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Taking the Road Less Traveled: Highway Construction and the Carbon Credit Bonus

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I. Introduction

Arkansas provides the outdoor enthusiast with a gamut of recreational opportunities. Whether it be kayaking Class V whitewater creeks into the first national river of the United States, rock climbing in "Horseshoe Hell," mountain biking the notorious "trails of Oz," hunting the "Duck Capital of the World," or relaxing in naturally occurring ancient thermal springs, the Natural State is an environmentalist's Mecca. Mere hours separate an expansive river delta, home to thousands of wetland plant and animal species, from the (comparatively) towering Ozark mountain range, with its abundance of trout, elk, and black bear. Growing up in a place like this, it is hard not to develop a profound appreciation for the natural environment and all its wonders—and a fervent desire to preserve it for the enjoyment of future generations.

Unfortunately, it does not take a savant to realize that climate change has the potential to upend all of it, destroying all the splendors a diverse, healthy, and balanced natural climate provides. Of course, Arkansas will not be alone in suffering the consequences of climate change—its ramifications are already being felt worldwide. Indeed, among other things, climate change has the potential to prompt more frequent extreme weather events, droughts, wildfires, drastic increases in sea levels, an unprecedented loss in biodiversity, and rising human vulnerability to diseases.[1]

Climate change is a by-product of greenhouse gas ("GHG") emissions.[2] GHGs are gases that trap heat in the atmosphere. The more GHGs that are emitted, the more heat is trapped in the atmosphere, creating what has come to be known as the "greenhouse effect."[3] Most scientists agree that the greenhouse effect, in turn, causes the global climate to change.[4]

GHG emissions are produced by a number of human activities such as energy production, construction, transportation, and agriculture.[5] According to the U.S. Global Change Research Program ("USGCRP") and the Intergovernmental Panel on Climate Change ("IPCC"), substantial reductions in GHG emissions will be required by mid-century in order to limit global warming to no more than 2°C, and ideally 1.5°C, thereby minimizing the risk of the severe impacts of climate change.[6] Specifically, industrialized countries must reduce their GHG emissions by at least 80% below 1990 levels by 2050 in order to stay within the 2°C target.[7] Given this extraordinarily aggressive goal, every reduction in GHG emissions counts.

It is no secret that the construction industry is one of the world's largest GHG emitters, releasing billions of tons of carbon dioxide ("CO_2")[8] into the atmosphere every year.[9] According to a recent International Energy Agency ("IEA") report, in 2018, the buildings and construction sector alone accounted for 39% of global CO_2 emissions.[10] Highway construction specifically adds significantly to this carbon footprint, as it accounts for approximately 13% of the construction industry's CO_2 emissions in the United States.[11] Large quantities of GHGs are emitted not only in the actual construction phase, but also in "producing and acquiring materials for the construction, maintenance, and rehabilitation of highway infrastructure."[12] For example, highway construction requires an enormous amount of concrete—"the carbon . . . emissions from the production of [which] are so high that if concrete were a country, it would be the third-largest emitter of CO_2 behind China and the United States."[13] Indeed, producing the concrete alone for a mile of a single interstate lane can result in hundreds of tons of CO_2 emissions.[14]

Putting this figure into perspective, there are currently 4.2 million miles of public roads in the United States, a number which is constantly growing.[15] Beyond simply building new roads, the government must also maintain and reconstruct old roads. Thus, along with the construction of new roads, reconstruction of old roads, and persistent maintenance of existing roads comes huge amounts of CO_2 emissions. This problem will only worsen as the population and concomitant traffic demand increase. Indeed, over the next several decades, the United States "alone is projected to construct 6 million km of roadway[.]"[16] As the online commerce sector of the global economy continues to grow, road maintenance and construction will become increasingly important for shipping purposes. Thus, the highway construction sector has a significant role to play in reducing GHG emissions but is often overlooked.[17]

Road construction and maintenance are generally the responsibilities of state and local governments, as 97% of U.S. roads are under their jurisdiction.[18] Thus, it is largely up to state and local transportation agencies to implement strategies to reduce GHG emissions associated with the construction and rehabilitation of highway infrastructure.[19] Given the recent legislative attempts to pump trillions of dollars of federal funding into "green infrastructure,"[20] the United States' re-entry into the Paris Agreement,[21] and the fact that more than two-thirds of Americans support initiatives to fight climate change,[22] there could not be a better time for state and local governments to adopt aggressive CO_2 reductions policies.

To date, the road to reduced CO_2 emissions in the highway construction industry has been paved with great intentions, but limited successes. It is time for a simple solution that aligns stakeholders' interests and provides a market incentive for highway contractors to adopt CO_2 reductions strategies. State and local transportation agencies across the United States can provide this simple solution by implementing a "Carbon Credit Bonus" in public construction contracts. Simply put, a Carbon Credit Bonus would incentivize highway contractors to adopt more climate-friendly construction methods and materials, invest in greener technologies, and ultimately reduce the highway construction industry's massive carbon footprint.

The Carbon Credit Bonus would work much like an early completion bonus (already used in at least 46 states and the District of Columbia).[23] At the beginning of the project, a State employee or consultant will calculate the baseline projected CO_2 emissions for the project. During the project, the contractor will then document the ways in which it has implemented carbon reduction strategies to reduce the CO_2 emissions of the project. For example, by using biofuels, electric vehicles, "warm-mix" asphalt, or recycled concrete. At the end of the project, the contractor must have an independent entity certify the project with a "carbon declaration." This independent account will tally the contractor's total CO_2 emissions for the project as built and compare it to the State-created baseline. Prior to paying the bonus, the State may verify the carbon declaration, and all false claims could be subjected to a serious penalty, similar to those under the federal False Claims Act.[24] After verification, the State employee or consultant will multiply the tons of CO_2 emissions saved by the Social Cost of Carbon.[25] The resulting figure will be the basis for which to award the Carbon Credit Bonus to the contractor at the end of the project.

Much like an early completion bonus, state and local governments could cap the bonus a contractor could receive. The Carbon Credit Bonus is politically palatable, in stark contrast to the idea of a carbon tax,[26] and would have the added effect of ultimately making those highway contractors who emit the least amount of CO_2 the most competitive, as these contractors could account for projected Carbon Credit Bonuses in their bids. Furthermore, because government entities constitute the largest clients in the road construction sector, the Carbon Credit Bonus would have an extraordinary impact on greening the industry.[27]

Following this introduction, Part II documents the ever-increasing centrality of sustainability and mitigating climate change as policy interests of the United States. Part III discusses a similar concept already in effect in the Netherlands and its limitations. Part IV examines carbon monetization mechanisms and explains why the Carbon Credit Bonus should be tied to the Social Cost of Carbon. Part V discusses how state and local governments could go about calculating the CO_2 baseline for their road construction projects. Part VI explains the Carbon Credit Bonus in more detail and discusses its potential benefits. Finally, Part VII summarizes the primary justifications for adopting the Carbon Credit Bonus.

II. U.S. Climate Change Policy

Scientists have studied the "greenhouse effect" since the mid-19th century.[28] However, it was not until the 1980s that governments around the world began to take climate change seriously, starting with the establishment of the IPCC in 1988.[29] Shortly thereafter, in 1992, President George H. W. Bush made the United States a party to the United Nations Framework Convention on Climate Change ("UNFCCC"),[30] declaring that, "[t]he United States fully intends to be the world's pre-eminent leader in protecting the global environment."[31] Since then, sustainability and the mitigation of climate change have increasingly become central policy concerns of the United States. Indeed, President Bush's statement was almost immediately followed by Congress's passing of the Energy Policy Act of 1992, aiming to reduce U.S. dependence on fossil fuels by encouraging the use of, and investment in, renewable energy sources.[32] Under the next administration, President Bill Clinton promulgated environmentally-friendly executive orders throughout his tenure[33] and even signed the United States onto the Kyoto Protocol—an international agreement which would have required massive cuts in GHG emissions.[34]

Although the George W. Bush administration was notoriously regressive on climate change,[35] during his tenure, Congress continued to pass environmentally friendly legislation.[36] Then, starting in 2008, President Barack Obama revitalized the nation's pre-W. Bush position as he constantly issued executive orders designed to mitigate climate change[37] and even signed the United States onto the Paris Agreement, a landmark international climate change treaty designed to achieve a climate neutral world by mid-century.[38] Although President Donald Trump temporarily removed the United States from the Paris Agreement, the Federal Acquisition Regulation ("FAR")'s Part 23, generally directing federal agencies to purchase energy efficient products, and Part 36, directing agencies to implement high-performance sustainable construction practices, remained in effect.[39]

Moreover, since the United States joined the UNFCCC, state and local governments have adopted an extensive array of initiatives designed to mitigate climate change.[40] Many of these initiatives have targeted the construction industry specifically.[41] Indeed, even after President Trump withdrew the United States from the Paris Agreement, twenty-four states and hundreds of cities and companies pledged to uphold the Agreement's GHG reductions goals.[42]

Returning again to the federal government, today, there are constantly proposals in front of Congress seeking to address climate change.[43] Moreover, President Joe Biden has once again made the global environment a top priority of the Executive Branch, issuing executive orders designed to mitigate climate change since his first day in office,[44] reaffirming the United States' commitment to the Paris Agreement,[45] and playing a major role in developing a multi-trillion dollar green infrastructure plan.[46] Ultimately then, sustainability and the mitigation of climate change certainly constitute central policy concerns of the United States.

Since the construction industry is a major GHG emitter, it has become a crucial target for U.S. policymakers. Because the proposed Carbon Credit Bonus is designed to incentivize highway contractors to adopt more sustainable and climate-friendly materials, methods, and technologies, and ultimately to reduce their CO_2 emissions, it aligns with these central policy concerns and provides policymakers an effective tool for achieving their GHG reductions goals.

III. The Netherlands Concept

Currently, neither any of the fifty states nor the federal government implement anything like the proposed Carbon Credit Bonus. The Netherlands, on the other hand, employs a similar approach. On all public highway construction projects in the Netherlands, the Rijkswaterstaat ("RWS")[47]—the Dutch governmental body responsible for infrastructure—utilizes a bidding methodology referred to as "the most economically advantageous tender (MEAT)."[48] Under MEAT, the RWS is required to consider sustainability when evaluating contractors' bids.[49] In assessing the sustainability of each bid, the RWS focuses on CO_2 emissions.[50]

The RWS does this by using a tool known as the "CO_2 Performance Ladder."[51] The CO_2 Performance Ladder has five levels, ascending from 1 to 5.[52] For participating companies, a centralized agency known as the Ladder Certification Institution ("LCI") reviews the organization's documents, business practices, technologies, etc. and assigns the company a level on the ladder corresponding to the amount of CO_2 the company emits.[53] For example, a company that emits relatively little CO_2 and employs proven CO_2 reduction strategies and practices is assigned to Level 5 (subject to annual audits by the LCI), whereas a company that emits heavily and is just beginning to explore CO_2 reductions strategies is assigned to Level 1.[54] Then, in submitting bids on highway construction projects, certified bidders have their bid price reduced by a percentage corresponding to their certificate level (i.e., a Level 1 contractor has its bid reduced by 1%, Level 2 by 2%, and so on) for a maximum reduction of 5%.[55] Once the bid is awarded, the requirements of the certification level become part of the agreement.[56] Throughout construction of the project, the contractor is monitored, and if it does not comport with the requirements of the certification level, the RWS assesses a penalty of 1.5 times the discount awarded.[57] The CO_2 Performance Ladder thus has the effect of making those contractors who emit the least CO_2 the most competitive, as they are awarded a significant advantage in the bidding process. Thus, heavy emitters are pushed out of the market, light emitters remain, and overall CO_2 emissions are reduced. However, there are several problems with this approach.

First, the administrative costs are enormous. The RWS not only requires agencies to certify contractors under an intense auditing process, but also requires them to constantly monitor all of the contractor's activities throughout an entire project. The difficulty of quantifying CO_2 emissions also provides the contractor an advantage, as the burden is on the RWS to demonstrate that the contractor is not complying with the requirements of its certification level during the project (further, the contractor might comply at some times during the project and not others). Moreover, while the Netherlands' approach does provide contractors with an incentive, it does so only to the extent of bidding the job. It does not provide contractors with strong incentives to continue to look for ways to reduce their CO_2 emissions throughout the execution of the project, where it matters most. Indeed, studies suggest that many contractors have already been certified at the highest level, meaning there "is no incentive for these companies to go further in developing [CO_2 reductions] practices."[58]

Additionally, there is a substantial barrier to entry for highway contractors. The certification process imposes a significant cost on contractors in order for them to even be eligible for the program's benefits in the first place, serving as a substantial deterrent from their participating in it.[59] Finally, this approach does not actually monetize CO_2. Rather, it simply rewards a contractor for general environmental friendliness. An approach that ties the contractor's reward directly to CO_2 reductions on an individual project by putting a dollar figure on those CO_2 reductions, such as the Carbon Credit Bonus does, will be far more effectual in incentivizing GHG reductions.

IV. Monetizing CO_2

This of course begs the question: how should state and local transportation agencies monetize CO_2? There are essentially two options: allow the market to set the price or allow regulators to set the price. Allowing the market to set the price would mean tying the price per ton of CO_2 reduced to a cap-and-trade program's CO_2 "allowance"[60] price. Allowing regulators to set the price would mean tying the price per ton of CO_2 reduced to the Social Cost of Carbon.

A. *Cap-and-Trade Markets*

One method state and local governments could use to put a dollar figure on CO_2 reductions is to tie the price per ton of CO_2 reduced to an established CO_2 cap-and-trade market allowance price. A cap-and-trade program essentially allows the free market to indirectly determine the price of CO_2.[61] Under this pricing mechanism,

> a government agency establishes a limit, or cap, on regulated polluters' carbon emissions and then allocates set numbers of emission allowances among them. Trading of these allowances determines the value of allowances and creates a market between polluters. If targeted polluters surpass this cap, they must purchase reduction credits from other regulated polluters who go below their assigned caps.[62]

In this way, the market determines a price for the government allowances, and as a result, the price per ton of CO_2 emitted.[63] Of course, under a cap-and-trade program, the market only sets the price to a certain extent, as regulators first establish how many allowances to grant, which industries are subject to the program, and other artificial parameters.

Currently, there are several independent CO_2 cap-and-trade markets around the world. The largest and most renowned is certainly the European Union Emissions Trading System ("EUETS"),[64] established in 2005.[65] There are also two in the United States: one in California[66] and another in the Northeast known as the Regional Greenhouse Gas Initiative ("RGGI"), comprised of 11 states.[67] Arguably, since these programs have been around for years now, state and local transportation agencies could tie the Carbon Credit Bonus to the price per ton of CO_2 in one of these cap-and-trade markets. For example, using the EUETS, as of April 16, 2021, the price of one ton of CO_2 emissions was €44.33, or $53.63.[68]

However, there are several problems with tying the price per ton of CO_2 reductions in the Carbon Credit Bonus to a cap-and-trade market price. First, "in real-world cap-and-trade programs . . . the price of emissions permits has proven extremely volatile,"[69] occasionally even leading to price collapses.[70] The U.S. sulfur dioxide ("SO_2") market is a perfect example. "At one point, SO_2 emissions allowances traded for over $1600 per ton before dropping to less than $3 per ton."[71] Indeed, the EUETS CO_2 price has crashed multiple times.[72] In the past year alone, it has more than doubled.[73]

Additionally, the cap-and-trade system is highly complex. If policymakers do not provide enough CO_2 allowances, the price of CO_2 soars. However, if they provide too many allowances, "the price of CO_2 drops and the market disintegrates."[74] If the price per ton of CO_2 on a project is tied to an existing cap-and-trade market, policymakers will have extremely limited control and there will be no certainty tied to the Carbon Credit Bonus. As a result, contractors will be unable to adequately take the Carbon Credit Bonus into account during the bidding phase of the project, and many of the Carbon Credit Bonus's benefits will go unrealized.

Moreover, current CO_2 markets are limited to only certain sectors of the economy. For example, the RGGI cap-and-trade market is limited to those "fossil-fuel-fired electric power generators with a capacity of 25 megawatts[] or greater."[75] This means that the CO_2 price in these markets does not reflect *all* the negative effects of CO_2 on society as a whole. As a result, many of the negative externalities associated with CO_2 are not accounted for in this price.

B. *The Social Cost of Carbon*

The Social Cost of Carbon is an estimate developed by a federal interagency working group ("IWG") designed to put a precise dollar figure on the long-term damage done by one ton of CO_2 emissions today.[76] It is the:

> monetary value of the net harm to society associated with adding a small amount of [CO_2] to the atmosphere in a given year. In principle, it includes the value of all climate change impacts, including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The [Social Cost of Carbon], therefore, should reflect the societal value of reducing emissions of the gas in question by one metric ton. The marginal estimate of social costs will differ by the type of greenhouse gas (such as carbon dioxide, methane, and nitrous oxide) and by the year in which the emissions change occurs. The [Social Cost of Carbon is] the theoretically appropriate value[] to use in conducting benefit-cost analyses of policies that affect [CO_2] emissions.[77]

Federal agencies first started developing the Social Cost of Carbon in 2008 under Executive Order 12,866, in response to a Ninth Circuit Court of Appeals decision requiring the U.S. Department of Transportation to "consider the value of reducing CO_2 emissions in [the] rulemaking process."[78] Thus, originally, it was designed for federal agency use in the cost-benefit analysis part of the rulemaking process, so as to provide decisionmakers a dollar figure by which to assess the climatic effects of potential regulatory actions.[79] Shortly thereafter, in 2009, President Obama established an IWG "of technical experts from across the government to develop a single set of estimates,"[80] so as "to ensure that agencies were using the best available science and to promote consistency in the values used across agencies."[81]

In developing its Social Cost of Carbon estimates, the IWG utilizes "an ensemble of three widely cited integrated assessment models (IAMs) that estimate global climate damages using highly aggregated representations of climate processes and the global economy combined into a single modeling framework."[82] In addition to relying on multiple highly acclaimed climate models, the IWG has constantly solicited public comments and refinements from the most knowledgeable climate experts in the world in order to ensure its estimates are accurate. For example, in 2015, "the IWG asked the National Academies of Sciences, Engineering, and Medicine to conduct a multi-discipline, two-phase assessment of the IWG estimates and to offer advice on how to approach future updates to ensure that the estimates continue to reflect the best available science and methodologies."[83]

Although the IWG was temporarily disbanded under the Trump administration pursuant to Executive Order 13,783,[84] President Biden brought it back with a vengeance on his first day in office.[85] With the exception of a minor respite during the Trump administration, then, the Social Cost of Carbon has reflected the use of the best scientific estimating techniques in the world for assessing the true, *comprehensive* costs to society of each ton of CO_2 emitted, for a decade now. Currently, the federal Social Cost of Carbon is $51 per ton of CO_2.[86]

Indeed, because the Social Cost of Carbon has become such a valuable and reliable tool for assessing the true costs of CO_2 emissions on society, many states have either created their own or incorporated the federal Social Cost of Carbon into their regulatory cost-benefit analyses.[87] Beyond that, much like the proposed Carbon Credit Bonus, both New York and Illinois already use the Social Cost of Carbon to put a price on CO_2 emissions. Indeed, both of these states use the Social Cost of Carbon to put a dollar figure on "zero-emission credits" paid to electric utilities under their respective states' clean energy legislation.[88]

In New York, for example, qualifying nuclear power plants are awarded "state-created and state-issued credits certifying the zero-emission attributes of electricity [they] produce[]."[89] These credits, known as "zero-emissions credits," then operate as subsidies for participating nuclear plants in that the State allows the plants to sell the credits at a price tied to the Social Cost of Carbon.[90] The New York Independent System Operator, Inc. ("NYISO"), the organization responsible for managing New York's electric grid and its competitive wholesale electric marketplace, has heaped extraordinary praise on pricing CO_2 using the Social Cost of Carbon and providing private actors with incentives in this way.[91]

While not without its own problems,[92] the Social Cost of Carbon is the best method by which to price CO_2 reductions in the Carbon Credit Bonus calculation for several reasons. First, unlike a CO_2 price tied to a cap-and-trade market, policymakers have an extraordinary amount of control over the price of CO_2 using the Social Cost of Carbon. The federal Social Cost of Carbon rarely changes, and these potential changes are announced far in advance, much unlike the highly volatile cap-and-trade markets. Moreover, state and local transportation agencies would have even more control over the price of CO_2 if they tied it to their own State's Social Cost of Carbon. In this way, CO_2 pricing could also reflect the unique policy interests of the individual State. Further, along with increased control over the CO_2 price comes increased certainty in bonus calculations for contractors. Highway contractors will know up front, before submitting their bids, exactly what the Social Cost of Carbon is, and can incorporate their projected Carbon Credit Bonuses into their final bids. To hedge even further against uncertainty, public contracts could specify that the Carbon Credit Bonus for a certain project will be tied to the Social Cost of Carbon on a specific date (i.e., "this Carbon Credit Bonus will be calculated using the federal Social Cost of Carbon on April 29, 2021"). Reduced uncertainty then leads to less risk and a higher perceived return on investment for contractors.

Finally, unlike cap-and-trade markets, which only take into account some of the negative consequences of CO_2 emissions in the price of allowances, the Social Cost of Carbon is a far more advanced estimate of the comprehensive consequences of a ton of CO_2 emissions on global society long-term. Tying the price of CO_2 to the Social Cost of Carbon therefore far more accurately rewards contractors for reducing their CO_2 emissions.

V. Calculating a CO_2 Baseline

In order for state and local transportation agencies to verify that a highway contractor has reduced overall emissions on a project, they will first have to establish a

CO_2 baseline for comparison. Calculating a CO_2 emissions baseline for a road construction project is nothing new. Indeed, there are several industry-standard models and tools already widely in use, in both the United States and globally: PaLATE,[93] GREET,[94] DuboCalc,[95] Klimatkalkyl,[96] e-CALC,[97] BE^{2}ST in-Highways,[98] AU Materials Calculator,[99] Project Emission Estimator,[100] Carbon Footprint Calculator,[101] and SimaPro,[102] among others. For example, on all projects with a contract sum in excess of five million Euro, the Swedish Transportation Authority uses Klimatkalkyl to develop a CO_2 emissions baseline on road construction projects.[103] If that baseline is met or exceeded by highway contractors, they are awarded a bonus of a maximum of approximately 1% of the contract sum.[104]

Each of these baseline calculation tools employ life cycle analysis techniques to provide comprehensive quantitative assessments of the total GHG emissions associated with specific highway construction projects.[105] These calculations examine "the inputs and outputs throughout the life cycle of the product, system, or process, from obtaining raw material to the end of its useful life."[106] While there are variations between models, most baseline calculator tools take into account: (1) the emissions associated with the production of the materials (asphalt, concrete, rebar, steel, recycled aggregate, etc.) used in the project, (2) the emissions associated with each stage of the project (material extraction, construction, transportation, operation, and end of life), and (3) the project length in miles or kilometers.[107]

In calculating the CO_2 baseline on road construction projects, state and local transportation agencies could adopt one of the industry standard CO_2 calculation tools or develop their own. Whether the agencies adopt an industry standard tool or create their own, the primary concern is that they take into account the comprehensive projected CO_2 emissions for the project. At the beginning of the project, since most public highway construction contracts require design-bid-build contracting structures, the state or local transportation agency should have a nearly complete design on which to base its original calculations.[108] As change orders are adopted and incorporated into the project, agencies will need to update their calculations.

Agencies should calculate the baselines using industry standards. For example, in calculating the CO_2 emissions associated with asphalt production, the agency should calculate this figure based on the use of hot-mix-asphalt, as this is the industry standard. As another example, in accounting for transportation emissions, the agency should calculate the baseline using fossil fuels like diesel and gasoline, as opposed to biofuels, as fossil fuels are currently the industry standard. As more climate-friendly methods and materials are adopted in response to the Carbon Credit Bonus, and industry standards start to shift, agencies should reflect these changes in their baseline calculations. For example, once it becomes common for contractors to use more climate-friendly warm-mix asphalt, agencies can take this into account in the baseline. As baseline emissions shrink, it becomes more difficult for contractors to receive a Carbon Credit Bonus. This further incentivizes them to pursue even more significant CO_2 reductions strategies and innovations—yielding a perpetual feedback loop of climate friendliness in road construction.

Moreover, in developing a baseline, agencies should assume “best-case-scenario emissions.” This means that for the particular product, process, or system at issue, the agency should assume the baseline emissions are those of a best-practices contractor. This assumption will make it harder for contractors to show that they have made substantial reductions in CO_2 emissions over the course of a project and will encourage them to adopt best-practices when it comes to CO_2 reductions.

The primary critique lodged at requiring state and local transportation agencies to calculate a carbon emissions baseline, and recalculate it as the scope is updated throughout a project, will be the associated cost.[109] There can be no doubt that such a requirement will entail a significant cost for the government agency in question. However, the benefits of such a requirement far outweigh its associated costs. First, the contractor will have an incentive to reduce CO_2 emissions on the project because of the potential for a Carbon Credit Bonus at the end. The CO_2 emissions reductions produced as a result of this incentive are an enormous benefit to society and aid in decreasing nationwide GHG emissions.

Second, government agencies should be calculating a carbon emissions baseline *anyway*, even without the Carbon Credit Bonus justification. Requiring state and local agencies to calculate a carbon emissions baseline contributes extraordinarily to “carbon literacy," meaning that government agencies will become carbon-educated by understanding how much CO_2 is associated with different products, processes, and systems throughout the course of projects.[110] This, in turn, will make it far easier for state and local governments to implement initiatives designed to reduce CO_2 because their employees will be well versed in the jargon and strategies, and there will be existing databases documenting best-practices for CO_2 reductions. This contributes significantly to accurate, reasonable, and tangible policy actions that actually achieve CO_2 reductions. Finally, accounting for the CO_2 emissions on a project before it begins will help policymakers determine its comprehensive costs to society.

VI. The Carbon Credit Bonus

Unlike building construction, heavy highway work presents a unique challenge. In the building sector, progressive owners can embrace CO_2 reductions via LEED certification, selecting alternative designs and materials, seeking out the assistance of design professionals who specialize in sustainable architecture, etc. Take, for example, the University of Arkansas's recent construction of Adohi Hall using cross laminated timber, a material that can reduce CO_2 emissions by up to 80% of its concrete counterpart.[111]

This does not translate well to highway projects, where contractors are dealing with dirt, concrete, steel, and asphalt—period. Indeed, highway contractors have operated in much the same way throughout their existence; all that has really changed is the technology related to the speed of construction. This has allowed them to develop economies of scale and maintain their competitiveness in their respective markets. These contractors are not going to change their behavior and adopt CO_2 reductions strategies unless they either (1) have to adapt to become more competitive or (2) have to adapt to avoid some governmental penalty. It does not require decades of social science to know that people respond more favorably to incentives than penalties—in comes the Carbon Credit Bonus.

State and local transportation agencies across the United States should implement a Carbon Credit Bonus in public highway construction contracts. They could do so by adding a provision into the contract—modeled on existing contract bonus structures for early completion[112]—providing that, at the end of the project, the contractor will be awarded a Carbon Credit Bonus in the amount of the tons of CO_2 reduced times the Social Cost of Carbon. Importantly, contractor participation would be totally optional—contractors do not have to participate unless they elect to do so. Indeed, nothing about the bidding process will need to change, and the lowest responsible bidder will still get the job.[113]

At the beginning of the project, a State employee or consultant will calculate the baseline projected CO_2 emissions for the project, in tons. Periodic updates will have to be made as change orders are issued—an inevitable part of every construction project. The State employee or consultant can calculate this baseline and concomitant updates using one of the tools referenced above,[114] or the state/local transportation agency can require the use of its own tool. Having the State calculate the baseline is important for several reasons. First, it ensures legitimacy and removes unfairness in the baseline calculations. If the State is using a singular calculation method, employing the same assumptions consistently, it levels the playing field among contractors and removes a significant degree of subjectivity that would otherwise be present if contractors were allowed to calculate the baselines themselves. Furthermore, it ensures that state and local transportation agencies are monitoring the CO_2 emissions of all publicly funded highway construction projects and becoming carbon-educated. The State can then publish its baseline along with the bid documents so that contractors can analyze the best and most efficient ways to capitalize on the Carbon Credit Bonus.

Next, during the project, the contractor will document the ways in which it has implemented carbon reduction strategies to reduce the CO_2 emissions of the project. The contractor is already required to provide extensive records and documentation for reporting purposes—for example, a detailed accounting of all the materials that are incorporated into the project are required for payment—so this would not constitute much of an additional burden.

Importantly, the State should leave it entirely up to the contractor to determine the best ways to reduce CO_2 emissions.[115] In other words, the contractor should be free to reduce emissions by any means it sees fit. The contractor could reduce emissions in the road construction process through a variety of means. These means include, for example:

using alternative fuels for asphalt plants, biofuels for dump trucks, electric vehicles, "warm-mix" asphalt, fly ash, incorporating recycled materials, minimizing hauling distances, etc. Whatever the contractor decides to invest in will incentivize efficiency and CO_2 reducing innovation.

Upon completion of the project, the contractor must have an independent entity certify the project with a "carbon declaration." This independent account would tally the contractor's total CO_2 emissions for the project as built, using the same tool and assumptions as the State, and compare this number to the baseline. The difference between the State baseline and the carbon declaration would then become the basis for the bonus payment. Prior to paying the bonus, the State would be entitled to an opportunity to verify the carbon declaration. As a further deterrent from falsifying records, all false claims could be subjected to a serious penalty similar to those under the federal False Claims Act, such as treble damages.[116] After verification, the State employee or consultant will multiply the tons of CO_2 emissions saved by the Social Cost of Carbon. The resulting figure will be the Carbon Credit Bonus awarded to the contractor at the end of the project. Much like an early completion bonus, state and local governments could cap the bonus a contractor could receive. Indeed, the Federal Highway Administration ("FHA") has suggested setting a cap on early completion and like incentives at a maximum of 5% of the contract price.[117]

The following table provides several examples of what a real-world Carbon Credit Bonus would look like, using past highway infrastructure jobs from three different states: Arkansas,[118] Texas,[119] and California.[120] Arkansas was chosen as it is the home state of the author. Texas and California were chosen because they are both renowned for their massive infrastructure projects, and they are in very different areas of the United States. While these jobs are not a representative sample of the entire country, their wide variety—in terms of both geography and scope—demonstrates the wide-ranging application of the Carbon Credit Bonus. The estimated baselines were calculated in metric tons of CO_2 ("MTCO_2") using the Project Emission Estimator tool.[121] Importantly, these calculations are only rough estimates based on information provided in the bid documents. The true measure of CO_2 emissions can vary depending on what assumptions are made when inputting data into the estimating tool. This is why it is important that a State employee or consultant is calculating the baseline in the same way every time. Because there is a certain degree of subjectivity going into the estimations, this allows policymakers to establish higher or lower baselines depending on the particular State's policy preferences.

Agency	Job No.	Contract Amount	Job Description	Lane Miles	Estimated Baseline ($MTCO_2$)	Social Cost of Carbon	5% Contract Bonus
Arkansas DOT	020763	$3,849,823	Road Improvements – Asphalt Mill & Overlay	9.27	3,244.50	$165,470	$192,491
Arkansas DOT	030501	$20,547,510	Bridge Construction & Road Improvements	1.73	2,589.00	$132,039	$1,027,376
Texas DOT	C 16-5-120	$5,145,675	Resurface – Reconstruction Roadway	0.55	828.00	$42,228	$257,284
Texas DOT	F 2021(587)	$3,518,108	Resurface – Reconstruction Roadway	1.70	1,868.90	$95,314	$175,905
Texas DOT	BR 2021(343)	$5,478,921	Bridge Replacement	0.28	980.00	$49,980	$273,946
California DOT	06A2691	$261,162	Resurface – Reconstruction Roadway	0.71	213.00	$10,863	$13,058
California DOT	02-4E6404	$5,747,451	Bridge & Roadway Reconstruction	0.60	1500.00	$76,500	$287,373

The table demonstrates that using the Social Cost of Carbon to monetize CO_2 emissions does not result in a windfall for the contractor. Indeed, in all the examples, the maximum potential Carbon Credit Bonus is lower than 5% of the contract price. Based on these figures, the economics of the Carbon Credit Bonus are likely insufficient to incentivize immediate behavior, at least in the short run on a per-job basis. However, it is important to keep in mind that, every year, state and local transportation departments across the country are dumping billions of dollars into highway infrastructure. According to the Texas Department of Transportation's most recent reports, in Fiscal Year 2020, Texas alone administered more than 800 highway infrastructure projects, worth almost 8 billion dollars.[122] Thus, although it may not have an extraordinary impact on an individual job, savvy contractors will quickly realize the cumulative potential of the Carbon Credit Bonus over time. As a result, long term, the Carbon Credit Bonus will incentivize contractors to invest in CO_2 reductions strategies in order to remain competitive and reap the economic benefits.

The Carbon Credit Bonus is politically palatable, in stark contrast to the idea of a carbon tax,[123] and would have the added effect of ultimately making those highway contractors who emit the least amount of CO_2 the most competitive, as these contractors could account for projected Carbon Credit Bonuses in their bids. Furthermore, because government entities constitute the largest clients in the road construction sector, the Carbon Credit Bonus would have an extraordinary impact on greening the industry.[124] As contractors respond favorably to the Carbon Credit Bonus and adopt new methods, materials, and processes to reduce CO_2, state and local transportation agencies can start to modify their designs to reflect these new industry standards. As a result, supply chains and materials manufacturers will begin to make investments in their equipment and production processes to meet the new demand for low CO_2 emitting products. It becomes an iterative feedback loop whereby the market incentive aligns the stakeholders' interests.

Furthermore, unlike the Netherlands' approach, the Carbon Credit Bonus would not require state and local transportation agencies to constantly monitor all the contractor's activities throughout the course of a project. Instead, the onus is on the contractor to demonstrate it has reduced CO_2 at the end of the project. Finally, there is no initial certification cost to contractors. Indeed, nothing about the competitive bidding process or contract administration will materially change—participation in the Carbon Credit Bonus program will be voluntary for highway contractors.

VII. Conclusion

Twenty of the warmest years on record have occurred in the last twenty-two years.[125] In 2019, in response to rising sea-levels, Indonesia announced plans to move its capital city of Jakarta—home to ten million people—to a different island.[126] In 2020—the hottest year on record[127]—the concentration of CO_2 in the atmosphere was the highest it has been in human history.[128] 2020 also set an annual record of twenty-two climate disaster events with losses exceeding $1 billion to the United States, "shattering the previous annual record of 16 events that occurred in 2011 and 2017."[129] This compared to an annual average of only 7.1 events between 1980 and 2020.[130] The point is this: the climate is clearly changing—for the worse.

As a result, global society needs to take drastic action—yesterday. In order to achieve the goals set by the 197 parties to the Paris Agreement[131] and keep the consequences of climate change to a minimum, every sector of society must do its part to drastically cut its GHG emissions. The highway construction industry, as a notorious emitter, is no exception. Reducing its GHG emissions can make a real difference. Indeed, simply by using recycled materials in roadway construction nationwide, "energy savings commensurate with the annual energy consumption of households in a state comparable in size to Illinois or Pennsylvania can be achieved[.]"[132]

The Carbon Credit Bonus is the perfect three-legged stool by which state and local transportation agencies can incentivize highway contractors to pursue drastic CO_2 reductions such as this. First, the Carbon Credit Bonus serves the public good. It requires government agencies to calculate a CO_2 emissions baseline on all their projects, thereby ensuring the government is aware of the true costs to society of all highway infrastructure projects. In requiring the calculation of this baseline, it contributes to government carbon literacy, ensuring that policymakers implement accurate, reasonable, and tangible policy actions that actually achieve CO_2 reductions. Moreover, it reduces CO_2 emissions in the construction industry, and provides an iterative feedback loop in which there is a "race to the top" for contractors to become the most CO_2 neutral companies.

Second, the Carbon Credit Bonus incentivizes contractor innovation. With profit on the line, contractors will pursue CO_2 reductions strategies in order to ensure that they remain competitive in their respective markets. Indeed, the less CO_2 a highway contractor emits, the more of a competitive advantage it will have. This contractor will want to maintain its competitive advantage and will continue to adopt even more significant CO_2 reductions strategies. In response, other highway contractors will either have to invest in CO_2 reductions strategies themselves or they will be pushed out of the market. This in turn creates more jobs in the CO_2 reductions sector and pumps more money into researching and developing climate-friendly materials, methods, technologies, and systems. Third, and finally, the Carbon Credit Bonus ensures consumers get better, more climate-friendly products, and for better prices.

The United States has some of the best scenic drives in the world. Whether one is heading down "the pig trail" in Arkansas in the fall, cruising through tunnels of vibrant autumn foliage to a Razorback football game; snaking past steep sea-cliffs, lush with blooming mango trees rising out of pristine turquoise pools on the famous Hana Highway in Hawaii; twisting through hundreds of miles of Appalachia along the Blue Ridge Parkway, filled with undulating slopes of color and unparalleled panoramic overlooks; or driving awe-struck along the Great River Road, marveling at the might of the Mississippi River and stopping to stare at the nation's largest alluvial plain; one lesson can be drawn from this experience: highway construction and the natural environment are not mutually exclusive. A better environment means better business. While environmentalists and highway contractors may have diverging views of the "green" that matters, their interests can be aligned with the Carbon Credit Bonus. In adopting this idea, state and local governments can go a long way towards preserving this nation's natural wonders—for generations to come.

[1] *Impacts on Society*, U.S. GLOB. CHANGE RSCH. PROGRAM, https://www.globalchange.gov/climate-change/impacts-society (last visited Apr. 18, 2021); *The Effects of Climate Change*, NAT'L AERONAUTICS & SPACE ADMIN., https://climate.nasa.gov/effects/ (last visited Apr. 18, 2021); *Tackling Climate Change and Biodiversity Loss Together*, UNITED NATIONS ENV'T PROGRAMME WORLD CONSERVATION MONITORING CTR. (Nov. 3, 2020), https://www.unep-wcmc.org/news/tackling-climate-change-and-biodiversity-loss-together; *Climate Change Impacts*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts (last visited Apr. 18, 2021).

[2] INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS (T.F. Stocker et al., eds., 2013), https://www.ipcc.ch/report/ar5/wg1/ [hereinafter CLIMATE CHANGE 2013].

[3] *What is the Greenhouse Effect?*, NAT'L AERONAUTICS & SPACE ADMIN., https://climate.nasa.gov/faq/19/what-is-the-greenhouse-effect/ (last visited Apr. 27, 2021).

[4] *Id.*

[5] *Climate Change Indicators*, ENV'T PROT. AGENCY (Nov. 9, 2020), https://www.epa.gov/climate-indicators/greenhouse-gases. These gases are commonly listed as carbon dioxide, methane, nitrous oxide, and fluorinated gases. *Id.*

[6] INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, GLOBAL WARMING OF 1.5°C (Valérie Masson-Delmotte et al., eds., 2018), https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf [hereinafter GLOBAL WARMING OF 1.5°C]; U.S. GLOB. CHANGE RSCH. PROGRAM, FOURTH NATIONAL CLIMATE ASSESSMENT VOLUME II (2018), https://nca2018.globalchange.gov/ [hereinafter FOURTH NATIONAL CLIMATE ASSESSMENT]; Paris Agreement to the United Nations Framework Convention on Climate Change, art. 2, Dec. 12, 2015, T.I.A.S. No. 16-1104.

[7] GLOBAL WARMING OF 1.5°C, *supra* note 6; FOURTH NATIONAL CLIMATE ASSESSMENT, *supra* note 6.

[8] While there are GHGs other than CO_2, most of the literature focuses primarily on CO_2, as it is the single most problematic GHG. Indeed, many other GHG emissions calculations are expressed in CO_2 equivalents ("CO_2e") for this very reason. *See, e.g.*, JINCHEOL LEE ET AL., USE OF BE^{2}ST IN-HIGHWAYS FOR GREEN HIGHWAY CONSTRUCTION RATING IN WISCONSIN (2011). Thus, the focus of this Article will be on CO_2 specifically, though the ideas and principles suggested can be extrapolated to all other GHGs, especially since they are often calculated in CO_2e.

[9] Lizhen Huang et al., *Carbon Emission of Global Construction Sector*, 81 RENEWABLE & SUSTAINABLE ENERGY REVS. 1906, 1907 (2018) (explaining that, in 2009 alone, the global construction sector emitted 5.7 billion tons of CO_2).

[10] *2019 Global Status Report for Buildings and Construction*, INT'L ENERGY AGENCY, https://webstore.iea.org/download/direct/2930?filename=2019_global_status_report_for_buildings_and_construction.pdf. (last visited Apr. 27, 2021).

[11] Christopher S. Hanson et al., *Life-Cycle Greenhouse Gas Emissions of Materials Used in Road Construction*, 2287 TRANSP. RSCH. REC. 174 (2012); *Environmental Technical Assistance Program Newsletter*, CTR. FOR ENV'T EXCELLENCE (2021), https://etapnews.transportation.org/can-highway-construction-achieve-net-zero-carbon-emissions/.

[12] Darrell Cass & Amlan Mukherjee, *Calculation of Greenhouse Gas Emissions for Highway Construction Operations by Using a Hybrid Life-Cycle Assessment Approach: Case Study for Pavement Operations*, 137 J. CONSTR. ENG'G & MGMT. 1015 (2011).

[13] Roger Warburton, *Global Warming has Concrete Problem When it Comes to CO2*, ECORI NEWS (Oct. 4, 2019), https://www.ecori.org/climate-change/2019/10/4/global-warming-has-a-co2ncrete-problem; Elisheva Mittelman, *The Cement Industry, One of the World's Largest CO2 Emitters, Pledges to Cut Greenhouse Gases*, YALE ENV'T 360 (Dec. 28, 2018), https://e360.yale.edu/digest/the-cement-industry-one-of-the-worlds-largest-co2-emitters-pledges-to-cut-greenhouse-gases.

[14] Warburton, *supra* note 13 (using figures provided by the Federal Highway Administration and National Ready Mix Concrete Association).

[15] *Highway Statistics Series*, FED. HIGHWAY ADMIN., https://www.fhwa.dot.gov/policyinformation/statistics/2019/vmt421c.cfm (last visited Apr. 28, 2021).

[16] LEE ET AL., *supra* note 8.

[17] *Id.*

[18] *Scope of the U.S. Highway Network*, AM. RD. & TRANSP. BUILDERS ASS'N (Sept. 2017), https://www.artba.org/government-affairs/policy-statements/highways-policy/. That being said, "the federal government has shared the cost of improvements to the core highways . . . most essential to the strength and performance of the nation's economy." *Id.*

[19] Cass & Mukherjee, *supra* note 12, at 1015 (citing NICHOLAS SANTERO ET AL., LIFE CYCLE ASSESSMENT OF PAVEMENTS: A CRITICAL REVIEW OF EXISTING LITERATURE AND RESEARCH (2010)).
[20] *See, e.g.*, H.R. Res. 109, 116th Cong. (2021) (recognizing the duty of the federal government to create a "Green New Deal" with goals of, *inter alia*, achieving net-zero GHG emissions and investing in infrastructure); BUILD Green Infrastructure and Jobs Act, S.___, 116th Cong. (2021) (providing for $500 billion in grant funding over ten years for electrifying public transit systems), https://www.warren.senate.gov/imo/media/doc/BUILD%20GREEN%20Bill%20Text.pdf; Jonathan Ponciano, *Here's What We Know About Democrats' 'Big' and 'Green' Multi-Trillion-Dollar Infrastructure Plan*, FORBES (Mar. 14, 2021), https://www.forbes.com/sites/jonathanponciano/2021/03/14/democrats-big-and-green-multi-trillion-dollar-infrastructure-plan/?sh=5b1e45ba2624 (discussing congressional proposals of dumping somewhere between $2 and $4 trillion into green infrastructure); Jim Tankersley, *Biden Team Prepares $3 Trillion in New Spending for the Economy*, N.Y. TIMES (Mar. 22, 2021), https://www.nytimes.com/2021/03/22/business/biden-infrastructure-spending.html (same).
[21] U.N. Secretary-General, C.N.10.2021 Treaties-XXVII.7.d (Jan. 20, 2021), https://treaties.un.org/doc/Publication/CN/2021/CN.10.2021-Eng.pdf. In re-entering the Paris Agreement, the United States has reaffirmed its commitment to making drastic cuts in GHG emissions over the next several decades. *See generally* Paris Agreement to the United Nations Framework Convention on Climate Change, *supra* note 6.
[22] John Schwartz, *Survey Finds Majority of Voters Support Initiatives to Fight Climate Change*, N.Y. TIMES (Jan. 15, 2021), https://www.nytimes.com/2021/01/15/climate/climate-change-survey.html.
[23] NAT'L COOP. HIGHWAY RSCH. PROGRAM, TIME-RELATED INCENTIVE AND DISINCENTIVE PROVISIONS IN HIGHWAY CONSTRUCTION CONTRACTS 8-10 (2010).
[24] 31 U.S.C. § 3729(a)(1).
[25] The Social Cost of Carbon "is the monetary value of the net harm to society associated with adding a small amount of [CO_2] to the atmosphere in a given year. In principle, it includes the value of all climate change impacts, including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The [Social Cost of Carbon], therefore, should reflect the societal value of reducing emissions of the gas in question by one metric ton." INTERAGENCY WORKING GROUP ON SOCIAL COST OF GREENHOUSE GASES, TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON, METHANE, AND NITROUS OXIDE INTERIM ESTIMATES UNDER EXECUTIVE ORDER 13990 (Feb. 2021), *available at* https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf. [hereinafter TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON]. For more on the Social Cost of Carbon, *see infra* Part IV.B.
[26] Reuven S. Avi-Yonah & David M. Uhlmann, *Combating Global Climate Change: Why a Carbon Tax is a Better Response to Global Warming Than a Cap and Trade*, 28 STAN. ENV'T L.J. 3 (2009) (discussing the widely held belief that, "a carbon tax cannot get enacted because it is a tax."); *see also* Jim Rossi, *Carbon Tax by Regulation*, 102 MINN. L. REV. 277 (2017) ("Legislative adoption of a national carbon tax is widely considered infeasible and is stalled, at least for the foreseeable future").
[27] Adriana X. Sanchez et al., *Evaluation Framework for Green Procurement in Road Construction*, 3 SMART & SUSTAINABLE BUILT ENV'T 153 (2014).
[28] David King, *A Chemist Ahead of His Time*, GUARDIAN (Feb. 3, 2005), https://www.theguardian.com/science/2005/feb/03/lastword.environment#:~:text=The%20story%20starts%20in%201827,things%2C%20suitable%20for%20human%20beings.
[29] *The Intergovernmental Panel on Climate Change*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2021), https://www.ipcc.ch/ (discussing how the IPCC was established "to provide policymakers with regular scientific assessments on climate change, its implications and potential future risks, as well as to put forward adaptation and mitigation options."); *see also* John C. Dernbach & Seema Kakade, *Climate Change Law: An Introduction*, 29 ENERGY L.J. 1, 3 (2008).
[30] Dernbach & Kakade, *supra* note 29, at 9.
[31] *Rio Earth Summit*, C-SPAN (June 13, 1992), https://www.c-span.org/video/?26576-1/rio-earth-summit.
[32] Energy Policy Act of 1992, Pub L. No. 102-486, 106 Stat. 2776 (1992).
[33] *See, e.g.*, Exec. Order No. 12,845, 58 Fed. Reg. 21,887 (Oct. 20, 1993) (requiring federal agencies to purchase energy efficient computer equipment); Exec. Order No. 12,873, 58 Fed. Reg. 54,911 (Oct. 20, 1993) (promoting recycling and environmental procurement); Exec. Order No. 13,031, 61 Fed. Reg. 66,529 (Dec. 13, 1996) (requiring federal agencies to acquire alternatively fueled vehicles); Exec. Order No. 13,123, 64 Fed. Reg. 30,851 (June 8, 1999) (advocating the procurement of environmentally friendly products and mandating federal agencies reduce GHG emissions attributed to their "facility energy use").

[34] *Signing the Kyoto Protocol*, WHITE HOUSE GREEN BLDG., https://clinton.presidentiallibraries.us/exhibits/show/green-building/kyoto-protocol (last visited Apr. 19, 2021). For an extensive list of the Clinton administration's pro-environment measures, *see Environmental Actions by President Clinton and Vice President Gore*, THE WHITE HOUSE (2000), https://clintonwhitehouse4.archives.gov/media/pdf/ch13.pdf. Shortly thereafter, the Senate failed to ratify the Kyoto Protocol and President Bush announced the United States would no longer be a party. S. Res. 98, 105th Cong. (1998) (effectively prohibiting the United States from ratifying the Kyoto Protocol).

[35] *See, e.g.*, Armin Rosencranz, *U.S. Climate Change Policy under G.W. Bush*, 32 GOLDEN GATE UNIV. L. REV. 479 (2002).

[36] *See, e.g.*, Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594 (2005) (greatly increasing the amount of biofuels and renewable resources imported into the United States); Energy Independence and Security Act of 2007, Pub. L. No. 110-140, 121 Stat. 1492 (requiring federal buildings to reduce total energy use by 30%, creating the Office of Federal High Performance Green Buildings, and drastically increasing fuel efficiency standards).

[37] *See, e.g.*, Exec. Order No. 13,514, 74 Fed. Reg. 52,117 (Oct. 5, 2009) (instructing federal agencies to set or achieve various GHG emissions reductions and energy and environmental benchmarks by 2015, 2020, and 2030); Exec. Order No. 13,547, 75 Fed. Reg. 43,023 (July 19, 2010) (establishing a policy of "adaptive management to enhance our understanding of and capacity to respond to climate change and ocean acidification."); Exec. Order No. 13,653, 78 Fed. Reg. 66,819 (Nov. 1, 2013) (announcing an initiative to prepare the United States for the impacts of climate change); Exec. Order No. 13,693, 80 Fed. Reg. 15,871 (outlining methods by which federal agencies must increase energy efficiency, thereby reducing GHG emissions).

[38] Tanya Somanader, *President Obama: The United States Formally Enters the Paris Agreement*, THE WHITE HOUSE (Sept. 3, 2016), https://obamawhitehouse.archives.gov/blog/2016/09/03/president-Obama-United-states-formally-enters-Paris-agreement; *The Paris Agreement*, UNITED NATIONS CLIMATE CHANGE, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement (last visited Apr. 19, 2021).

[39] *See, e.g.*, FAR 23, 36.104, 36.509 (2021).

[40] *See, e.g.*, Chris Henry, *A Succinct, Holistic Look at Climate Change Legislation*, 39 S. ILL. U. L.J. 231, 234 (2015); *The Regional Greenhouse Gas Initiative*, REG'L GREENHOUSE GAS INITIATIVE, https://www.rggi.org/program-overview-and-design/elements (last visited Apr. 22, 2021) (documenting an initiative developed by 11 Northeastern states to reduce CO_2 emissions by implementing a cap-and-trade program); *Cap-and-Trade Program*, CA AIR RES. BD., https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/about (last visited Apr. 30, 2021) (discussing the intra-California cap-and-trade program designed to stem CO_2 emissions).

[41] *See, e.g.*, Patrick J. O'Connor, *Legal Considerations in Sustainable Design and Construction*, 5 NO. 1 J. OF THE AM. COLL. OF CONSTR. LAWYERS 4 (2010) (discussing a University of Wisconsin study documenting "134 mandatory government green [construction] programs and 85 voluntary programs in place in 118 counties, municipalities, and districts in the United States."); Carl J. Circo, *Using Mandates and Incentives to Promote Sustainable Construction and Green Building Projects in the Private Sector: A Call for More State Land Use Policy Initiatives*, 112 PENN. ST. L. REV. 731 (2008).

[42] Robinson Meyer, *Dozens of States Want to Keep America's Broken Climate Promise*, ATLANTIC (Dec. 9, 2019), https://www.theatlantic.com/science/archive/2019/12/24-states-are-still-paris-theyre-also-cutting-emissions/603250/.

[43] *See, e.g.*, H.R. Res. 109, 116th Cong. (2021) (recognizing the duty of the federal government to create a "Green New Deal" with goals of, *inter alia*, achieving net-zero GHG emissions and investing in infrastructure); BUILD Green Infrastructure and Jobs Act, S.___, 116th Cong. (2021) (providing for $500 billion in grant funding over ten years for electrifying public transit systems), https://www.warren.senate.gov/imo/media/doc/BUILD%20GREEN%20Bill%20Text.pdf.

[44] *See, e.g.*, Exec. Order No. 13,990, 86 Fed. Reg. 7,037 (Jan. 20, 1990); Exec. Order No. 14,008, 86 Fed. Reg. 7,619 (Jan. 27, 2021).

[45] U.N. Secretary-General, C.N.10.2021 Treaties-XXVII.7.d (Jan. 20, 2021), https://treaties.un.org/doc/Publication/CN/2021/CN.10.2021-Eng.pdf.

[46] *See, e.g.*, Ponciano, *supra* note 20 (discussing congressional proposals of dumping somewhere between $2 and $4 trillion into green infrastructure); Tankersley, *supra* note 20 (same).

[47] The RWS is a "part of the Dutch Ministry of Infrastructure and Water Management and [is] responsible for the design, construction, management, and maintenance of the main infrastructure in the Netherlands." *About us*, RIJKSWATERSTAAT, https://www.rijkswaterstaat.nl/en/about-us (last visited Apr. 22, 2021).

[48] *Going Green: Best Practices for Green Procurement – Netherlands*, ORG. ECON. COOP. & DEV. (2014), https://www.oecd.org/gov/ethics/gpp-procurement-Netherlands.pdf.

[49] *Id.*

[50] *Id.*

[51] *How to Use the CO_2 Performance Ladder: A Practical Manual for Companies*, STICHTING KLIMAATVRIENDELIJK AANBESTEDEN & ONDERNEMEN, https://ska-skao.ams3.digitaloceanspaces.com/media/documents/Practical%20Guide%201.pdf (last visited Apr. 22, 2021).
[52] *Handbook: CO_2 Performance Ladder 3.1*, STICHTING KLIMAATVRIENDELIJK AANBESTEDEN & ONDERNEMEN (June 22, 2020), https://ska-skao.ams3.digitaloceanspaces.com/media/documents/Handbook_31_EN.pdf.
[53] *Id.*
[54] *Id.*
[55] *Id.* Importantly, non-certified bidders may also participate under the program by indicating in their bid that they will comply with a certain certification level throughout the construction of the particular project.
[56] ANNA KADEFORS ET AL., PROCUREMENT REQUIREMENTS FOR CARBON REDUCTION IN INFRASTRUCTURE CONSTRUCTION PROJECTS (2019), https://www.diva-portal.org/smash/get/diva2:1324140/FULLTEXT01.pdf.
[57] *Id.*
[58] Anna Kadefors et al., *Designing and Implementing Procurement Requirements for Carbon Reduction in Infrastructure Construction—International Overview and Experiences*, 64 J. ENV'T PLANNING & MGMT. 611 (2021).
[59] *Id.*
[60] The term "allowance" refers to the units which are bought and sold under cap-and-trade markets. It is often used interchangeably with the terms "CO_2 permit" or "right to pollute."
[61] David M. Driesen, *Emissions Trading versus Pollution Taxes: Playing "Nice" with Other Instruments*, 48 ENV'T L. 29 (2018); Chios Carmody, *A Guide to Emissions Trading Under the Western Climate Initiative*, 43 CAN.-U.S. L.J. 148 (2019).
[62] Stephen Sewalk, *Carbon Tax with Reinvestment Trumps Cap-and-Trade*, 30 PACE ENV'T L. REV. 580 (2013) [hereinafter Sewalk I]; *see also* Robert N. Stavins, *A Meaningful U.S. Cap-and-Trade System to Address Climate Change*, 32 HARV. ENV'T L. REV. 293, 298 (2008); Gary M. Lucas, Jr., *Behavioral Public Choice and the Carbon Tax*, 2017 UTAH L. REV. 115 (2017); Stephen Sewalk, *Europe Should Dump Cap-and-Trade in Favor of Carbon Tax with Reinvestment to Reduce Global Emissions*, 5 WASH. & LEE J. ENERGY, CLIMATE, & ENV'T 355 (2014) [hereinafter Sewalk II].
[63] Erik Haites et al., *Experience with Carbon Taxes and Greenhouse Gas Emissions Trading Systems*, 29 DUKE ENV'T L. & POL'Y F. 109 (2018).
[64] *EU Emissions Trading System (EU ETS)*, EUR. UNION, https://ec.europa.eu/clima/policies/ets_en (last visited Apr. 23, 2021); *see also* Carmody, *supra* note 61.
[65] Bruno Zeller, *Systems of Carbon Trading*, 25 TOURO L. REV. 909 (2009).
[66] *Cap-and-Trade Program*, *supra* note 40; *see also* Justin Gundlach, *To Negotiate a Carbon Tax: A Rough Map of Interactions, Tradeoffs, and Risks*, 43 COLUM. J. ENV'T L. 269 (2018).
[67] *The Regional Greenhouse Gas Initiative*, *supra* note 40. These states are Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont, and Virginia. *Id. See also* Gundlach, *supra* note 66.
[68] *Daily EU ETS Carbon Market Price (Euros)*, EMBER (Apr. 16, 2021), https://ember-climate.org/data/carbon-price-viewer/.
[69] Lucas, Jr., *supra* note 62.
[70] Sewalk II, *supra* note 62.
[71] *Id.*
[72] *Id.*; *see also* Damian Carrington, *EU Carbon Price Crashes to Record Low*, GUARDIAN (Jan. 24, 2013), https://www.theguardian.com/environment/2013/jan/24/eu-carbon-price-crash-record-low.
[73] *See Daily EU ETS Carbon Market Price (Euros)*, *supra* note 68.
[74] Sewalk II, *supra* note 62.
[75] *The Regional Greenhouse Gas Initiative*, *supra* note 40.
[76] Howard Shelinski & Maurice Obstfeld, *Estimating the Benefits from Carbon Dioxide Emissions Reductions*, WHITE HOUSE (July 2, 2015), https://obamawhitehouse.archives.gov/blog/2015/07/02/estimating-benefits-carbon-dioxide-emissions-reductions.
[77] TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON, *supra* note 25.
[78] *Id.*; Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1200 (9th Cir. 2008).
[79] Since the promulgation of Executive Order 12,291 by President Reagan, federal agencies have been required to assess the costs and benefits of certain proposed regulatory actions before taking them. Exec. Order No. 12,291, 46 Fed. Reg. 13,193 (Feb. 17, 1981); *see also* Robert B. Ahdieh, *Reanalyzing Cost-Benefit Analysis: Toward a Framework of Function(s) and Form(s)*, 88 N.Y.U. L. REV. 1983 (2013).

[80] Shelinski & Obstfeld, *supra* note 76.
[81] TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON, *supra* note 25.
[82] *Id.*
[83] *Id.*
[84] Exec. Order No. 13,783, 82 Fed. Reg. 16,093 (Mar. 28, 2017). Despite President Trump's disbandment of the IWG, the Social Cost of Carbon remained in effect.
[85] Exec. Order No. 13,990, 86 Fed. Reg. 7,037 (Jan. 20, 1990). Under the Biden administration, the IWG is directed not only to develop a Social Cost of Carbon, but also a Social Cost of Methane and Social Cost of Nitrous Oxide, all of which have been combined to form the Social Cost of Greenhouse Gases. *See* TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON, *supra* note 25. However, for simplicity's sake, this Article is limited to the use of the Social Cost of Carbon.
[86] TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON, *supra* note 25.
[87] *See, e.g.*, *States Using the SCC*, INST. FOR POL'Y INTEGRITY, https://costofcarbon.org/states (last visited Apr. 24, 2021) (exhibiting initiatives from 11 different states using the federal Social Cost of Carbon or a State equivalent).
[88] *See generally* Order Nos. 15-E-0302, 16-E-0270 (N.Y. PSC Aug. 1, 2016); Ill. Pub. Act 099-0906 SB2814 (2016), *available at* https://legiscan.com/IL/text/SB2814/id/1437265.
[89] Coalition for Competitive Elec., Dynergy Inc. v. Zibelman, 906 F.3d 41 (2d Cir. 2018).
[90] *Id.*
[91] *Carbon Pricing in Wholesale Energy Markets: Frequently Asked Questions*, NYISO (Apr. 16, 2020), https://www.nyiso.com/-/carbon-pricing-in-wholesale-energy-markets-frequently-asked-questions; *see also* SUSAN F. TIERNEY & PAUL J. HIBBARD, CLEAN ENERGY IN NEW YORK STATE: THE ROLE AND ECONOMIC IMPACTS OF A CARBON PRICE IN NYISO'S WHOLESALE ELECTRICITY MARKETS (2019).
[92] The Social Cost of Carbon is only as good as the models used to estimate it. Thus, critics argue that, if the basis by which the Social Cost of Carbon is calculated is faulty, policy initiatives relying on it are doomed. *See, e.g.*, *Carbon Valuation in UK Policy Appraisal: A Revised Approach*, DEP'T ENERGY & CLIMATE CHANGE (July 2009), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/245334/1_20090715105804_e____carbonvaluationinukpolicyappraisal.pdf (citing uncertainty in the Social Cost of Carbon estimates as the primary justification for moving away from its use in United Kingdom policy initiatives). These considerations have been considerably mitigated since the UK abandoned the Social Cost of Carbon in 2009. Indeed, climate science has made extraordinary strides since then and will only improve with time.
[93] *See* Hanson et al., *supra* note 11.
[94] *See id.*
[95] *What is DuboCalc?*, RIJKSWATERSTAAT, https://www.dubocalc.nl/en/what-is-dubocalc/ (last visited Apr. 26, 2021).
[96] SUSANNA TOLLER, KLIMATKALKYL—CALCULATING ENERGY USE AND GREENHOUSE GAS EMISSIONS OF TRANSPORT INFRASTRUCTURE FROM A LIFE CYCLE PERSPECTIVE (2018), *available at* https://www.trafikverket.se/contentassets/eb8e472550374d7b91a4032918687069/klimatkalky_report_v_5_0_and_6.0_english.pdf.
[97] *See* Cass & Mukherjee, *supra* note 12. This article proposes two additional baseline calculation tools, referred to as Hybrid Model 1 and 2. *Id.*
[98] *See* LEE ET AL., *supra* note 8.
[99] *See* Kadefors et al., *supra* note 58.
[100] AMLAN MUKHERJEE & DARRELL CASS, CARBON FOOTPRINT HMA AND PCC PAVEMENTS (2011), *available at* https://www.michigan.gov/documents/mdot/MDOT_Research__Report_RC-1553_363800_7.pdf.
[101] Siksha Kar et al., *Estimation of Carbon Footprints in Bituminous Road Construction: A Case Study*, 43 INDIAN HIGHWAYS 27 (2015).
[102] *About SimaPro*, SIMAPRO, https://simapro.com/about/ (last visited Apr. 26, 2021).
[103] *See* Kadefors et al., *supra* note 58.
[104] *Id.*
[105] Marianela Espinoza et al., *Carbon Footprint Estimation in Road Construction : La Abundancia—Florencia Case Study*, 11 SUSTAINABILITY 1 (2019).
[106] *Id.*
[107] *Id.*
[108] *See, e.g.*, Ross J. Altman, *Project Delivery Systems in* CONSTRUCTION LAW 63-77 (Carol J. Patterson et al., eds., 2d ed. 2019).
[109] *See* Kadefors et al., *supra* note 58.

[110] Fernando Correia et al., *Low Carbon Procurement: An Emerging Agenda*, 19 J. PURCHASING & SUPPLY MGMT. 58 (2013).
[111] Sydney Franklin, *America's Largest Mass Timber Building Opens at the University of Arkansas*, ARCHITECT'S NEWSPAPER (Nov. 25, 2019), https://www.archpaper.com/2019/11/adohi-hall-university-of-arkansas/; *Södra's Cross-laminated Timber Reduces Carbon Footprint by Up to 80 Percent*, BIOENERGY INT'L (Feb. 5, 2021), https://bioenergyinternational.com/biochemicals-materials/sodras-cross-laminated-timber-reduces-carbon-footprint-by-up-to-80-percent.
[112] These early completion bonuses are widely used by state and local transportation agencies throughout the United States. NAT'L COOP. HIGHWAY RSCH. PROGRAM, TIME-RELATED INCENTIVE AND DISINCENTIVE PROVISIONS IN HIGHWAY CONSTRUCTION CONTRACTS 8-10 (2010) (documenting use of early completion bonuses in at least 46 states and the District of Columbia as of 2010).
[113] In other words, unlike the Netherlands approach, the State will not take into account the sustainability of each contractor's proposal in the bidding phase. However, the Carbon Credit Bonus will allow those contractors who can find the best ways to reduce their CO_2 emissions to become the most competitive, as they can account for these potential bonuses in their bids, resulting in a lower bid from the outset.
[114] *See supra* Part V.
[115] Importantly, this does not mean the contractor would have a license to diverge from State mandated performance standards in the name of carbon reductions. In public highway construction, State engineers establish certain performance criteria for all materials going into the project, all the way down to the paint used in striping the road. After a contractor is awarded a job, it is required to go through a submittal process in which all of its proposed materials must be approved by the State. Although a material may be environmentally friendly, the contractor will not be permitted to diverge from the State criteria on this basis. Thus, the Carbon Credit Bonus contemplates that the contractor will pursue CO_2 reductions within State approved parameters.
[116] 31 U.S.C. § 3729(a)(1).
[117] *Technical Advisory Incentive/Disincentive (I/D) for Early Completion*, FED. HIGHWAY ADMIN. (Feb. 8, 1989), https://www.fhwa.dot.gov/construction/contracts/t508010.cfm.
[118] *Arkansas Department of Transportation Bid Tabulation Summary 020763*, ARK. DEP'T TRANSP. (May 19, 2021), https://www.ardot.gov/wp-content/uploads/2021/05/May-21-Bid-Tabs_PM.pdf; *Arkansas Department of Transportation Bid Tabulation Summary 030501*, ARK. DEP'T TRANSP. (Sept. 16, 2020), https://www.ardot.gov/wp-content/uploads/2020/12/Sep-20-Bid-Tabs_PM.pdf.
[119] *Tabulation of Bids for Project C 16-5-120*, TEX. DEP'T TRANSP. (June 18, 2021), http://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/bidtab/06043209.htm; *Tabulation of Bids for Project F 2021(587)*, TEX. DEP'T TRANSP. (June 18, 2021), http://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/bidtab/06043215.htm; *Tabulation of Bids for Project BR 2021(343)*, TEX. DEP'T TRANSP. (June 18, 2021), http://www.dot.state.tx.us/insdtdot/orgchart/cmd/cserve/bidtab/05063230.htm.
[120] *Bid Results: Week of May 2, 2021*, CALTRANS (May 2, 2021), https://dot.ca.gov/programs/procurement-and-contracts/bid-results/bid-week-2021-05-02 (listing bid information for job number 06A2691); *Project Record Estimate*, CALTRANS (Aug. 1, 2019), http://website.dot.ca.gov/hq/construc/estdet/02-4E6404-025.txt (listing bid information for job number 02-4E6404).
[121] MUKHERJEE & CASS, *supra* note 100.
[122] *TxDOT Progress Report*, TEX. DEP'T TRANSP., https://www.txdot.gov/government/reports/progress-report.html (last visited June 22, 2021).
[123] Avi-Yonah & Uhlmann, *supra* note 26 (discussing the widely held belief that, "a carbon tax cannot get enacted because it is a tax."); *see also* Rossi, *supra* note 26 ("Legislative adoption of a national carbon tax is widely considered infeasible and is stalled, at least for the foreseeable future").
[124] Sanchez et al., *supra* note 27.
[125] *WMO Confirms Past 4 Years Were Warmest on Record*, WORLD METEOROLOGICAL ORG. (Feb. 6, 2019), https://public.wmo.int/en/media/press-release/wmo-confirms-past-4-years-were-warmest-record.
[126] Jonathan Watts, *Indonesia Announces Site of Capital City to Replace Sinking Jakarta*, GUARDIAN (Aug. 26, 2019), https://www.theguardian.com/world/2019/aug/26/indonesia-new-capital-city-borneo-forests-jakarta.
[127] *2020 Tied for Warmest Year on Record, NASA Analysis Shows*, NAT'L AERONAUTICS & SPACE ADMIN. (Jan. 14, 2021), https://www.nasa.gov/press-release/2020-tied-for-warmest-year-on-record-nasa-analysis-shows.
[128] Trevor Nace, *Carbon Dioxide Levels Just Hit 417ppm, Highest in Human History*, FORBES (June 10, 2020), https://www.forbes.com/sites/trevornace/2020/06/10/carbon-dioxide-levels-just-hit-417ppm-highest-in-human-history/?sh=11a03c19229f.

129 *Billion-Dollar Weather and Climate Disasters: Overview*, NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://www.ncdc.noaa.gov/billions/#:~:text=The%20U.S.%20has%20sustained%20279,279%20events%20exceeds%20%241.825%20trillion. (last visited Apr. 27, 2021).
130 *Id.*
131 *The Paris Agreement*, *supra* note 38.
132 LEE ET AL., *supra* note 8.