has estimated such losses to be about $47 per ton of GHG emissions.[5] Such number may seem small but when multiplied by the total amount of GHG produced, for example, 37.1 billion tons in 2018,[6] social cost of CO_2 produced in just one year translates to roughly $1.5 trillion for 2018 alone, more than $200 per person on earth. While the global warming effect of GHG emissions has been well documented and is accepted science, progress is being made in evaluating and quantifying the impact of other pollutants and they are also expected to be significant. For example, air pollutants like PM2.5 and PM10 that are caused by burning of solid fossil fuels, hazardous chemicals used in mining and fracking, and agricultural (livestock as well as crops) waste and fertilizer runoff in soil and water also impose considerable social costs.

Policy makers use several approaches to address the expense and hazards of pollution externalities including i) regulation, ii) remediation and iii) taxation. Often, policy makers combine one or more of these approaches to achieve particular goals. (Please see sidebars).

Policy action has been somewhat successful in moderating the growth in pollution though it is still increasing at an alarming pace, it has been less successful in recovering costs. Regardless, none of these approaches have worked effectively to reduce GHG emissions and other pollutants in our environment.

There are two reasons that these approaches have failed to successfully address the issue of pricing and internalizing of these externalities. The first reason is the non-uniformity of the approaches taken by various governments and regulatory bodies. For example, carbon taxes (or non-taxation) have been set at very different levels in different countries (Please see SIDEBAR - Taxation). The second reason is the lack of a uniform global standard system that can be applied to all companies in polluting industries. For example, one ton of GHG emissions produced by power generation, automobiles, or steel industry has the same effect on global warming regardless of the countries or regions in which these industries or companies are located. However, due to various political-economic reasons, different industries are treated differently. Even same industries face differential economic, legal and regulatory regimes across different countries.[7]

To overcome these challenges and to more fully account for the pollution costs transferred to society so that they can be transferred back to polluting industries and companies within these industries, we propose a globally uniform environmental rating system for polluters (and polluting industries). Among other uses as discussed elsewhere, this rating system can be used to apply a surcharge, or a P.A.T (Pollution Added Tax) per standardized unit of economic output.

The concept of ratings is well accepted worldwide. Markets price bonds or other types of debt based on credit ratings provided by a credit rating agency like Moody's, Morningstar, Fitch or S&P. Similarly, consumers debt is priced based on credit-scores issued by credit

bureaus which are a function of, among other things, a consumer's history of availing, usage and repayment of debt.

Effort to include environmental risk[8] in credit and other analysis has been underway for some time. For example, several credit ratings agencies have made efforts to incorporate environmental, social and governance (ESG) risks in their credit ratings framework due to heightened concerns and awareness of ESG issues. They have attempted to be more transparent regarding the way ESG issues factor into rating assessments.[9, 10]

Moody's Investors Service, has developed a "Green Bond Assessment" which focuses on the proclaimed use of issuance proceeds and practices relative to environmental goals rather than the likelihood of repayment. [11] (Please see sidebar on Green Bonds). Moody's has recently published a Request for Comment (RFC) in which it is proposing a new rating scale CT-1 through CT-10 to assess the carbon transition risk to an issuer as opposed to social cost imposed by an entity on the society. [12] These assessments while providing more transparency have two significant limitations. One, the pollution externalities of the issuer's total business activity are not measured and/or quantified in this framework. Two, a company can get a very high green bond assessment (or GB1 in Moody's Scale of GB1 to GB5 for Green Bond Assessments) as long as the proceeds from that particular bond, however small compared to the company's total capital, are stated as to be used for "green initiatives."

These assessments while providing more transparency have two significant limitations. One, the pollution externalities of the issuer's total business activity are not measured and/or quantified in this framework. Two, a company can get a very high green bond assessment (or A in Moody's Scale of A to D for Green Bond Assessments) as long as the

proceeds from that particular bond, however small compared to the company's total capital, are stated as to be used for "green initiatives." Fitch's ESG Relevance Scores speak about "how environmental, social and governance (ESG) factors impact individual credit rating decisions."[13] S&P, in its recent launch of ESG Evaluation also focuses on ESG risks to the companies, instead of ESG risks that a company imposes on the society.[14] While these efforts are laudable, at best they offer very limited assessments of the environmental impact of corporate activity.

There have been some laudable efforts by companies that have tried to implement ESG ratings (or assessments), for example, Vigeo-Eiris and MSCI. However, these assessments focus on companies' efforts to incorporate ESG factors into their strategy, decision making and investments. For example, Vigeo – Eiris, a company in which Moody's Corporation recently acquired a majority stake,[15] states that their "ESG ratings demonstrate an issuer's capacity to integrate and manage the key sustainability issues in its sector of activity. ….Ratings indicate a company's performance level and the degree to which legal, reputational and operational risks are mitigated. As a true 360° audit, our ESG rating report is a gold mine of information that can be used to inform company strategy and communications."[16] MSCI, describes its ESG ratings as "providing insights into ESG risks and opportunities within multi-asset class portfolios." [17] These ratings, while useful for companies and asset managers, do not speak of social cost of externalities caused by companies.

Entities like Carbon Disclosure (http://www.cdp.net) have attempted to encourage companies to more fully account for and publicly disclose their estimates of GHG emissions and other pollutants. As an incentive to provide more comprehensive, timely and accurate

disclosures companies are scored on a scale from A to D. While this effort has been very effective in getting companies to disclose, it is purely voluntary and lacks any enforcement mechanism, and pricing or recovery mechanism.

To address and quantify the environmental cost of economic activities of companies, we propose an Environmental Rating System that:

- Is universally recognized and understood
- Is comparable across industries, regions, and size
- Incorporates all relevant information related to amounts and social costs of *all* pollution caused by a company
- Is independent of financial considerations – for example, financial data generally used by investors and credit rating agencies to come to investment decisions
- Helps investors make informed investment decisions
- Assists policymakers and governments in making policy decisions regarding taxation, licensing, industry makeup and socio-economic implications of pollution

One of the most important questions relates to the "meaning" of environmental ratings that we propose. As mentioned earlier, credit rating agencies have already attempted to provide ESG grades. For example, Moody's provides ESG grades[18] for Green Bonds based on the *stated* use of proceeds. Such stated use of proceeds includes amelioration of existing pollution issues, or investing in new "green initiatives." [19] Fitch's ESG relevance scores[20] do not evaluate the ESG characteristics of the issuer per se; rather they measure the extent to which ESG considerations impact (and are relevant) to the determination of a credit rating for the issuer. None of these scores or ratings speak to the pollution caused by these companies and the social costs transferred to the society. In fact, in a perverse way, *ceteris paribus,* a company might end up receiving a *higher* credit rating if the company is able to transfer all such pollution costs to the society because all profitability and other credit measures used by rating agencies are likely to be better for such a company than for a company that pays for pollution control measures. To their credit, rating agencies have stated that they account for all "risks to the company", which would include relevant regulatory risks, when assigning a credit rating. However, corporate credit ratings are, in a large part, a function of balance sheet and income statement measures. For example, two companies operating in the same industry with exactly same *operating* characteristics are likely to get two very different ratings if they have very different leverage ratios. While they may face the same "regulatory risk", it is neither quantified nor discussed in a credit rating opinion.

Environmental ratings proposed here are a single measure of all types of pollution produced by a company per some standard unit of measure. They are devoid of any financial measures or artifacts and designed to achieve only two objectives:

1. Unambiguously rate polluting companies based on the social costs they are transferring to the society.
2. Act as a standalone indicator that can be used to price such transference and help market participants, including investors and regulators, take such prices into their investment and regulatory decision making.

The first step in designing an environmental rating system is to consider the type of rating system that will achieve above objectives. We consider the following two options:

1. Relative Rating System
2. Absolute Rating System

These terms in credit ratings have well-defined meanings and interpretations. A relative ranking system is one in which entities are rank-ordered relative to each other but not to any specified external measure. In the case of relative credit ratings, one can say that a more highly rated entity is of stronger credit quality and less likely to default on its obligations relative to a lower rated entity. Absolute ratings, on the other hand, are anchored to specified measures; for example, an absolute credit rating would be connected to some specific probability of default (PD) which is then "bucketed" into a rating scale. Both of these credit rating systems speak to creditworthiness of an obligor in ways which are comparable across industries, regions, and size. For example, a Baa1 rating (as assigned by Moody's) has the same meaning (at least aspirationally) for obligors in steel,

mining, banking or any other industry; a buyer of the debt need not worry about idiosyncratic factors of a particular industry when analyzing agency rated debt.

However, in the case of environmental ratings, absolute ratings and relative ratings can take on a very different meaning (or interpretation) from those in the case of credit ratings. Let us take an example of two industries that create vastly different amounts and types of pollutants: power generation and meatpacking. Because these industries by their *nature* create different types and amounts of pollutants, a reasonable question arises: Should companies operating in these industries be rated using different standards that take into account the *inherent nature* of the industry or should companies in both industries be evaluated independently of their industries' respective inherent characteristics.

It is an important question that we need to resolve at the outset because these two ratings systems lead to two very different interpretations of environmental ratings. For example, in the relative ranking system where we take into account the inherent nature of an industry while rating companies in that industry, it is very likely that environmental ratings will become industry specific. Continuing with our example of power generation and meatpacking industries, let us assume that power generation industry produces *less* pollution per standardized unit of output than the meatpacking industry. In such a scenario, the power generation *industry* will get a *higher rating* and power generation companies will get ratings that will be notched up or down relative to this industry rating based on the amount of pollution they produce relative to the industry average. This relative notching will need to be constrained both up and down to maintain the relevance of the industry rating. However, this constraint has the potential of penalizing companies within that industry that are outliers in their pollution performance. For example, a power

producer that produces 100% of its power using renewables (solar, hydroelectric, and wind etc.) would be constrained to a rating that is likely to be much lower than what it truly deserves. Perversely, poor performers in the industry will end up getting the benefit of constrained notching and will end up receiving ratings higher than what they truly deserve. Obviously, one easy solution is to *not constrain the* notching, effectively breaking the nexus between industry ratings and companies' ratings. But that simply leads to absolute ratings.

Secondly, relative ratings with constrained notching within an industry lead to incomparability across industries. To use environmental ratings for investing purposes, market participants should be able to use the environmental rating as an input that includes all environmental factors about a company regardless of the industry in which the company operates. So, in our example, a company in power generation industry that is rated Bbb3 (we discuss our rating scale in later sections) on environment factors should have the same environmental attributes as a company rated Bbb3 in the meatpacking industry. This is only possible with absolute environmental ratings.

Our proposed rating system, therefore, is an absolute rating system.

We propose an environmental rating scale that is similar to a credit rating scale, running from Aaa (the highest grade – lowest pollution) to C (lowest grade – highest pollution). While there are other scales that even credit rating agencies are using (See Moody's ESG grades, for example), we propose a scale with which markets are familiar and provide

enough separation (and granularity) between the best and the worst, and everyone in between.

In the most simplistic fashion, our proposed rating scale simply rank orders all companies based on some standardized measure of pollution over a standard unit of output based on the economic activity of a company.

For this scale to be universally applicable, we need to define:

1. Standardized unit of economic output
2. Standardized unit of pollution

1. Standardized Unit of Economic Output: For us to be able to compare pollution across various industries, we need a standardized unit of economic output. Various industries use different measures of economic output for Y-O-Y comparisons. They do so to strip out the effect of inflation or other monetary aspects of their business. For example, passenger airlines report on million-passenger-miles, and steel industry reports on millions of tons (or MT). Power industry reports in terms of BTUs (British Thermal Units) or MWh (Megawatt per hour), while car companies use millions of cars.

   These economic activity measures, while useful for these industries, cannot be used for our rating scale for the obvious reason: X tons of GHG per MWh does not compare to Y tons of GHG per million-passenger-miles, for example. We need to define a unit of economic output this is (a) public (b) not easy to manipulate and (c) comparable across industries. Therefore, we propose and use million dollars of

revenue as the standard unit of output of economic activity to compare companies across industries. In this sense, not only we strip away industry jargon, but also make it simple by following the standard practice of comparing companies in terms of a common financial metric.

2. Measuring standardized pollution across industries: One could argue that once the standardized output of economic activity has been defined there is no need for a scale, as the absolute amount of pollution per million dollars of revenue is the purest indicator of the social cost transference and should therefore be used for decision making purposes. While theoretically that may be true, a rating system allows for compressing such absolute numbers into more manageable categories that can be used more meaningfully for decision making. For example, how do we compare company A which produces 411 tons of CO_2 and 2 tons of PM2.5 per million dollars of revenue versus company B that produces 500 tons of N_20 per million dollars of revenue. To compare and rate these companies we need to standardized the unit of pollution too. The second challenge, therefore, is to find a way to normalize (or standardize) the amount of *all types of pollution* produced by industries. For example, meatpacking industry produces more methane (livestock effluents), while steel industry produces not only GHG but also PM2.5 and PM10. Same is the case of power industry which not only produces different amounts and types of GHG based on different inputs (coal, gas, solar, etc.) but within an input like coal, different grades of coal (for example, anthracite, lignite, and bituminous) produce GHGs of different compositions (not to mention ash, PM2.5, PM10 and other particulates, etc.) and different amounts. One can think of countless such examples. Such

variations among different industries create analytical challenges for any rating system. Therefore, we must define a standardize unit of pollution (or social cost) for the scale to be meaningful.

Keeping aside for the moment the different types of pollutants, even if we were only concerned about a single pollutant like CO_2, we would still need a rating scale. For example, how does one compare between absolute numbers like 411 tons of CO_2 emissions versus 418 tons CO_2 emissions per million dollars of revenue for investment or other analysis. Such absolute numbers introduce artificial finesse in the analysis and decision making that may not be meaningful. A rating scale which removes such artificial finesse while retaining its usability is still needed.

Let us continue with the example of CO_2 emissions and see how a pure CO_2 based rating scale might look.

For our proposed ratings scale to be meaningful, we need to create the two boundary conditions that bookend our scale: The highest rating of Aaa is reserved for companies that produce zero (or close to zero, minimal) emissions of any type of pollutant, while the lowest rating of C is reserved for companies that produce the highest amount of pollutants. [21]

While it is trivial to assign zero to Aaa we need to estimate the amount of pollution for the bottom rung of the scale. One of the ways to create the high pollution boundary is to look at the EIA and EPA data on GHG (and CO_2) emissions by various activities,[22] assuming that that we are interested in only the CO_2 emissions and exclude everything else. We look at power generation industry, because empirically that is causing the most amount of GHG emissions; within the power industry, we have the most variety of ways in which power can be produced from fossil fuels.

TABLE 1 -
CO2 EMISSIONS PER MILLION DOLLAR REVENUE

FUEL FOR POWER GENERATION	MTON CO2 EMISSIONS/MM BTU	MT CO2/MM USD
COAL (ANTRACITE)	0.35	3931.53
COAL (BITUMINOUS)	0.32	3537.69
COAL (LIGNITE)	0.33	3704.51
COAL (SUB-BITUMINOUS)	0.33	3685.59
DIEAL FUEL AND HEATING OIL	0.25	2774.08
GASOLINE (W/O ETHANOL)	0.24	2703.57
PROPANE	0.22	2390.56
NATURAL GAS	0.18	2012.20

NOTES- (1) CONVERSION FACTORS
(A) POUNDS TO METRIC TONS(MT), 2204.62 LBS TO MT
(B) BTU TO KWH, 3412.142 BTU TO 1 KWH
(C) AVERAGE PRICE OF ELECTRICITY, $0.09/KWH
(2) SOURCE: EIA AND AUTHORS

It is clear that the most amount of CO_2 produced per million dollars of revenue is from burning anthracite coal for power generation as shown in the table above, part of which is reproduced from EIA.[23]

Now that we have the boundary conditions, an illustrative ratings scale is shown below:

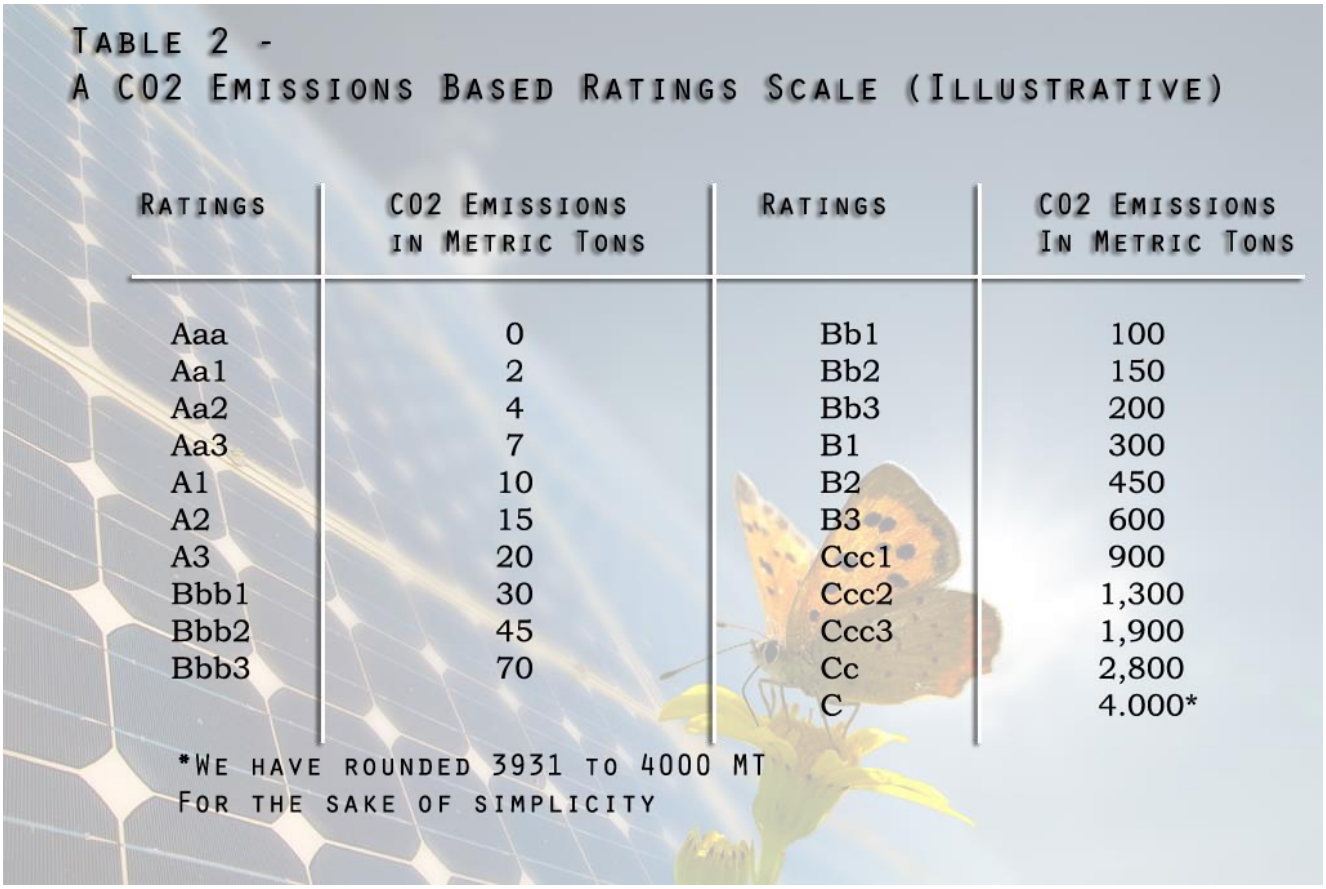


TABLE 2 -
A CO2 EMISSIONS BASED RATINGS SCALE (ILLUSTRATIVE)

RATINGS	CO2 EMISSIONS IN METRIC TONS	RATINGS	CO2 EMISSIONS IN METRIC TONS
Aaa	0	Bb1	100
Aa1	2	Bb2	150
Aa2	4	Bb3	200
Aa3	7	B1	300
A1	10	B2	450
A2	15	B3	600
A3	20	Ccc1	900
Bbb1	30	Ccc2	1,300
Bbb2	45	Ccc3	1,900
Bbb3	70	Cc	2,800
		C	4.000*

*WE HAVE ROUNDED 3931 TO 4000 MT
FOR THE SAKE OF SIMPLICITY

This type of scale, while useful for rating companies on a single type of pollutant, poses a dilemma. This scale is not transferable to non-CO_2 type of pollutions, for example, other GHG gases, solid and liquid pollutants like water run-offs caused by fracking, methane produced by live-stock and ancillary industries, and forestry-products-waste produced by the likes of Amazon and other e-commerce companies. For the scale to be universally applicable, it must speak to the **social welfare costs (or externalities) in monetary terms** imposed by economic activities of the companies. As such, we present below a scale that is correlated with the social cost of externalities.

TABLE 3 - A SOCIAL COST BASED RATINGS SCALE

Ratings	Social Cost in USD per Million USD Rev	Ratings	Social Cost in USD Per Million USD Rev
Aaa	$100	Bb1	$13,500
Aa1	$1,500	Bb2	$17,000
Aa2	$2,000	Bb3	$21,000
Aa3	$2,500	B1	$26,000
A1	$3,500	B2	$32,500
A2	$4,500	B3	$41,000
A3	$5,700	Ccc1	$50,000
Bbb1	$7,000	Ccc2	$65,000
Bbb2	$8,700	Ccc3	$80,000
Bbb3	$10,500	Cc	$100,000
		C	$125,000*

*WE HAVE USED AN AVERAGE OF $31,25 PER MT OF GHG AS SOCIAL COST AND ADJUSTED THE NUMBERS FOR EACH FOR UNIFORMITY

The benefits of such a scale are clear. Our proposed eliminates any complexity in presentation and understanding of a particular rating and translates all type of pollution from every industry to a single, easily understood and universally applicable number. For example, a Bbb1 rated company in steel industry is imposing $7,000 of social cost on society per million dollars of revenue which is less than a B3 rated company in automobile industry which is causing $41,000 of social cost to society per million dollars revenue. Thus, this scale eliminates every industry, region, regulation and type of pollution complexity in rating a company.

Now that we have set the ratings scale, we need to look at the social cost of various pollutants as hypothetically presented below[24]:

TABLE 4 -
SOCIAL COSTS OF VARIOUS POLLUTANTS

	POLLUTANTS	SOCIAL COST OF POLLUTANTS PER METRIC TON
1.	GHG Gases	$31.25
2.	Airborne Particulates PM 2.5 and PM 10	C2
3.	Livestock Methane and Other Gases	C3
4.	High Sulphur and Nitrogen Derivative Gases Like Sulphur Dioxide and Nitrous Oxide	C4
5.	Fracking Waste	C5
6.	Plastic Containers for Drinking Liquids	C6
7.	Forest Products for Shipping and Packaging	C7
8.	Fertilizer Runoff	C8
9.	Untreated Indutrial Effluents Draining Into Public Waters and Lands	C9
10.	Other Pollutant A	C10
11.	Other Pollutant B	C11

When combined with industry specific methodologies for environmental ratings, these two tables would provide an analytical framework.

WHAT TO MEASURE

One of the most important challenges, and perhaps the most complex one, is what to measure – inputs used in producing a product or service, or outputs that may cause pollution. For example, an automobile manufacturer produces 100,000 cars with internal

combustion engines per year (ICE vehicles). Inputs for producing these cars emit, say 100,000 tons of GHG. However, over their lives, these 100,000 cars produce 100 million tons of GHG (again, hypothetically). Let us now compare this manufacturer to another automobile manufacturer that produces 100,000 cars with electric powerplants (or commonly known as Electric Vehicles). Inputs for producing these 100,000 EVs, emit, say 100,000 tons of GHG (same as those emitted as a result of producing 100,000 ICE vehicles). But these 100,000 EVs are likely to emit 0 GHGs directly over their lifetime (recycling of batteries notwithstanding and assuming 0 reliance on fossil fuels).[25]

If we just focus on GHG emissions of inputs, we are likely to rate these two automobile producers very similarly on our rating scale. However, is that the right approach? It is an important question to address, for this is likely to be the case with many industries. For example, how should we rate coal mining companies. If we were to rate them based on the GHG footprint of their *inputs,* they are likely to be rated very high, as the GHG footprint of their inputs is likely to be insignificant compared to the GHG footprint of their outputs. The extreme opposite is true for electricity producers whose input is primarily coal. Their input GHG footprint will be extremely large compared to the GHG footprint of their output, namely electricity.

One way to address this issue could be to think in terms of GHG/pollution footprint of the economic output of any activity. Continuing with our example of coal miners and power producers that use coal as their primary input, they both will likely be rated comparably if we are to simply think in terms of economic output. In case of the two hypothetical auto manufacturers in our example above, they are likely to be rated very differently. However,

we believe that this very important issue needs to further analyzed and settled. We expect to further explore and analyze this issue in a follow-up paper.

We envision various uses for such ratings, both market-based and social/regulatory. Following are some of the ways Environmental Ratings could be used.

1. **Policymaking and Regulatory use**: Regulators and policymakers at local, state and federal level can use our ratings in numerous ways. For example, they can use ratings for licensing purposes and implement a licensing fee based on the Environmental Ratings the company has received. This licensing fee can be annual and be significant enough either to pay for the social costs or to force behavior change. They can also use Environmental Ratings as a way to manage their environmental footprint. Another way policymakers at the federal level can use Environmental Ratings is by imposing a surcharge per financial transaction (equity or debt) and transmitting that revenue to an agency set up for remediation. Afterall, the environmental ratings proposed are expressions regarding the likely impact of *company* activity from which investors and management are benefitting, reflecting an expectation of discounted costs. A rating below a certain threshold could trigger an add-on charge, perhaps expressed in terms of basis points per annum, which would be remitted as a tax to the government. A precedent for a basis point tax charge on

issuance already exists; a 10-basis point GSE guarantee fee surcharge currently is levied to replace payroll taxes that were temporarily reduced during the Great Recession. Where costs are demonstrably lower than forecast, surcharge taxes can be adjusted.

2. **As an Input to Credit Ratings Analysis**: One of the most direct uses of Environmental Ratings would be in credit analysis and ratings assignment. As we discussed earlier, credit rating agencies are making efforts to incorporate ESG risks into their credit assessments. While those efforts are laudable, we believe that a standalone ESG (or at least an E- rating) acts as an unbiased universal measure that encompasses purely environmental factors and provides a direct proxy for the all possible environment related risks that a company faces. This is due to the fact that Environmental Ratings tell us the social cost in monetary terms a polluter is transferring via externalities which is exactly equal to economic/financial risk (though in the maximum) the polluter faces. Therefore, credit rating agencies can use Environmental Ratings as a direct input to their ratings analysis and can adjust the economic cost/risk to a particular company based on their knowledge of the industry and region/regulation and how likely is that company to be regulated and what percentage of total social costs the company might be forced to bear. This "adjusted social cost" can then be used to appropriately calibrate financial statements to arrive at Environmental Ratings adjusted ratios that can be used for credit ratings
3. **Self-Assessment:** One of the great uses of our Environmental Ratings is in making an assessment of its social cost foot print by a company. Afterall, companies know exactly what pollution causing inputs (and outputs) are involved in their economic

activity. Using our system described above and the standardized templates that we expect to publish in later papers, a company can create a document outlining every input and its social cost and arrive at an "indicative rating" which can then either be published as a "self-rating" or a "ratified rating" after it being certified by a third-party. This self-assessment rating, we believe, will create a much greater level of transparency than any method currently in place.[26] It is clearly much easier to compare pollution footprints based on standardize methods that produce a letter rating than comparing and contrasting various public disclosure documents with different formats, requirements and even different units of measure.[27]

4. **Consumers**: Environmental Ratings can be used an input by consumers for making more informed purchasing and consumption decision. Environmentally conscious consumers may want to look at the Environmental Rating before purchasing products from a particular company. They may be willing to pay more for products from a company that has higher Environmental Rating than for products from a company that has low Environmental Rating. Consumers, in the extreme, may even want to boycott products from companies that are rated very low on the environmental rating scale. Such consumer actions could possibly provide enough incentives for companies to make efforts that will make them move up the rating scale.
5. **Various corporate and financial organizations**. Such firms may wish to adapt the proposed rating system to create benchmarks for evaluation purposes, investment products and structure various financial instruments linked to pollution reduction initiatives. (See SIDEBAR - Debt with Coupons Linked to Sustainability, ESG or Carbon Reduction Targets)

It is envisioned that these ratings, once assigned, would not be cast in stone but would be subject to surveillance and would change on the basis of relevant changes in corporate behavior as well as changes in the social impact of that behavior. We envision that all ratings would be reviewed periodically for accuracy

to ascertain whether the actual environmental impact of rated corporate activity as a whole conformed, on a reasonable probabilistic basis with projections.

SIDEBAR - ENVIRONMENT COSTS ARE VERY HIGH

While assessments regarding the costs associated with greenhouse gas ("GHG") emissions vary, for US Federal rule-making purposes, The Interagency Working Group on the Social Cost of Carbon established by the Obama administration was authoritative.[28] The IWG released its first estimates in 2010. (*see* Interagency Working Group on the Social Cost of Carbon, US Government, "Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866" (February 2010)). The calculations of global cost associated with domestic emissions were derived by averaging outcomes generated by three existing integrated models and varied substantially depending on the rate used to discount future losses.

A regional allocation of cost and benefit is also contingent on the discount rate selected. The initial report was updated in May 2013, November 2013, July 2015, and August 2016. SCC estimates are expressed in terms of 2007 dollars per metric ton carbon dioxide equivalent emissions. The central value proposed in the Technical Support Documents is the average estimate across three selected models using a 3% discount rate. SCC estimates are time-specific and increase as forecasts extend into the future. The estimate of the 2020 SCC presented in the 2016 report is $42 (2007 $) per metric ton. Using the Bureau of Economic Analysis Implicit Price Deflator, 2007 dollars can be converted to 2017 dollars (the latest date for which annual deflators are today available) by a factor of approximately 1.17. (*see* Bureau of Economic Analysis, NIPA Table 1.1.9). If the SCC was about $40 (2007 $) per metric ton in 2017, the 2017dollar equivalent would be about $46.80. The

International Energy Agency estimates carbon emissions in 2017 reached 32.5 gigatons. (*See* International Energy Agency, "Global Energy and CO_2 Status Report" (March 2018))

Using the 3% discount and the estimate of $40 per metric ton in social cost externalities, the global social cost of carbon in 2017 was roughly $1.5 trillion in 2017 dollars. We note that social cost of carbon estimates are highly sensitive to the choice of interest rate because carbon dioxide introduced into the atmosphere takes a long time to dissipate. At a 5% discount rate, the IWG (op. cit.) estimates the social cost of carbon was $11 ($2007) per ton in 2015. The IWG estimates of annual social cost of carbon estimates all increase with time. The appropriate discount rate could e.g. be tied to the cost of Federal long-term funding. However, such average estimates will vary depending on the horizon selected.

SIDEBAR - REMEDIATION

Remediation attempts to repair the effects of pollution and can involve a charge to corporate polluters particularly where responsibility can be established to a legally satisfactory standard. An example is the US Superfund. In response to media reports of severely polluted hazardous waste sites in the late 1970s, the US Congress passed The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (later amended by the Superfund Amendments and Reauthorization Act in 1986). CERCLA created a tax on the chemical and petroleum industries (lapsed, with collections ending in 1995), established legal liability for the release of hazardous pollutants from waste sites, and defined standards for closed and abandoned waste sites. (*See* Environmental Protection Agency, epa.gov/superfund/superfund-cercla-overview) The law embodies the principle that "the polluter pays", a principle widely accepted in democracies of the developed world, but in practice, the general public must pay for clean-up work where "Potentially Responsible Parties" can't be found, legal liability can't be established, or the polluter does not have the ability to pay. (Beyond CERCLA, see e.g. Directive 2004/35/CG of the European Parliament and of the Council; Charter for the Environment (2004) Constitutional Block of the French Constitution; Environmental Damage (Prevention and Remediation) (England) Regulations 2009 and the Environmental Damage (Prevention and Remediation) (Wales) Regulations 2009; New South Wales, Protection of the Environment Administration Act 1991-Sect 6. The concept is also referred to as "Extended Producer Responsibility" (Organisation for Economic Cooperation and Development (OECD).

Environment Directorate, Paris, France (2006) "Extended Producer Responsibility" Project Fact Sheet.)

For more than two decades, taxpayers have financed over $21 billion in cleanup expenses at Superfund sites while hundreds of culpable corporate polluters have avoided payment. (*See* Bryan Anderson, "Taxpayer Dollars Fund Most Oversight and Cleanup Costs at Superfund Sites," Washington Post (September 20, 2017)). Funding for Superfund clean-up in both absolute and real terms has been falling over the last decade and a half. (*See* Katherine Probst, "Superfund 2017: Cleanup Accomplishments and the Challenges Ahead," (2017) p.ix)

For the purpose of our scale, we have taken an average of various estimates.

SIDEBAR- REGULATION

Remediation attempts to address the impact of previous polluting activities. To address ongoing activities and prevention as well as abatement, policy makers rely on regulation. This is particularly important where pollutants present a substantial risk to life and health or substantial damage to property. Regulation requires definition, authorized bodies, procedures and policies, and funding. It can involve international negotiations and agreements. Regulation typically also requires coordination and support between federal and local-level efforts.

The history of US environmental regulation is instructive. US federal regulation of air pollutants began with the Clean Air Act of 1963; the law authorized the creation of a national research body, provide financial assistance for national and state pollution control agencies, and established mechanisms for controlling and abating inter-state pollution from fixed sources. (*See* Government Publishing Office, www.govinfo.gov/content/pkg/STATUTE-77/pdf/STATUTE-77-Pg392.pdf). A 1965 amendment set the first emission standards for motor vehicles. The law was further amended in 1970, establishing ambient air standards, motor vehicle and engine compliance testing, new motor vehicle emission standards, regulation of fuels, emergency powers, state implementation plans, and provided for citizen suits. (*See* https://www.govinfo.gov/content/pkg/STATUTE-84/pdf/STATUTE-84-Pg1676.pdf). Further amendments were enacted in 1977 and 1990.

States also have the power to regulate pollution which is important since emissions and discharges often are locally specific and local authorities will be knowledgeable about the particular industries and conditions in their respective areas. Nevertheless, Federal rules define binding minimum standards; states may enact more restrictive codes but cannot reduce standards.

The 1970 National Environmental Policy Act obligated executive federal agencies to perform environmental assessments and issue environmental impact statements. In December 1970, the Environmental Protection Agency (EPA) was established as an independent agency of the US government, unifying federal environmental research, standard-setting, and enforcement. In December 2010, the EPA announced rules regarding Greenhouse Gas (GHG) emissions following an April 2007 Supreme Court finding that GHGs are pollutants covered under the Clean Air Act. (*See* EPA, "Clean Air Act Permitting for Greenhouse Gas Emissions – Final Rules Factsheet," (December 2010))

Regulation of water pollutants began in 1948 under the Federal Water Pollution Control Act but the law was substantially rewritten under an amendment in 1972. The Control Act as amended is commonly known as the Clean Water Act of 1972. (*See* EPA: https://www.epa.gov/laws-regulations/summary-clean-water-act) The law is administered by the EPA which sets standards, policies, restrictions, issues emission permits to businesses and exemptions and enforces compliance. The law was amended in 1981 to facilitate improvements in municipal treatment plants and again in 1987 to replace the grant program with a new Clean Water State Revolving Fund. (*See* EPA: www.epa.gov/laws-regulations/history-clean-water-act). Clean water regulation for the Great Lakes needed to be coordinated with Canadian efforts. The Great Lakes Water Quality Agreement of 1978

and the Great Lakes Critical Programs Act of 1990 represented international agreements to limit certain toxic pollutants. The EPA administered the US obligations, establishing certain specific water quality standards for the Great Lakes and facilitating State level implementation of criteria per schedule.

While the Clean Air Act, Clean Water Act, and CERCLA are the most prominent environmental laws in the US, the EPA is the leading implementation authority for other important environmental laws such as the Federal Insecticide, Fungicide, and Rodenticide Act, the Resource Conservation and Recovery Act, the Safe Drinking Water Act, and the Toxic Substance Control Act.

From the great surge of legislation in the 1960s and 70s, a robust regulatory infrastructure developed which effectively addressed many environmental problems. Toxic emissions were substantially reduced, smog was controlled, and fuel efficiency was improved. (*See e.g.* John Bachmann, David Calkins, and Margo Oge, "Cleaning the Air We Breathe: A Half Century of Progress, EPA Alumni Association (September 2017): "Over the last half century, Clean Air Act programs have cut air pollution emissions by 70% while the economy has more than doubled." page 5). But regulation also became the focus of litigation and politics as corporate interests fought to avoid or control costs and controls. Many EPA scientists complain of political interference in the work of the agency. (*See* Associated Press, "Meddling at the EPA? Activists Point to Survey," Environment on NBCNews.com (4/23/2008)). While the EPA is responsible for extensive resource demands connected with research, standards, coordination, control, and enforcement, it has been working with a budget which has been steadily declining in real and nominal terms for a decade. (See: www.epa.gov/planandbudget/budget). The enacted budget for 2010 included stimulus

money and was unusually high. The fiscal year 2011 enacted budget was $8.682 billion; the 2017 FY enacted budget was $8.058 billion. The Superfund budget for 2018 was frozen at 2017 levels (Bloomberg BNA 3/21/2018). The proposed FY 2019 Superfund budget is $6.146 billion (www.epa.gov/planandbudget/cj).

SIDEBAR- TAXATION

Regulation establishes important benchmarks regarding levels of pollutants which are harmful to health and property but typically has little to say regarding the appropriate distribution of permissible pollution among the various activities that generate it. The English economist, Arthur Pigou, developed the concept of externality initially presented in a very limited way by his professor, Alfred Marshall, and proposed that taxes be used, set at the social cost of the externality, to recover the social cost and reintroduce it into the pricing system. (Arthur Pigou, The Economics of Welfare, MacMillan and Co., Limited (1920). In the Fourth Edition (1932), the topic is covered in Chapter 9, beginning in paragraph 10 (the second kind of divergence between social and private net product). Bounties and taxes are proposed as a solution in paragraph 13. For a review of the complexities involved in the term 'externality' see: Steven Medema, "Exceptional and Unimportant: Externalities, Competitive Equilibrium, and the Myth of a Pigovian Tradition" (January 2019). The working paper is available on-line. Publication is forthcoming in the journal: History of Political Economy).

Through the introduction of the tax, the externalities of activity would be internalized into the pricing system and a more efficient social allocation of resources would be achieved. The primary problem connected with this approach is the determination of the social cost that needs to be recovered. For a variety of reasons, in practice, low-end estimates of social cost are favored under the idea that social costs are likely to be at least this much and that some recovery and price adjustment is better than none.

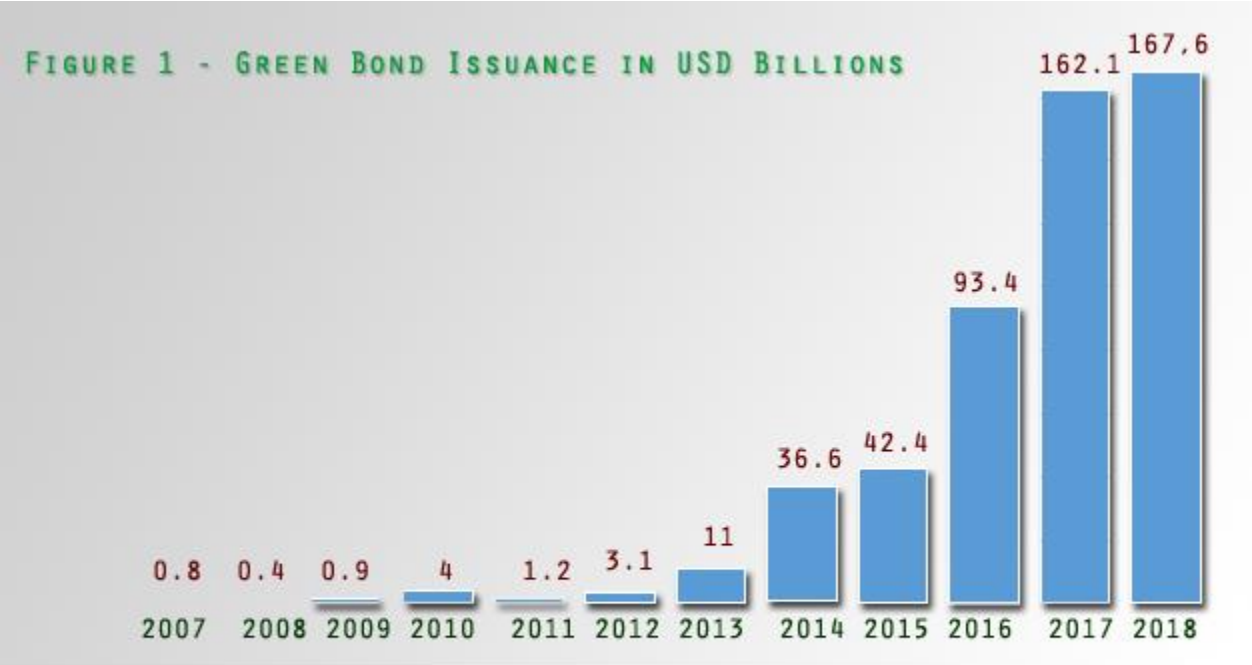
Carbon taxes have been applied in a number of countries, including Australia, Chile, Finland, Ireland, Sweden, and the United Kingdom. Chile offers the lowest rate and about $5 per ton CO_2 emissions. The more typical rates are in the neighborhood of $20-25 per ton. Figures are approximate due to need for currency conversions at rates which change regularly. The rate in Sweden is much higher (about $150 per ton of CO_2 emissions though complications in the application of the tax make the effective rate materially lower than the headline rate. Typically, the revenue is not used explicitly to abate pollution costs but rather reverts to respective national Treasuries for general expenditures. Carbon taxes are credited with helping to achieve substantial reductions in emissions primarily through cuts in the use of coal and by enhancing the demand and use of non-carbon energy sources. (for more detail, please see: https://www.carbontax.org/where-carbon-is-taxed, Carbon Tax Center)

An alternative approach to taxation which establishes incentives to reduce targeted pollutants is "cap and trade". Under cap and trade policy, a total emissions rate is established (cap) and permits are issued to participating companies. Trade in the permits establishes a price for emissions and creates incentives to substitute away from the targeted pollutant while allowing businesses generating high value added from their polluting activities to continue. An early example of a cap and trade application was the Acid Rain Program created and 1995 and administered by the EPA. The European Union Emissions Trading Scheme (ETS), launched in 2005, is a very large program involving thousands of firms. The program has been criticized for generous allocations of permits to "grandfathered" firms at the initiation of the scheme. A large number of economists prefer tax-based policies to recover externality costs and effect market-based outcomes. (Please see: The Economists' Statement on Carbon Dividends,

https://www.clcouncil.org/economists-statement). However, cap and trade policies remain a politically attractive market-based alternative.

SIDEBAR- GREEN BONDS

The vast amount of investment needed to tackle the infrastructure and technological requirements to bring about a transition to a low-carbon greener economy is such that there is a need for both private and public sector engagement, collaboration and funding. To that end, new financial instruments and strategies have been developed and it is expected that these will continue unabated, including our proposed environmental rating system. Counted among the more successful market-based initiatives to-date is the Green Bond, an instrument that is likely to continue to play an important role in catalyzing a shift of the financial landscape. Since their launch in 2007, a cumulative total of $523.5 billion in green bonds have been issued. New green bond issuance has been gaining momentum, particularly since 2013 (refer to Fig 1). From $36.6 billion issued that year, annual green bond issuance has increased by 358% and by some estimates green bonds issuance is expected to reach $200 billion in 2019. Yet even at these levels, given the scale of the investment and the time horizon involved, green bonds alone are not likely to meet long-term investments needed to finance the low-carbon transition.



SOURCES: MOODY'S INVESTORS SERVICE, CLIMATE BOND INITIATIVE AND OTHER SOURCES

Launched by the European Investment Bank (EIB) in 2007 and followed in short order with an offering by the World Bank (International Bank for Reconstruction and Development, IBRD) in partnership with Skandivaviska Enskilda Banken (SEB) to meet the demands of institutional investors by extending the EIB framework to focus on transparency and reporting, Green bonds are defined as fixed-income securities, both taxable and tax-exempt, that raise capital exclusively for use in projects or activities with specific climate or environmental sustainability purposes. These include senior unsecured obligations with direct recourse to issuers, project finance or revenue bonds, with and without recourse to issuers, and securitizations that collateralize projects or assets whose cash flows provide the first source of repayment. Regardless of structure, green bonds are generally issued pursuant to a set of voluntary guidelines or frameworks. A key voluntary guidelines framework in the form of green bond best practices was formulated in 2014 by a

consortium of U.S., European banks, led by Citi, JPMorgan, Bank of America/ML in the US and Credit Agricole in Europe, that came to be known as the Green Bond Principles (GBP), now administered by the International Capital Markets Association (ICMA). With their emphasis on transparency, disclosure and standards setting, these organizations, working together, catalyzed the green bonds market by codifying a set of voluntary guidelines for green bonds that include criteria for the use of proceeds, the issuer's process for project evaluation, the management of proceeds and reporting on a periodic basis. In the process, the GBP served to expand the eligible security types and issuer base to include financial institutions, corporations, sovereigns, sub-sovereigns.

The near-universal commitment to limit global warming that led to the adoption of the Paris Climate Agreement in 2016 ushered in a number of public policy and private sector initiatives to support and reinforce the commitments to keep global warming at or below 2° Celsius above pre-industrial levels. It also served to direct attention on analyzing the risks and opportunities linked to climate change and stimulated demand for investments that are aligned with climate considerations. Green bonds have helped meet that demand but it must also be recognized that green bonds represent just one pathway along the financial transformation arc that has to be taken if we are to reach the required scale.

SIDEBAR- DEBT WITH COUPONS LINKED TO ESG TARGETS

As attention to ESG risks and opportunities has gained traction world-wide, ESG targets generally and carbon reduction initiatives more specifically have been connected with debt issuance in ever more sophisticated ways. One of the latest developments involves "positive incentive loans" linking the coupon payment on a debt obligation to some ESG or carbon reduction target performance of the obligor.

In June 2019, Nokia issued a five-year revolving facility in which the margin Nokia pays is contingent on performance relative to pre-determined targets regarding greenhouse gas emissions connected with Nokia production and those that can be reasonably associated with customer use of Nokia products.

At the same time, Durr, a German machinery company, issued a €200 mm Schuldschein in which the coupon is linked to a sustainability rating issued by EcoVadis. A Schuldschein is an unlisted, unregistered, privately placed, traditionally German, bi-lateral loan instrument which the lender either keeps or syndicates the loan via separately documented assignments. The primary lender often is an arranger which may also act as a loan administrator and as an agent facilitating secondary trading.

Unlike Green Bonds, the proceeds are not targeted for any explicitly environmental or ESG connected purpose.

ABOUT THE AUTHORS

Praveen Varma

Praveen Varma is currently a managing director at AlphaDelta Analytics, Inc. (a fintech/regtech company (https://www.alphadelta.co) specializing in credit and market risk strategies, analytics and reporting.

Previously, Praveen spent more than 15 years at Moody's in various capacities, from a research analyst to head of consulting to leading a Moody's startup. During his tenure at Moody's he developed an understanding and deep appreciation of the role ratings play in reducing information asymmetry in credit markets. He believes that environmental ratings can play a similar role in bringing transparency to not only financial markets, but other sectors of the economy. As Research Director for Credit Strategy and Standards division at Moody's Investors Service, he also was actively involved in the ESG research at Moody's. Praveen has written and published several papers on corporate and sovereign credits.

Praveen has keen interest in exploring and learning about the contributions of human activity to climate change and other environmental elements.

Mark Gold

Mark Gold is an economist and finance professional with over thirty years of professional experience working as a transactor, advisor, risk manager, modeler, and writer.

Receiving his PhD from NYU with Wassily Leontief as his advisor, Mark began his career advising AT&T during the transition to a competitive industrial organization and worked as an interindustry forecaster and consulting economist for DRI McGraw-Hill. His work there won him a company award.

Mark moved to S&P as a quantitative analyst with the Derivative Products Group. He left to join the financial engineering unit of a financial insurer and participated in early structured credit transactions.

After ten years in financial insurance and two years in banking, Mark joined NSM Capital Management in September 2008. The firm became Financial Agent to the Treasury on TALF and Mark became the primary point of contact, designing models, drafting reports, and developing new business.

Mark remained in the advisory business five years, after which he was hired by Moody's to bring his skills as an economist to bear on default research and internal analytical challenges. His published research includes a paper on rated banks during the financial crisis which won praise from the IMF. While at Moody's, Mark was introduced to ESG issues and participated in research on ESG and Moody's ratings.

Mark is currently a private consulting economist. He has authored numerous technical papers and articles.

Henry Shilling

Henry Shilling is the Founder and Director of Research of Sustainable Research and Analysis LLC, a firm dedicated to providing independent research, analysis, education and training for asset owners and institutional investors interested in sustainable investing. The firm maintains www.sustainableinvest.com, a website that supports and empowers sustainable investors.

Previously, while employed at Moody's Investors Service to June 30, 2017, Henry initiated, led and coordinated Moody's worldwide efforts to bolster the rating agency's research activities and marketplace engagement within the broad environmental, social and governance (ESG) sphere. In this connection, he spearheaded Moody's strategy to bring transparency and expand the firm's disclosures around the topic of environmental, social and governance factors/risks and their impact on assessments of creditworthiness applicable to corporations, financial institutions, government entities, sovereign as well as local governments and agencies, and structured finance transactions. In these and other capacities over a 25-year career at Moody's, Henry published research articles, was a frequent commentator, and regularly presented Moody's views at various industry conferences.

ENDNOTES

[1] William Nordhaus, "To Slow Or Not To Slow: The Economics of the Greenhouse Effect," The Economic Journal, 101 (July 1991) p923

[2] For recent assessments see e.g. Solomon Hsiang et al., "Estimating Economic Damage From Climate Change in the US," Science (July 5, 2017); Government Accounting Office, "Information on Potential Economic Effects Could Guide Federal Efforts to Reduce Fiscal Expenses," GAO-17-720 (September 28, 2017).

[3] The World Bank and The Institute for Health Metrics and Evaluation, "The Cost of Air Pollution: Strengthening the Economic Case for Action," International Bank for Reconstruction and Development/The World Bank (2016) p. xii

[4] See e.g. National Climate Assessment, "Fourth National Climate Assessment," (November 23, 2018). The National Climate Assessment is a US government interagency effort on climate science which issues reports every four years as mandated by the Global Change Research Act of 1990.

[5] Interagency Working Group on the Social Cost of Carbon, US Government, "Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866" (February 2010). This report was updated in 2016: Interagency Working Group on the Social Cost of Carbon, US Government, "Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866" (August 2016). Estimates averaging the outcomes of three separate models have been developed by at various discount rates and are sensitive to the choice of discount. The central value proposed in the Technical Support Documents is the average across three selected models using a 3% discount rate. The Social Cost of Carbon (SCC) estimates are time-specific and increase over time. The 2020 SCC central estimate presented in the 2016 report (p.4) is $42 (2007$) per metric ton. Using the Bureau of Economic Analysis Implicit Price Deflator, 2007 dollars can be converted to 2017 dollars (the latest date for which annual deflators are today available) by a factor of approximately 1.17 (See BEA NIPA Table 1.1.9). If the SCC was about $40 (2007 $) per metric ton in 2017, the $2017 equivalent would be about $46.80. The International Energy Agency estimates carbon emissions in 2017 reached 32.5 gigatons (International Energy Agency, "Global Energy and CO_2 Status Report" (March 2018)).
Using the 3% discount and the estimate of $40 ($2007) per metric ton in social cost externalities, the global social cost of carbon in 2017 was roughly $1.5 trillion in 2017 dollars.

[6] https://www.wri.org/blog/2018/12/new-global-co2-emissions-numbers-are-they-re-not-good

[7] https://www.carbontax.org/where-carbon-is-taxed/

[8] We used pollution and environmental risk interchangeably to convey the same externalities

[9] To facilitate clarity regarding corporate social responsibility and socially responsible investing, the United Nations launched a series of initiatives beginning with the Global Reporting Initiative (1997) promoting transparency regarding environmental impact, working conditions, and financial reporting. This was followed by the Global Compact (2000, 2003) which was a set of principals guiding corporate behavior with respect to human rights, labor practices, the environment, resistance to corruption. The UNEP FI report (2004) on "the materiality of environmental, social, and corporate governance considerations and criteria as they relate to the portfolio management of mutual and other institutional funds," concluded that "environmental, social, and corporate

governance criteria affect shareholder value both in the short and long term." The Principles of Responsible Investing (2006) committed signatories to include environmental, social, and governance (ESG) concerns in investment decisions. Well over a thousand organizations are signatories with a covered AUM of many trillions of dollars.

[10] To see rating agency presentations regarding the way ESG concerns impact credit rating decisions, see e.g. "General Principles for Assessing Environmental, Social and Governance Risks," Moody's Investors Service (January 9, 2019); "Introducing ESG Relevance Scores for Corporates," Fitch Ratings (January 7, 2019)

[11] "Green Bond Assessment (GBA)," Moody's Investors Service (March 30, 2016)

[12] https://www.moodys.com/research/Moodys-requests-feedback-on-a-new-carbon-transition-risk-assessment--PBC_1171112

[13] *ibid*

[14] https://www.spglobal.com/_Assets/documents/Ratings/ESG_Evals_Digital_Brochure.pdf

[15] https://ir.moodys.com/news-and-financials/press-releases/press-release-details/2019/Moodys-Acquires-Majority-Stake-in-Vigeo-Eiris-a-Global-Leader-in-ESG-Assessments/default.aspx

[16] http://www.vigeo-eiris.com/solutions-for-companies-organisations/services-for-rated-companies

[17] https://www.msci.com/esg-ratings

[18] *ibid*
[19] *ibid*

[20] https://www.fitchratings.com/site/re/10058480

[21] Ratings analysis and assignment would be performed by a qualified organization using personnel trained and experienced in environmental matters.

[22] https://www.eia.gov/tools/faqs/faq.php?id=73&t=11

[23] https://www.eia.gov/tools/faqs/faq.php?id=73&t=11

[24] The mapping of pollutants to unit social costs would be prepared by experts.

[25] Indirectly, the GHG emissions of electric cars would depend upon how the electricity used to recharge the car is generated.
[26] https://www.cdp.net/en/scores

[27] https://www.cdp.net/en/scores
[28] We acknowledge the limitation of our analysis in this and later sections as being US centric