Green Finance: Can We Build a Bridge Across the Renewable Spending Gap?

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I. Abstract

The United States and the rest of the world is in a climate financing deficit. If the United States is to meet the goal of 2 degrees Celsius outlined by the Paris Climate Accord by year 2030 spending on renewable energy needs to increase significantly. Green Finance can provide an innovative framework that the United States can use to ramp up investment in renewable energy and bridge the renewable energy spending gap. One tool in the green finance framework, green banks, are focused on in this paper as a potential way to catalyze private spending in renewable energy through public funds. This paper examines the background of green banks and the development processes of these funding entities. A case study analysis with a criteria framework is then conducted to assess the efficacy of green banks with two green banks in the United States serving as the examples: The Connecticut Green Bank and the New York Green Bank. The findings in the case study analysis leads to a set of policy recommendations in this paper to aid policymakers in establishing green banks to help bridge the renewable energy spending gap.

II. Acknowledgements

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III. Introduction

Planet Earth is becoming increasingly overheated. With an increasingly inter-connected planet and with the fiftieth anniversary of Earth Day occurring just one year ago, many recognize the existential threat of climate change and what it holds for the population's future. Although green technology use is accelerating at a rapid pace due to increased human capital and more government spending towards research and development (R&D), it is not being utilized enough to meet the strict climate goals outlined by the 2015 Paris Climate Accord or the 2015 UN Sustainable Development Goals (SDGs) (Leonard 2015, 199). The Paris Climate Accord and the SDGs are the guiding climate policies globally and both have a goal of keeping the mean temperature below 2 degrees Celsius by 2030 (Sachs 2019, 1). This paper refers to this goal throughout as the "2030 climate goal." According to the Paris Agreement climate targets, global infrastructure spending will require investment of $6.9 trillion annually up through 2030 to meet the 2030 climate goal (Déséglise 2019, 34). And as of 2018, infrastructure investments only totaled $3.4 - 4.4 trillion a year meaning the world has fallen short in its green technology investment by $2.5 - 3.5 trillion annually to meet the 2030 climate goal (Déséglise 2019, 34).

In addition to this global climate infrastructure investment deficit, the United States in particular has also failed to meet green technology investment commitments necessary to meet its portion of the 2030 climate goal (Déséglise 2019, 34). "The future of clean energy no longer concerns science and technology; it is all about access to finance" (Taghizadeh-Hesary 2020, 1). The main problem is that financing clean energy projects requires significant amounts of capital and carries with them a stigma of being a high-risk low return investment (Leonard 2015, 199). As a result, private sector investors often stay away from investing in renewable energy

developments and instead favor fossil fuel investments that are heavily subsidized by the government (Leonard 2015, 199).

Green finance has received attention in recent years as a tool to help close the climate finance gap, especially with renewable energy financing, so that we can meet and fund our climate goals. Green finance is a general term that encompases financial mechanisms and also policy choices; for scope and clarity this report will focus on one tool in the green financing toolbox: green banks (Wright et al. 2018, 109). Green banks have gained attention in recent years as a tool in the green finance arsenal because of their attention from international and financial institutions. Green banks are either public, private, or quasi-public funding entities that leverage capital to crowd in private sector spending to fund clean energy projects (Grbusic 2020). But while green banks can be used as a tool to provide financing to clean energy projects but what is the role of them in funding renewable energy developments specifically? This paper will outline the importance and background of green banks and how they can be used to fund renewable energy developments in the United States. Overall, we must close the climate finance gap by embracing a green finance framework that uses the strength of green banks. Green banks have potential in funding clean energy projects in the United States and can be utilized more extensively so that new green bank locations can be set up to assist in accelerating the transition to renewable energy and move us closer towards achieving the 2030 climate goals.

IV. Background

A. Spending Gap

According to the American Council on Renewable Energy, $1 trillion annually in private sector investment in renewable energy alone is needed to meet the 2030 climate goal (Westone 2020). In fact, it would take $4.5 trillion of investment alone to decarbonize the energy supply in

the United States (Schub 2019). The United States is far off from this figure (Schub 2019). Our country must significantly increase our annual investment to reach the 2030 climate goal (Westone 2020). In 2018, the private sector in the United States invested $68.4 billion in renewable energy projects (ACORE 2020, 3). But the US needs an average annual investment of $87.5 billion a year in renewable energy and enabling grid technologies through 2029 if we hope to meet the 2030 climate goal (ACORE 2020, 3). This equates to a 28% annual renewable energy investment increase over the 2019 investment level or a $20-30 billion annual renewable energy financing gap in the United States alone (ACORE 2020, 3).

B. Green Finance

What is green finance and how can it be a solution to close the global infrastructure gap? Green finance has its origins in Western countries in response to the environmental movements and protection measures undertaken by the world as a result of public realization of the impacts of climate change (Peoples Bank of China, 2. Green finance is a broad term that refers to "financial investments flowing into sustainable development projects and initiatives, environmental products, and policies that encourage the development of a more sustainable economy" (Wright 2018, 109). More specifically, green finance includes: green banks, green bonds, carbon market instruments, fiscal policy, green central banking, financial technologies, community-based green funds, etc. (Sachs 2019, 1). As stated earlier, this research report will focus on one key component of green finance: green banks.

C. Green Banks

Green banks are "purpose-built financial institutions that facilitate funding of clean-energy projects" (Schub 2020). These financial institutions do so by raising and deploying capital for public, private, and philanthropic endeavors while working with private co-investors (Schub

2020). The concept of green banks was developed by western countries and was formally started in 2003 to protect the environment (Lalon 2003, 35). The Coalition for Green Capital, a non-profit green bank advisory organization, has as its mission a goal of establishing these green banks (Schub 2019, 4). As of 2019, the United States houses 14 green banks all of which are part of the American Green Bank Consortium, a membership organization for green banks (American Green Bank Consortium 2019, 5). The first green bank in the United States was the Connecticut Green Bank, established in 2011 (Environmental Finance 2020). The Connecticut Green Bank and the thirteen other U.S. green banks alone have created $3.67 billion of clean energy investment through 2018 (American Green Bank Consortium 2019, 6). Although the Energy Information Administration found that the U.S. consumed more renewable energy than coal during 2019 for the first time since 1885, renewable energy investments still have a stigma attached to them since they are deemed "risky" (Blunt 2020). The financial community (especially the private sector) are less likely to invest in green energy projects because of low rates of return and the associated risks that come from the nascent technology (Sachs 2019, 2). Green banks can help solve this problem by "crowding in private investment" and reducing the associated risks with renewable energy ventures (Taghizadeh-Hesary 2020, 2). After an initial seed investment made by venture capital firms typically deemed high risk high yielding, green banks can help carry the renewable energy project through the remaining funding stage pre-commercialization (DC Green Bank, n.d.). Since public capital is limited, green banks work to leverage private capital dollars that are more abundant and therefore typically only invest in mature clean energy projects (DC Green Bank, n.d.).

In addition to facilitating private investment spending on renewable energy projects, green banks provide a range of advantages when compared to traditional banks. First, green banks

create better credit conditions for clean energy projects (Sachs 2019, 6). Second, green banks aggregate small clean energy projects to "achieve a commercially attractive scale" (Sachs 2019, 6). Third, green banks can provide long-term capital that is reasonably priced to refinance projects which also helps attract private investors (Sachs 2019, 6). Although green banks are relatively new and are not yet fully accepted as *status quo* financial institutions they are promising especially for initial project capital deployment.

D. State Level Green Banks

Green banks can occur at both the state and national level. In the United States, green banks currently operate at the state level although legislation is currently being passed to establish a national climate bank (Congress 2019). Currently, there are two full green banks: the Connecticut Green Bank and the New York Green Bank, which will be discussed in detail later in the paper, as well as other financial institutions that blend elements of green banking such as the California Lending for Energy and Environmental Needs, the Rhode Island Infrastructure Bank, the Montgomery County Green Bank (Maryland, and the Hawaii Green Energy Market Securitization (NREL 2020).

E. National Level Green Banks

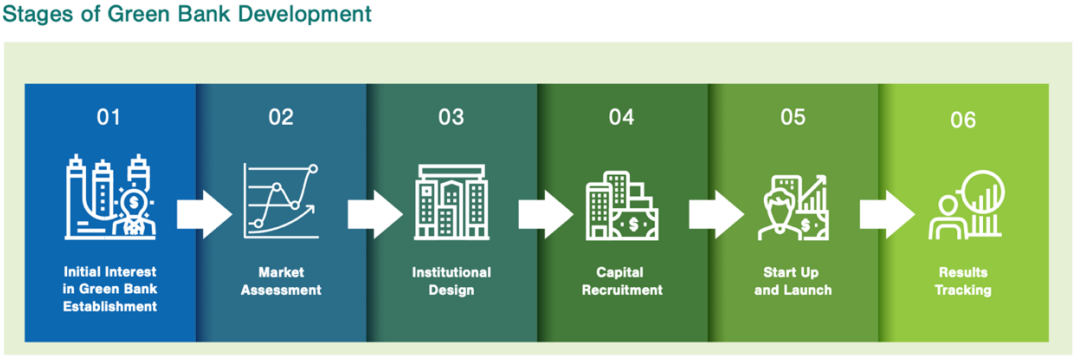
In addition to state level green banks, there are also national green banks. It is worth noting that it is difficult to dictate the exact number of green banks globally since some banks blend elements of green banking but are not fully considered "green banks." Both the Green Investment Group out of the UK and the Clean Energy Finance Corporation out of Australia are examples of two mature green banks outside of the United States (Green Bank Network 2020). The UK Green Investment Group was launched in 2012 by the UK Government to mobilize private finance into the green energy sector and was later acquired by Macquire Group Limited,

an investment bank out of Sydney, Australia (Green Investment Group 2020). Since the Green Investment Group's inception in 2012, it has generated 93,889 gwh of renewable energy and has avoided 198241 kt Co2e (kilotons of Co2 equivalent) (Green Investment Group 2020). The Clean Energy Finance Corporation out of Australia was established in 2012 under the Clean Energy Finance Corporation Act that was passed in Australian legislation and has caused $30.8 billion AUD in clean energy investments with a private to public leverage ratio of 2.5:1 (Clean Energy Finance Corporation 2020).

F. Green Bank Development

In creating a green bank it is important that policy makers follow certain guidelines so that the green bank can be successful in its operations by taking advantage of applicable governmental-mandated benefits and can crowd in private sector investment to a create a comparative advantage for the region where the green bank is operating. If the establishment of a green bank is being considered, developers should follow the six stages of green bank conception: initial interest, market assessment, institutional design, capital recruitment, start up/launch, and results tracking (Cid et al. 2020, 16).

Figure 1. Stages of Green Bank Development



(Cid et al. 2020, 16)

i. Gauge Initial interest in Green Bank Establishment

When proposing the establishment of a green bank it is important to make sure the environment has the right policies in place for a green bank to be formed. Currently, 35% of green bank proposals are at this stage of planning (Cid et al. 2020, 39). During the initial interest phase of the green bank establishment, advocates are focused on generating interest from government and private entities to generate stakeholder interest and enthusiasm (Cid et al. 2020, 16). Green banks are established as a result of government support of clean energy rather than being established to gain support from governments; accordingly, so it is important that the state or local government is supportive if the funding structure will contain any public funds (Cid et al. 2020, 14). The Connecticut Green Bank, for example, was established in 2011 by the Connecticut General Assembly to support the state government's energy strategy (Connecticut Green Bank 2020). And the UK Green Bank, was formed as a result of the 2008 passage of the Climate Change Act and the 2009 reports on the benefits of a green bank (Cid et al. 2020, 24).

ii. Generate a market assessment to show market potential of the bank

The next stage that proponents should consider when establishing a green bank is to conduct a market assessment. Today, 13% of green bank developments are in this stage of planning (Cid et al. 2020, 14). The success of a green bank is contingent on how sustainable and consistent the funding structure is. The developer should not develop green banks in places that do not have a market for renewable or clean energy developments, so it is important that any funds are raised for the funding and execution of the market assessment (Cid et al. 2020, 51). This strategy was also used in the establishment of the UK Green Bank. In 2010, the UK established the Green Investment Bank Commission and the Green Investment Bank Working

Group at the Department of Business, Energy & Industrial Strategy (BEIS) to conduct an assessment of market potential of the green bank (Cid et al. 2020, 51).

iii. Determine institutional design

Policymakers must also set up an institutional structure in establishing a green bank. Today, 23% of green bank developments are in this stage of conception (Cid et al. 2020, 39). This model will be tailored to the market conditions in which the banks operate. For example, policymakers must decide if the green bank will be a standalone institution or involve multiple institutions. Also, thought must be given to the barriers the green bank is trying to overcome which will affect the institutional design. In 2011 the BEIS published a report on the institutional design process of the Green Investment Bank showing that the UK Green Bank is one example that followed this process (Cid et al. 2020, 24).

iv. Capital recruitment

In addition to generating interest in assessing market potential and creating an institutional design, policy makers also must determine the optima capital structure of a green bank. Today, 13% of green bank developments are in this stage (Cid et al. 2020, 39). Unlike traditional banks, which rely on lending or borrowing from other countries to fund their operations, green banks rely solely on domestic and private sector support (Cid et al. 2020, 17). In addition to setting the capital structure, green bank developers must also help secure capitalization and design performance metrics and a monitoring/evaluation framework; similar to the UK Green Bank in 2011 with a 3 billion pound provision for its capitalization (Cid et al. 2020, 24). The funding structure that green banks adopt will depend on the investment landscape in the area where the green bank will be established and what support the bank will have from the public and private sector (Cid et al. 2020, 17). Currently, capitalization of green

banks in aggregate come from 70% in government appropriations, 11% from bond proceeds, 11% from bilateral and multilateral sources, 19% from private capital, 7% from carbon tax revenue, and 33% from other sources (Cid et al. 2020, 25).

One way green banks can be funded is through a single public entity. In general, it is easier for green banks to be capitalized by a single public source since combining several capital sources can complicate the design of the bank and each stakeholder may have different aspirations for the direction of the bank (Cid et al. 2020, 17). With only one stakeholder, structural changes of the green bank are easier to effectuate.

Green banks can also adopt a private funding structure. For places with stricter government regulation that are hesitant about clean energy deployment a private funding structure might be more useful if the support is found (Cid et al. 2020, 17). Although the goal of a green bank is to serve the public good utilizing a private funding structure may allow policymakers to bypass the regulatory processes and public funding campaign if the private sector commits to keeping the bank operational (Cid et al. 2020, 17). For example, India's Tata Cleantech Capital Limited was established in 2011 as a privately funded green bank since there was no desire by the Indian government to establish a green bank with public funding (Cid et al. 2020, 17).

Finally, green banks can adopt a funding structure that utilizes the funding resources from both the private and public sector. Green banks in investment landscape that have government support but may not have adequate governmental funds for a full public funding structure can opt for combining the support of the government with the financial backing of the private sector. This structure allows for cooperation between the public and private sector and is the most

secure out of the three because of the checks and balances system that keeps the public and private sector in check with each other.

v. Startup and launch

During the startup and launch phase, the green bank developer must work on the logistics of the green bank to ensure it has a successful business model. During this phase the developer forms management and operating teams, develops products, and develops a project pipeline (Cid et al. 2020, 51). Only 10% of current green bank developments are at this stage (Cid et al. 2020, 39).

vi. Results Tracking

Finally, developers should create a methodology to establish the track record of the green bank. Today only 6% of green bank developments are in this final stage (Cid et al. 2020, 39). Similar to the New York and Connecticut Green Banks, developers should establish impact reports to inform the public and future policymakers on the benefits of green banks and the environmental, economic, and social advantages that they add.

V. Literature Review

A. Overview

Green banks are a relatively new green finance concept, but already there are volumes of literature on the topic ranging from newspaper articles to PhD dissertations. Since most of the literature is from the last five years, themes were analyzed and aggregated in the literature to help explain the efficacy of green banks. The literature reveals that there are a variety of challenges with investing in renewable energy. Green banks can be viewed as a response to these challenges according to the reports; green banks can be used as a solution to address the

existing challenges of renewable energy investments. Finally, green banks provide a host of additional benefits that traditional financing structures have failed to consider.

B. Challenges with Renewable Energy Investment

i. High upfront costs

The most significant barrier to clean energy adoption is the high upfront costs associated with renewable energy projects. Renewable energy projects typically have high upfront costs and can present themselves as a financial burden to the homeowner or other consumer even after the U.S. Federal Investment Tax Credit of 30 percent (French et al. 2020, 10). Despite the fact that renewable energy consumption recently eclipsed coal consumption in the United States, there is still consensus in the business community that investing in renewable energy is still too risky and costly compared to other energy projects (Blunt 2020). Before the 2008 financial crisis, "growth in high income countries was propelled by spending on housing and private consumption and when this plummeted green finance did not pick up to replace these forms of investment." (Sachs 2019, 2). Even when the interest rates reached rock bottom after the recession (fiscal policy trying to assuage the economic difficulties) there was no corresponding increase in financing for renewable energy developments in the United States which further exacerbated the high costs (Sachs 2019, 2).

ii. Uneconomic project terms

The next barrier to clean energy adoption is that the clean energy project term investment does not present a clear and relatively short-term financial benefit for the investor. Banks that are willing to back clean energy projects typically offer high interest rates and short terms on loans (French et al. 2020, 10)

iii. Risks

Investors, like commercial banks, deem clean energy investments risky and therefore they include a green premium fee that comes with clean energy investments (French et al. 2020, 10). There are a variety of risks that investors believe come with renewable energy. Some believe that weather poses a serious risk to green energy projects, since these projects still depend materially on certain climate factors like the sun and the wind (since battery storage technology is still in its early stages) (Taghizadeh-Hesary 2020, 3). There are also political risks and natural disaster risks associated with renewable energy developments that hinder private sector investment (Taghizadeh-Hesary 2020, 4). Renewable energy advocates tend to be left-leaning politically which may also be viewed as "risky" to some and may deter clients from working with these types of assets (Leonard 2015, 199). And expensive developments placed in floodplains or in wildfire prone areas may also prevent investment. Also, normal banks which typically act as the lender for these large scale utility projects include a risk premium with many clean energy transactions because of the associated risks (which they believe are due to high upfront costs and unproven technologies) (Leonard 2015, 206).

iv. Traditional banking structure

Setting up a clean energy department within an existing banking structure can present itself as a challenge as this new department may not operate under the same mission as the financial institution (French et al. 2020, 11). Also, the Basel capital requirements, a banking regulatory framework created by the Basel Committee on Banking Supervision, may deter many private sector investors from pursuing renewable investments even if they are interested in getting involved (Taghizadeh-Hesary 2020, 1). Further, traditional private banking structures typically focus on short-term ROIs and large-scale utility renewable energy projects which, by

contrast, are long-term investments with long term financing requirements (Taghizadeh-Hesary 2020, 5). And since the renewable energy industry is still an underdeveloped secondary market, there is a low volume of loans being issued by traditional banks in comparison to fossil fuel projects which make it challenging to securitize the loans (another barrier to investors) (Weiss 2018, 3). When traditional institutional investors such as pension funds want to seek interest from their sovereign wealth funds to invest in energy projects they will typically look for stable yields with low-risk assets (Meltzer 2016, 20).

v. Ignorance about Clean Energy

Customers may not trust clean energy technology or they may view it as "unproven" (French et al. 2020, 11). Due to this ignorance, the United States still subsidizes fossil fuels heavily, and the elimination of these subsidies is politically difficult to achieve (Leonard 2015, 199). In fact "over the past 60 years, fossil fuels received $594 billion of government subsidies (70% of all subsidies for energy) while renewables have only received $4 billion, or just 9 percent of the total subsidies" (Leonard 2015, 201). And in 2017, global investment in renewable energy and energy efficiency had a 3% decline while fossil fuels continued to dominate the market (Sachs 2019, 1).

vi. Ineffective financing structures

Ineffective financing structures also prevent wide scale deployment of renewable energy. Typical government responses to stimulate growth in the renewable energy industry like grants or rebates will only temporarily help renewable energy growth (not long term) (French et al. 2020, 11). Rebates cannot help consistent market growth because of a finite amount of public dollars (French et al. 2020, 11).

C. Green Banks Can Address Barriers

While green banks help finance low carbon developments, their main function is to help stimulate private investment in green energy projects and reduce inherent risk since private investors do not have financial incentives to create 100% clean energy because of the low rate of return and associated risks. According to consulting firm Mckinsey & Co, "the private sector could close up to one half of the low carbon infrastructure spending gap"; accordingly, it is significant that green banks attract and retain, or "crowd," a large and diverse group of investors in green projects (Meltzer 2016, 5). Even the United Nations in 2015 acknowledged that future climate finance needs to come from the private sector (Global Green Growth Institute 2016, 1).

While the cost of clean energy technology is declining the cost of capital is not (Schub 2020). What makes green banks unique is that they offer the ability to cover the upfront costs and initial financing of renewable energy projects which reduces the risk for prospective private sector investors. These green banks do this "by using innovative loan structures that decrease the risk for investors allowing them to leverage public funds to attract private investment and ultimately increase the deployment of clean energy technology" (Leonard 2015, 201). There are other funding mechanisms outlined in the literature that can reduce risk for private sector investors as well. Through the creation of loan loss reserves, green banks have the ability to cover a portion of losses the private lenders incur if borrowers default on their loan (Leonard 2015, 206). Green banks can also subordinate debt by investing with a private lender but agreeing to subordinate a tranche of debt junior to that of other lenders (Leonard 2015, 206). This allows private lenders to be paid back prior to the subordinated lender in the event of a default or bankruptcy (Leonard 2015, 206). Green banks can also aggregate loans from a large number of small clean energy projects and securitize them into funding pools so that secondary lenders can invest without

worrying about high transaction costs (Leonard 2015, 207). By securitizing these aggregated loans, we can transform renewable energy projects into liquid assets with lower risk which become financially attractive for private investors (Meltzer 2016, 20). Finally, green banks can create structured products by using tax equity funds to attract investors, since structured products are low risk investments (Leonard 2015, 219).

Green banks can also crowd in private investment by utilizing Property Assessment Clean Energy (PACE) programs, which are programs that allow property owners to pay upfront costs (Schub 2020). For example, the Connecticut green bank, through the commercial property assessed clean energy program (C-PACE), allows building owners to finance energy efficiency upgrades and retrofits at no upfront costs which will make more clean energy investment attractive to investors (Schub 2020). This is a variation of the original lien-based financing in the US known as PACE (property-assessed clean energy) (Schub 2020). This form of financing is growing in popularity especially in Connecticut. Many of these commercial PACE programs have failed because of small investment scale but since green banks securitize their investments into pools PACE programs amongst green bank have proven to be successful (Green Bank Network 2020). Since green banks are often quasi-public entities, they are designed to not compete with commercial banks but rather to supplement them in funding renewable energy infrastructure. Because of this supplementary relationship, it is important that green banks focus on long term financing (loans) instead of short-term loans that commercial banks focus on (less than three years) (Taghizadeh-Hesary 2020, 7). Also, renewable energy infrastructure projects are often complex and tend to be long term projects which makes them better investments for green banks (Taghizadeh-Hesary 2020, 7).

D. Takeaways

In analyzing the strands of literature at hand it is apparent that there is widespread agreement on the definition and function of green banks. The main themes that gained widespread attention when analyzing the literature was that renewable energy investments are often avoided by the private sector community and that green banks can be used as a tool to help decrease this resistance. The literature available appears to provide extensive background on the origins and functions of green banks but data on them is inadequate in quantifying exactly how much this financial mechanism will close the green financing gap. Nonetheless this does provide positive support in closing the gap (Sachs 2019, 6). Part of this is due to the relatively new nature of this financial tool, but also because not all green banks finance projects that are made publicly available (American Green Bank Consortium 2020). Also, the literature does not consider the role of green banks in closing the renewable energy financing gap (just the overall climate financing gap). And the literature considers only the global climate financing gap, not the role of green banks and green bonds in closing the gap in the United States. This report will attempt to use the literature at hand to provide an assessment of using green banks to close the renewable energy infrastructure gap in the United States rather than focus on existing literature looking at a more generalized climate financing gap.

VI. Research Design and Methods

A. Research Design

In answering the question on the role of green finance in funding renewable energy developments in the United States it is important to consider the data available on green banks. Green banks are relatively new, with the first U.S. green bank established in Connecticut in 2011 (Environmental Finance 2020). Due to the lack of publicly available data on green bank

investments, it is difficult to determine a correlation between green bank investment with environmental performance or benefits and how this fairs when comparing these benefits at the counterfactual (scenario with the absence of a green banak). This is due to endogeneity concerns and lack of data that would be impossible to account for. Environmental performance is correlated with infinite environmentally sustainable practices irrespective of whether green banks were used to improve environmental performance. With green banks not all projects are made publicly available so it is difficult to capture all of the related investment data. Therefore, the research design is a qualitative case study analysis until there is a more robust dataset used to provide a quantitative analysis on the efficacy of green banks in closing the renewable energy financing gap in the Untied States to meet the nation's climate goals. In creating a qualitative analysis of green banks and green bonds, case-studies are used to look at green banks around the United States and the world to see the successes they have and whether they contribute to closing the renewable energy financing gap. Annual reports from green banks such as the New York Green Bank and the Connecticut Green Bank are used to develop a case study analysis and a criteria framework. With the statistics available, benchmarks are created to determine the efficacy of these financial institutions and whether they are effective in closing the renewable energy gap and making a positive clean energy impact on the region that they are in. And this report and analysis will aid policymakers in the United States in creating a more green investing environment with more local green banks.

Since this project is focusing on financing solutions to renewable energy developments in the United States, the Connecticut Green Bank and the New York Green Bank serve as case studies for this research paper. The Connecticut Green Bank and the New York Green Bank are

the most mature green banks in the country (NREL 2020). These two banks serve as examples of what the potential of green banks in the United States are.

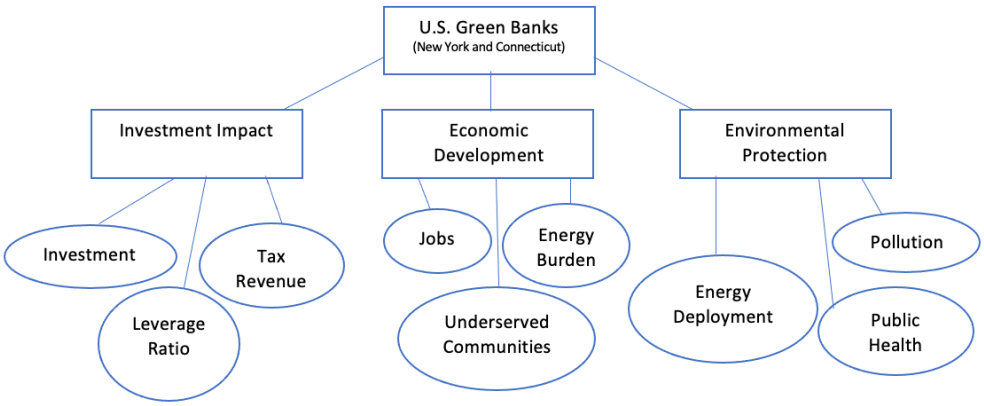
B. Data Collection

The data used is collected primarily from secondary sources. The Connecticut Green Bank website is used to look at the projects funded by the largest green bank in the United States as well as the investment trends in their annual reports from inception to the most recent fiscal year. Also, the New York Green Bank is used to look at the publicly available projects as well as the investment trends since inception. Data is taken from the respective websites of these banks and their annual reports and issuance statistics are analyzed to determine overall trends.

C. Methodology

In discussing how green banks can be used to close the renewable energy financing gap in the United States, it is important to assess the efficacy of these banks. In discussing the efficacy of these banks a case study analysis framework will be used. Due to the lack of data on whether these banks offer a comparative advantage, a more qualitative analysis is conducted under a set of criteria to discuss the impact that these banks have had including: investment impact, economic development, and environmental protection:

Figure 2. Green Bank Impact Diagram.



In analyzing the impacts, two green banks in the United States are discussed in the analysis: The Connecticut Green Bank (CT Green Bank) and the New York Green Bank (NY Green Bank). For each of these banks it is important to understand the investment impact, impact on economic development, and impact on environmental protection in discussing their effectiveness. With regards to investment impact the number of dollars invested into the economy, the tax revenue that is generated for the state, and the leverage ratio (the ratio of the amount of dollars crowded in by the private sector divided by the amount of dollars used by the green bank itself) are used for the assessment factors. Economic development is also a key macroeconomic indicator that includes how these green banks helped the overall state in terms of jobs, energy burden reduction, and empowering underserved communities. Finally, it is important to assess the magnitude of environmental protection that these green banks catalyze in regards to clean energy deployment, pollution reduction, and increasing public health measures.

VII. Analysis

A. Criteria Framework

The investment impact, economic development, and environmental impact factors are critical when analyzing the efficacy of green banks, but it is also important to consider the magnitude of the impact. In assessing the magnitude of impact that these banks have on their respective states to test how effective they are in (potentially) closing the renewable energy spending gap and more broadly the climate financing gap it is important to develop a criteria framework to see how big of an impact these banks cause. Using the general impact criteria that is utilized by the Connecticut Green Bank (investment impact, economic development, and environmental impact) a criteria framework was developed. There are many metrics that could

be included under these three impact areas so for scope and clarity only a set number of benchmarks were included as seen in the table below:

Figure 3. Green Bank Assessment Framework.

	Low	Medium	High
INVESTMENT IMPACT			
Leverage Ratio	Leverage ratio < 1:1	Leverage ratio = 1:1	Leverage ratio > 1:1
ECONOMIC DEVELOPMENT			
Jobs Created	< 40% of the state's energy workforce	~ 40% of the state's energy workforce	>40% of the state's energy workforce
Overall employment	<2.25% clean energy jobs	~2.25% clean energy jobs	>2.25% clean energy jobs
Underserved communities	10 poorest counties worse off with green bank program (jobs, economic growth)	10 poorest counties only marginally better off the green bank program (jobs, economic growth)	10 poorest counties better off with green bank program (jobs, economic growth)
ENVIRONMENTAL PROTECTION			
Energy generation	<19.8% electricity generation comes from renewable energy	~19.8% electricity generation comes from renewable energy	>19.8% electricity generation comes from renewable energy
Pollution	<2.8% per year co2 emissions reduction average	~2.8% per year co2 emissions reduction average	>2.8% per year co2 emissions reduction average

(Schroeder 2020) (Energy Information Administration) (CT Green Bank)

This framework is originally designed based off of standard renewable energy and financial metrics and will be used to assess the effectiveness of U.S. Green Banks (using both Connecticut Green Bank and the NY Green Bank as case studies). In assessing the investment impact the leverage ratio will be looked at to see how much private investment is crowded in by these banks. One of the key aspects of closing the renewable energy financing gap is to utilize the strength of the private sector to fund renewable and clean energy projects while using the public

sector to provide upfront costs (this is the goal of a green bank) (Cid et al. 2020, 48). The leverage ratio is a measure of how much private capital is spent towards renewable energy projects for every dollar of green bank capital spent (Connecticut Green Bank 2020). A leverage ratio of less than 1:1 means that the bank is not crowding in private capital and for each dollar the green bank spends there is less than 1 dollar being spent by the private sector. A leverage ratio of roughly 1:1 means that the private sector matches each dollar spent by the green bank. Finally, a leverage ratio of greater than 1:1 means that for each dollar a green bank spends on a clean energy project the private sector will invest more than 1 dollar on that project. When creating a criteria framework for economic development, job creation, and overall employment, the empowerment of underserved communities is also analyzed. The U.S. average for clean energy jobs as a percentage of total energy workforce is 40% so this number will be used as a benchmark to determine whether the state with the green bank exceeds this benchmark or falls short of it (Schroeder 2020). Employment will also be looked at. Out of all the jobs in the United States 2.25% are in the clean energy sector so this number will be used as a benchmark as well to see if states with green banks exceed this number or not (Energy Information Administration 2020). Finally, underserved community empowerment will be looked at. For the state of Connecticut, the 10 poorest counties in each state will be looked at to see the type of economic impact that green banks make on them (whether good or bad). Due to the lack of data reporting from the New York Green Bank on the impact on individual counties a more general assessment will be made. For the state of New York case a brief analysis will be made on the impact that the NY Green Bank has on underserved communities. And environmental protection energy generation as well as pollution reduction will be looked at to test the efficacy of these green banks. For energy generation sources in the United States, 19.8% of electricity

generation comes from renewable sources so this number will be tested against the states looked at (Connecticut and New York) (Energy Information Administration 2020). And for pollution reduction, each green bank will be looked at to see how much of a reduction in emissions each bank causes for their respective state.

Each bank studied at hand will contain an overview as well as their impact with regards to the three criteria: investment impact, economic development impact, and environmental impact.

B. Connecticut Green Bank

i. Overview

The Connecticut Green Bank is the first official green bank in the United States (opening in 2011) and has a goal of combating climate change by increasing the amount of private capital being spent on renewable energy projects in the state of Connecticut (American Green Bank Consortium 2020). By leveraging the mobilization of private capital, the Connecticut Green Bank can have an exponential impact on green projects in the state of Connecticut for each sum of money they invest. This bank evolved from the Connecticut Clean Energy Fund which existed pre-2011 before it was turned into the Connecticut Green Bank (Connecticut Green Bank 2020). The three key components of the mission of the Connecticut Green Bank are to innovate, educate, and active (Connecticut Green Bank 2020). Through innovation the bank makes energy investment safer, more affordable and more accessible (Connecticut Green Bank 2020). Through education, the bank helps make the benefits of clean energy clearer (Connecticut Green Bank 2020). And through activation this bank inspires people to take action to solve the climate financing crisis (Connecticut Green Bank 2020). By doing so, the bank accelerates the growth of clean energy. By providing the private sector low-cost long term sustainable financing and

mitigating risk for the private sector the Connecticut Green Bank hopes to debunk the myth that renewable energy investments are too risky to invest in.

The reason this bank was created was because of a new energy policy passed in Connecticut in June of 2011 by the Governor and the General Assembly. In passing this public policy the nation's first green bank was created (Connecticut Green Bank 2020). This policy was called Public Act 11-80 and created the Department of Energy and Environmental Protection (DEEP) and also created a Green Bank and emissions reduction targets (Connecticut Green Bank 2020).

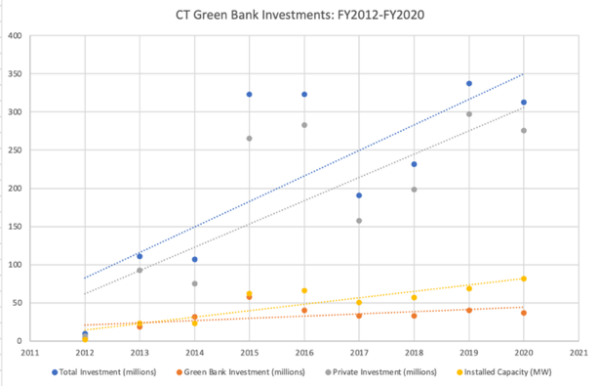
ii. Projected Funded

In 2019 alone the Green Bank used $36 million of public funds to cause $427 million in investment for Connecticut (American Green Bank Consortium 2020). Projects such as the solar Asset Backed Security, the Small Business Energy Advantage Program, the C-PACE program, and the fuel cell park acquisition in 2019 all contributed to this successful financial year for the bank (American Green Bank Consortium 2020).

iii. Investment Impact

The Connecticut Green Bank has seen a 382% increase in revenue since 2017 (Connecticut Green Bank 2020).

Figure 4. Connecticut Green Bank Investments.



(Connecticut Green Bank 2020)

Overall, the Connecticut Green Bank has a leverage ratio of 6.6:1 meaning that for every dollar that that CT Green Bank invests of its own money into a clean energy projects this crowds in $6.6 dollars of private capital (Connecticut Green Bank 2020). Overall, the Connecticut Green Bank has mobilized $1.94 billion of investment into the State's economy including $294.2 million of direct green bank investment and $1.65 billion of private investment that was credited as a result of the CT Green Bank actions (Connecticut Green Bank 2020). And from the FY 2012 to FY 2020 private investment increased at a multiple of 30.7x (3000%) with 10.2 million of private investment being crowded in in 2012 and 313.8 million in 2020 (Connecticut Green Bank 2020). Not only did private and green bank spending on clean energy projects increase since the bank's inception but tax revenues increased as well (Connecticut Green Bank 2020). The Connecticut Green Bank since its 8 years in operation helped generate nearly 100 million ($96.7 million in state tax revenues, $47.8 million in individual income tax, $24.7 million in corporate taxes, and $24.2 million in sales taxes) (Connecticut Green Bank 2020).

iv. Economic Development

When looking at the key macroeconomic indicators to assess the impact of the Connecticut Green Bank it is important to understand the impact the bank has had on job creation. The CT Green Bank helped create 23,387 direct, indirect, and induced job years (Connecticut Green Bank 2020). When the bank began its operation in 2012, only 231 job years were created as a result of the bank's operations but this jumped up to 3355 job years in 2020 for a multiple of 14.5 (Connecticut Green Bank 2020). In addition the bank reduced the energy costs for over 55,000 families and over 375 businesses in the state of Connecticut (Connecticut Green Bank).

It is also important to understand how the Connecticut Green Bank affects the underserved communities in the state of Connecticut. The ten poorest communities in Connecticut are rated based on median income, unemployment rate, and poverty rate (Sparks 2020). The chart below shows statistics for the ten poorest municipalities in Connecticut and all of the statistics (investment per capita, total job years created, tax revenue, and co2 tons avoided) which were caused directly by the CT Green Bank operations show positive change to these communities.

Figure 5. Connecticut Green Bank Underserved Communities.

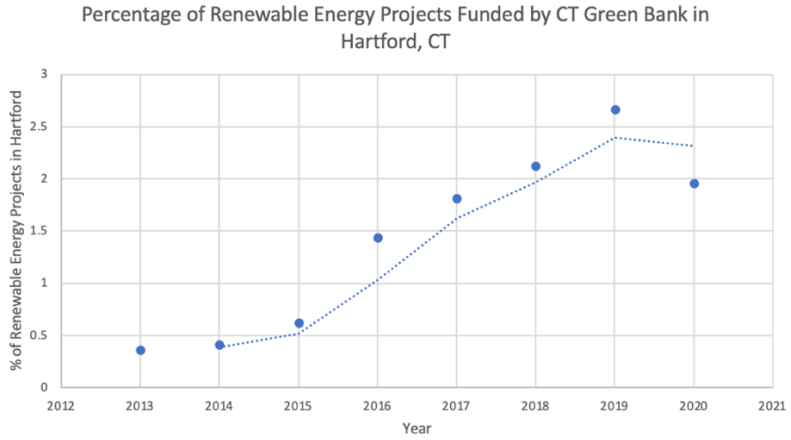
Municipality	Investment per capita	Total Job Years	Tax Revenue (Individual Income)	CO2 Tons Avoided
Hartford	374.17	510	1,097,508	201,904
New Haven	380.40	539	1,198,147	134,861
Waterbury	403.75	472	978,005	189,809
Bridgeport	2262.46	3088	6,044,377	1,187,511
New London	405.28	110	228,112	46,944
New Britain	776.64	628	1,384,531	142,498
Derby	473.59	62	131,599	25,796
Ansonia	540.00	105	223,396	42,272
Groton	130.61	57	128,034	23,652
Norwich	81.49	55	117,054	9293

(Sparks 2020)

Although the poorest municipalities listed in the table have below average impact metrics compared to the other municipalities in Connecticut, the Connecticut Green Bank still appears to have a positive impact on these communities (Connecticut Green Bank 2020). It is also worth noting that Bridgeport appears to be an outlier, having an investment per capita of more than five times the average of the other nine poor municipalities. Bridgeport is one of the most unequal areas in the country, with a large wealth disparity (Abel 2019, 59). Therefore the municipality contains some extremely wealthy people and also many poor people (Abel 2019, 59). Hartford,

the poorest municipality in Connecticut, appears to have a lower impact (Sparks 2020). Since Hartford is the poorest municipality the impact in this particular community will be discussed further to determine if this community benefits from the Connecticut Green Bank operations. In discussing the impact that the CT Green Bank has on Hartford it is important to understand how the CT Green Bank impacts the economic development trend of Hartford over the lifetime of the Bank. The charts below show the effect that the CT Green Bank has on the municipality of Hartford from Year 2013 through Year 2020.

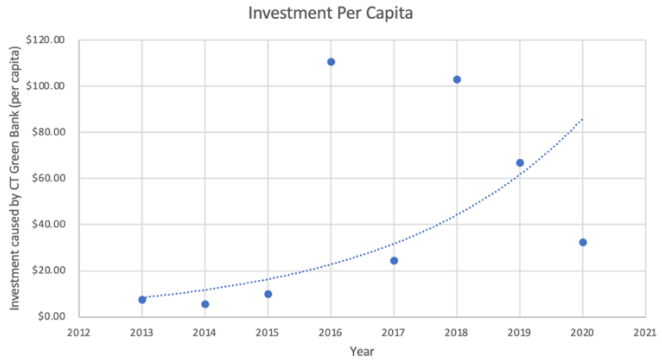
Figure 6. Connecticut Green Bank Renewable Energy Projects in Hartford.



(Connecticut Green Bank 2020)

As seen from the graph in Year 2013, one year after the Connecticut Green Bank opened its doors only about 0.3% of projects funded by the CT Green Bank for that year statewide were in Hartford but this trend has increased over the years showing that this community is seeing a greater share of renewable energy projects in their municipality than before (3% of all CT projects funded by the CT Green Bank in year 2019 are in Hartford) (Connecticut Green Bank 2020).

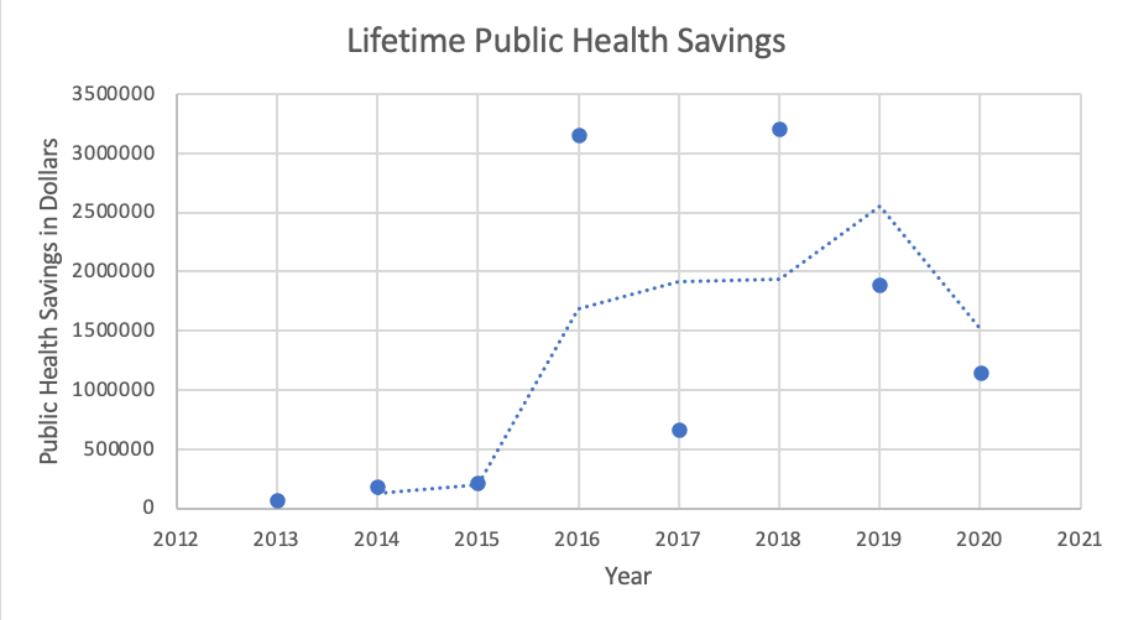
Figure 7. Investment Per Capita in Hartford caused by Connecticut Green Bank.



(Connecticut Green Bank 2020)

When excluding the outliers one can see that the total investment caused by the CT Green Bank (included both direct investment from the CT Green Bank and private investment crowded in (adjusted to a per capita basis) in the municipality of Hartford) is increasing exponentially showing that there is an exponential increase in renewable energy mobilization in this underserved community.

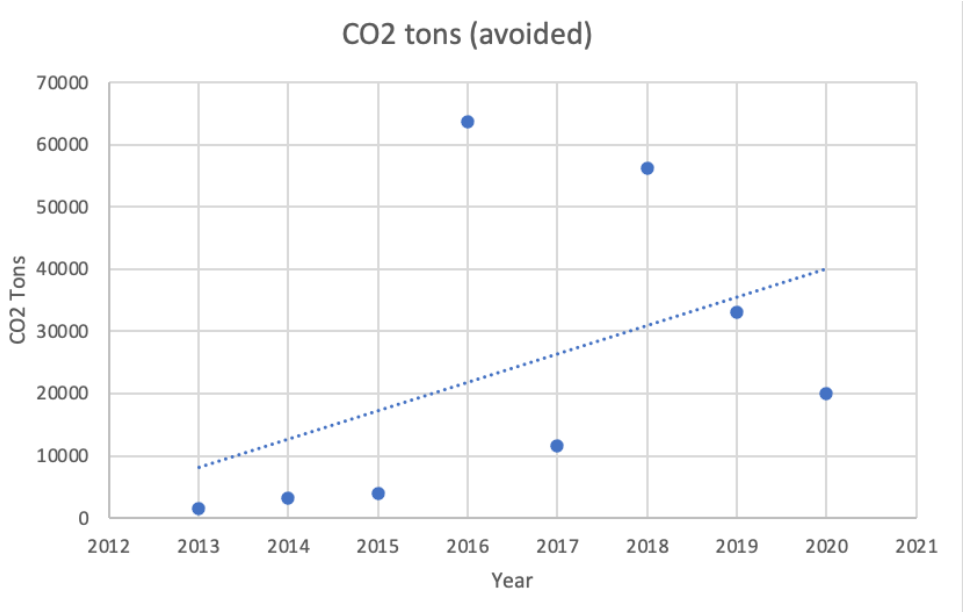
Figure 8. Lifetime Public Health Savings in Hartford caused by Connecticut Green Bank.



(Connecticut Green Bank 2020)

In addition to the increase in investment per capita in Hartford that results from the CT Green Bank operations there is also an increasing trend in the average lifetime public health savings in Hartford. In underserved communities, public health costs often times can be burdensome (especially during the current COVID-19 pandemic). But, being able to save on public health costs can lead to an increase in healthcare access and better overall health for the residents which is key in underserved communities.

Figure 9. CO2 Tons avoided in Hartford by Connecticut Green Bank in thousands.



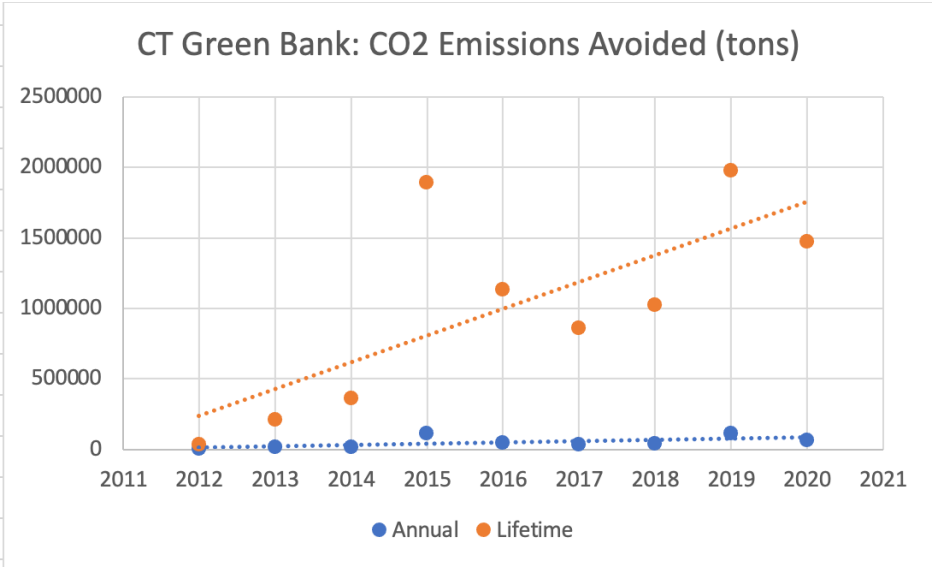
(Connecticut Green Bank 2020)

It is also important to consider how emissions reductions affect underserved communities. Statistics show that underserved communities in every state are disproportionately affected by emissions due to their lack of economic mobility, voice, healthcare systems, etc. Yet, the CT Green Bank appears to have a positive emissions impact on Hartford. As seen in the chart above, when excluding the outliers, there appears to be a liner decrease in emissions avoided each year.

v. Environmental Protection

Although we considered the environmental performance as a macroeconomic indicator for Hartford, one of Connecticut's poorest communities, it is important to consider the statewide environmental protection that the CT Green Bank offers to its state. The green bank has accelerated the growth of clean energy to more than 434MW of installed capacity of renewable energy (Connecticut Green Bank 2020).

Figure 10. CO2 Emissions Avoided as a Result of Connecticut Green Bank.



Overall, the CT Green Bank has helped reduce air emissions by 8.4 million pounds of SOx and 9.7 million pounds of NOx and 8.9 million tons of CO2 (equivalent to 1.7 million passenger vehicles driven for one year) (Connecticut Green Bank 2020). These emissions reductions have led to a $232.7-$525.4 million lifetime public health value created (Connecticut Green Bank 2020).

vi. Criteria Analysis

When assessing the Connecticut Green Bank under the criteria framework as either low, medium, or high it is important to consider the investment impact, the economic development indicators, and the environmental impact. Overall, the leverage ratio (6:1) scores high meaning that the bank has a positive investment impact (Connecticut Green Bank 2020). For the economic development criteria, it appears that roughly 66% of jobs in Connecticut are dedicated to clean energy and around 7% of these clean energy jobs are a result of the CT Green Bank so this also scores high for the criteria framework (Connecticut Green Bank 2020). Roughly 2.4% of the Connecticut labor force is involved with clean energy jobs so this is consistent with the medium criteria level for overall jobs (Connecticut Green Bank 2020). And with underserved communities it appears that the CT Green Bank operations make them much better off. For energy generation only around 4% of the state electricity generation comes from renewable energy (since the state is so reliant on nuclear and natural gas) so this scores low on the criteria chart (Connecticut Green Bank 2020). But the bank has caused an exponential drop in emissions (causing only a 31043 tons of Co2 decrease in 2012 versus 1,201,714 tons of co2 decrease in 2020) (Connecticut Green Bank 2020). Although the Connecticut Green Bank does not yet have significant impact on the state the trend statistics show that the bank is continuing to make a greater impact each year and is therefore effective.

C. New York Green Bank

i. Overview

Like the Connecticut Green Bank, the NY Green Bank (opened in 2014) has a mission of accelerating the deployment of clean energy into the state of New York by working with the

private sector to combine the financial power of both the public and private sector (New York Green Bank 2020). This bank is state sponsored yet works with the private sector (New York Green Bank 2020). This bank is part of the NYSERDA (New York State Energy Research & Development Authority) and a component of the overall state clean energy program orchestrated by New York Governor Andrew Cuomo and is used as a tool to set the state on a path to carbon neutrality by reducing greenhouse gas emissions by 2050 and creating a 100 % clean electric grid by 2040 (New York Green Bank 2020). The three approaches that the NY Green Bank takes to achieve the state's climate goals is 1) to leverage private sector capital 2) to grow capital markets to reduce the need of government support and 3) to deploy clean energy assets at a faster pace (New York Green Bank 2020). In order for the bank to invest, any proposed transaction must have a strong return to provide revenue to the bank and must contributed to market transformation and clean energy generation or savings.

The New York Green bank was initially created by current governor Andrew Cuomo in 2013 and later opened doors in 2014. (New York Green Bank 2020). In 2013 Governor Cuomo announced $210 million in initial capital to jump start the New York Green Bank (New York Green Bank 2020). The funding was approved by the Public Service Comission (PSC) as well as the Regional Greenhouse Gas Initiative (RGGI) (New York Green Bank 2020).

ii. Projected Funded

In the last fiscal year, the NY Green Bank made over $1.1 billion in clean energy investments within New York State (New York Green Bank 2020). This figure included many renewable energy transactions such as the SunRun Renewable Energy Project for 104 million, the Cypress Creek Renewable Community Solar Project for 45 million, and the Vivint Solar Project for 76.5 million (New York Green Bank 2020). Most of the projects that the NY Green

Bank funds are in the $5-50 million dollar range (New York Green Bank 2020). In the recent 2019-2020 fiscal year other projects that the NY Green Bank has funded include AES Project Aurora for $50 million which aims at distributing solar projects around the state, Generate Capital for $35 million which increases investment in NY State clean energy projects, and True Green Capital Management for $20.2 million which is a loan commitment made to help distribute solar projects totaling up to 70.2 MW around the state (New York Green Bank 2020).

iii. Investment impact

The NY Green Bank has a mobilization ratio of 8:1, even higher than the CT Green Bank, showing that for every $1 of investment the NY Green bank puts into clean energy this attracts $8 of private sector investment (New York Green Bank 2020). By 2025 the NY Green Bank expects to have mobilized $8 billion in clean energy activity (New York Green Bank 2020). The NY Green Bank is one of the largest green banks in the country and has surpassed last fiscal year $1.0 billion in capital commitments since inception and committed to over $222.3 million of capital to new clean energy developments (New York Green Bank 2020). This performance is achieved by mobilizing capital and the project and portfolio levels and driving clean energy investments in the state. Through the New York Green Bank's capital allocation, the project is expected to support nearly $3 billion in total clean energy projects (crowding in billions in private sector investment) (New York Green Bank 2020).

iv. Economic Development

The New York Green Bank has created 12,000 clean energy jobs since its inception (New York Green Bank 2020). And in 2020 the NY Green Bank completed a 25 million transaction aimed at helping low income communities at the state improve their environment and energy efficiency with clean energy (New York Green Bank 2020). This project was accomplished with

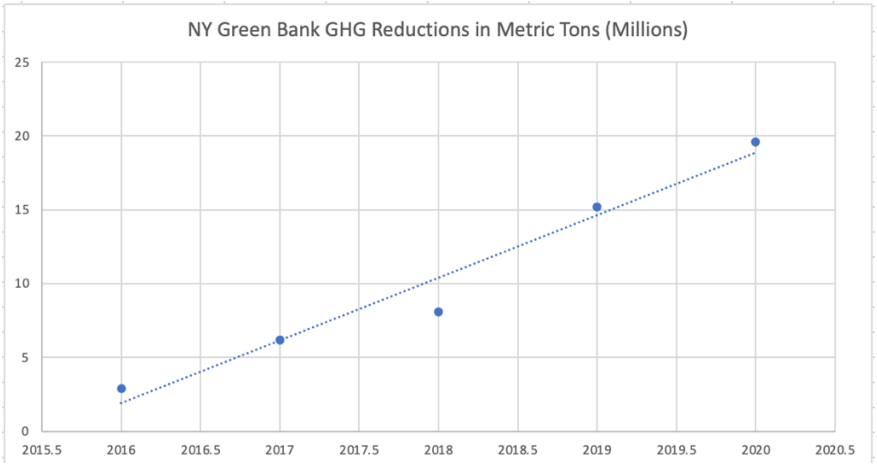
the help of Inclusive Prosperity Capital, a fund geared at helping underserved communities (New York Green Bank 2020). In this project clean energy projects will be further scaled in low income communities and the bank will create a replicable financing structure that additional capital providers can use in their communities (New York Green Bank 2020). This will not only help other capital providers apply this framework to their region but this will reduce greenhouse gas emissions (GHGs) in the state by as much as 520,000 metric tons (New York Green Bank 2020).

In addition to this transaction that the NYGB helped facilitate the NYGB has also engaged with other partners to help disadvantaged communities including: Energy Efficiency for All New York (EEFA), public housing authorities like the New York City Housing Authority (NYCHA), the NYS Association for Affordable Housing and other nonprofits, as well as disability assistance programs (New York Green Bank 2020). And in the 2020-2021 plan the NYGB will launch another initiative geared at mobilizing investmens in LMI and disadvantaged communities (New York Green Bank 2020).

v. Environmental Protection

With regards to energy generation, the NY Green Bank has generated 62 MWh of clean energy and has saved 137.0 MMBtus through energy efficiency (New York Green Bank 2020). The NY Green Bank has also reduced greenhouse gas emissions by up to 19.6 million metric tons in the state which is nearly double what is reduced in Connecticut by the CT Green Bank (New York Green Bank 2020). In addition, the NY Green Bank has generated 62 million megawatt hours of clean energy and has reduced 29 million metric tons of greenhouse gas emissions (New York Green Bank 2020).

Figure 11. New York Greenhouse Gas Emissions Reductions caused by New York Green Bank.



(New York Green Bank 2020)

vi. Criteria Analysis

When discussing the effectiveness of the NY Green Bank it is important to consider the anecdotal examples provided in the annual report due to the lack of concrete data. With regards to the investment impact, the NY Green Bank has a strong leverage ratio of 8:1 and plans to crowd in nearly $8 billion in private sector investment by year 2025 (New York Green Bank 2020). This leverage ratio shows that the NY Green Bank has a strong investment impact and scores high on the criteria framework. With regards to economic development, New York State ranks in the top 5 in the country for clean energy jobs (12,000 of which stemmed from the NYGB) showing that the state ranks high in clean energy job creation (New York Green Bank 2020). With regards to underserved communities there is a lack of data proving the effect the NYGB has on the 10 poorest communities but NYGB's commitments towards underserved communities are promising for clean energy generation in these areas (New York Green Bank 2020). In New York 28% of its total electricity generation comes from renewable energy showing that this is well above the U.S. average and with the GHG emissions that have been

reduced by the NYGB from 5 million metric tons in 2016 to 20 million metric tons in 2020 this shows that the trend is increasing in the right direction (New York Green Bank 2020). Overall, it appears that the NYGB is effective in providing a positive investment impact, economic development impact, and environmental impact.

D. National Climate Bank

Although Green Banks appear to have a positive impact on their respective states (although marginal) the need for a National Climate Bank may finally become a reality. In the National Climate Bank Act of 2019, the Clean Energy Jobs Fund could create 5 million clean energy infrastructure jobs which could help accelerate the transition to a 100% clean electricity grid in the United States (Coalition for Green Capital 2020). If we were to transform the entire power grid into clean electricity, this would average out to an annual investment of $225 billion per year and without the National Climate Bank Act this would never get done (Coalition for Green Capital 2020). Like the Connecticut Green Bank and the New York Green Bank this national climate bank could provide an even larger impact in the investment circle, economic development circle, and environmental circle.

VIII. Policy Recommendations

The United States must close the renewable energy financing gap and eliminate the "valley of death" that occurs between clean energy innovation and commercialization through the use of green banks (Leonard 2015, 197). But without the right policies in place green banks will never be created and the renewable energy industry will struggle to compete. Today the United States has two full green banks that are in operation with impact metrics that are publicly available: The Connecticut Green Bank and the New York Green Bank (French et al. 2020). Although these state-level banks are successful in scaling up clean energy infrastructure in their

respective states, policymakers should focus their efforts on establishing a national climate if the federal administration is supportive. If not politically feasible, policymakers should focus on establishing state level green banks.

A. Establishing State Level Green Banks

Before establishing a state level green bank, policymakers should determine the market needs of the green bank (French et al. 2020). Green banks can be used for a variety of purposes: to achieve economic goals, social goals or strictly for political purposes (French et al. 2020). Policymakers should work with the stakeholders such as private investors funding the banks or taxpayers to gauge the market needs of the state where the green bank will be set up so that the missions and function of the bank will have a clear direction (French et al. 2020). This will allow the government to address some of the issues the green bank is solving such as leveraging capital in underserved communities to target the impact of the green bank. Policymakers should also work with stakeholders to assess engagement and buy in potential (French et al. 2020). As discussed early as one of the stage of green bank creation, conducting a market analysis can help policymakers gain support from prospective stakeholders such as private corporations, taxpayers, etc. Next, policymakers need to pass legislation that creates a funding structure for the bank (French et al. 2020). Policymakers also need to choose whether the bank will be funded by government budgets, taxpayer dollars, or other grants (French et al. 2020).

B. Establishing a National Green Bank

Pollution does not see state or national borders so it is imperative that the bank impacts as many constituents as possible; this is only possible with a national climate bank. Therefore, congress should continue to pass legislation on the National Climate Act to make it a reality. The original national climate bank act was introduced to the U.S. Senate on July 8, 2019 and

proposes a National Climate Bank "to provide financing for clean technology" and support the creation of green banks (Markey 2019). Later, on December 12, 2019 Congresswoman Debbie Dingell of Michigan lead the house bill to establish a National Climate Bank (Dingell 2019). This National Climate Bank will leverage $35 billion in public funds to fund as much as $700 billion in clean energy investment (Markey 2019). Since 2020, legislation has been passed in the House twice to provide $20 billion in funding for the National Climate Bank which would create over 5 million job years (3.3 direct job years and 2.2 million indirect) (Cid et al. 2020, 17).

Even our most senior national leaders endorse this establishment such as President Biden and Vice President Harris that call in their climate plan for "innovative financing mechanisms that leverage private sector dollars to maximize investment in the clean energy revolution." (Coalition for Green Capital 2020) This national green bank also has the support of 25 governors, nearly 100 organizations, and 7 in 10 Americans according to recent polling (Coalition for Green Capital 2020). Unlike state level banks, a national climate bank may be more difficult to establish since it requires national support rather than just state level support. With an administration that changes every four years progress on federal climate bills can be stifled so it is important that policy makers educate the constituents on not just the environmental but the financial benefits of a national climate bank to appeal to fiscally conservative and independent voters.

IX. Conclusion

The clean energy movement is here. Clean energy is increasing in investment every fiscal year around the world and is now cheaper to operate and produce than coal and fossil fuel plants, yet we are still not meeting the climate goals outlined by the Paris Climate Accord that the United States recently rejoined (Blunt 2020). Green Banks are one way that the United States

can help close the renewable energy financing gap to meet these climate goals. First, green banks are proven (Cid et al. 2020, 64). The United States already successfully operates Green Banks such as in New York and Connecticut. Second, green banks can tailor our financial system to the Paris Climate Accord through the strengths of the public and private sector (Cid et al. 2020, 64). And third green banks can strengthen the overall investment environment for renewable energy by crowding in private sector capital and reduce the risk of these investments (Cid et al. 2020, 31). The Biden Administration has created an attractive landscape for renewable energy investment so it is important that the Untied States utilizes the power of green banks to close the renewable energy financing gap and in doing so we can protect the world for future generations.

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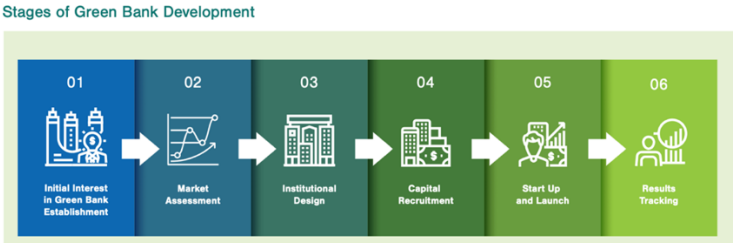
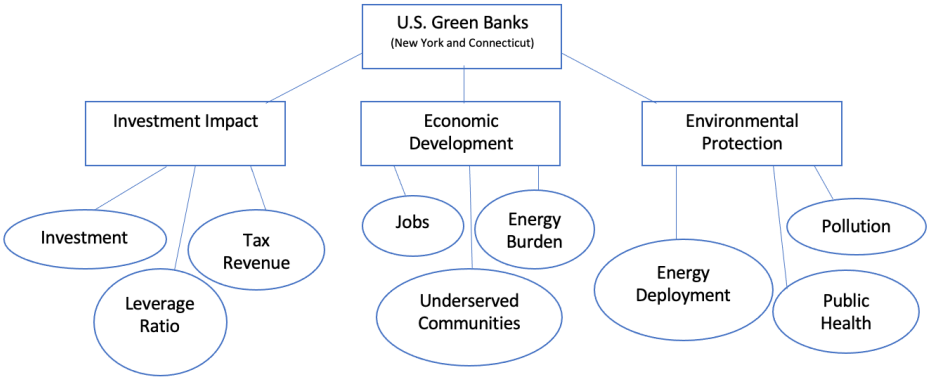
XI. Appendix: Figures and Tables

Figure 1. Stages of Green Bank Development



(Cid et al. 2020, 16)

Figure 2. Green Bank Impact Diagram.



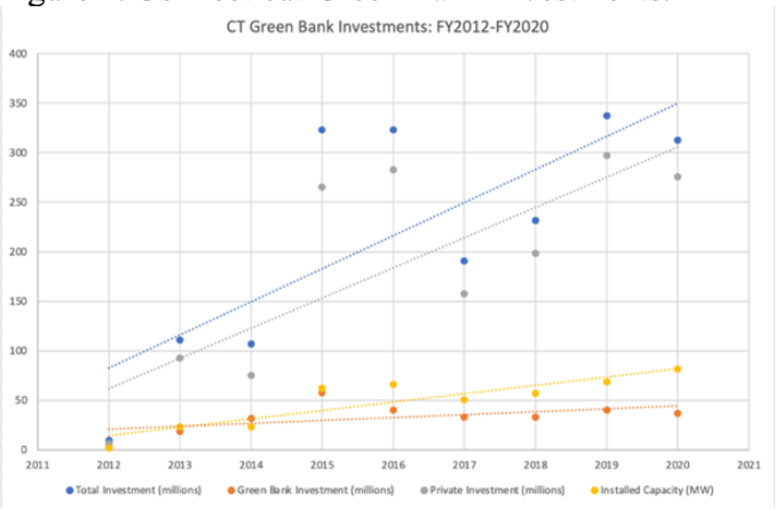
(Connecticut Green Bank 2020)

Figure 3. Green Bank Assessment Framework.

	Low	Medium	High
INVESTMENT IMPACT			
Leverage Ratio	Leverage ratio < 1:1	Leverage ratio = 1:1	Leverage ratio > 1:1
ECONOMIC DEVELOPMENT			
Jobs Created	< 40% of the state's energy workforce	~ 40% of the state's energy workforce	>40% of the state's energy workforce
Overall employment	<2.25% clean energy jobs	~2.25% clean energy jobs	>2.25% clean energy jobs
Underserved communities	10 poorest counties worse off with green bank program (jobs, economic growth)	10 poorest counties only marginally better off the green bank program (jobs, economic growth)	10 poorest counties better off with green bank program (jobs, economic growth)
ENVIRONMENTAL PROTECTION			
Energy generation	<19.8% electricity generation comes from renewable energy	~19.8% electricity generation comes from renewable energy	>19.8% electricity generation comes from renewable energy
Pollution	<2.8% per year co2 emissions reduction average	~2.8% per year co2 emissions reduction average	>2.8% per year co2 emissions reduction average

(Schroeder 2020) (Energy Information Administration) (CT Green Bank)

Figure 4. Connecticut Green Bank Investments.



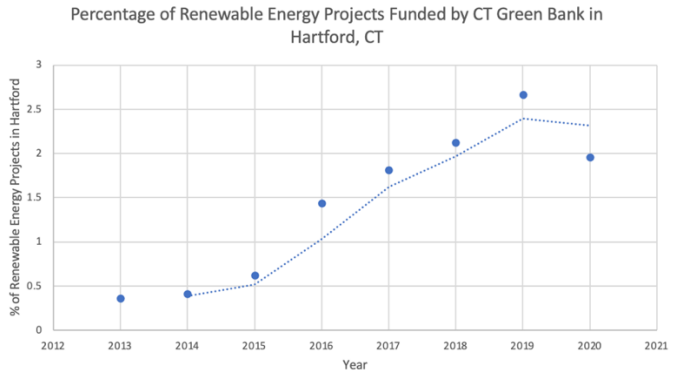
(Connecticut Green Bank 2020)

Figure 5. Connecticut Green Bank Underserved Communities.

Municipality	Investment per capita	Total Job Years	Tax Revenue (Individual Income)	CO2 Tons Avoided
Hartford	374.17	510	1097508	201904
New Haven	380.40	539	1198147	134861
Waterbury	403.75	472	978005	189809
Bridgeport	2262.46	3088	6044377	1187511
New London	405.28	110	228112	46944
New Britain	776.64	628	1384531	142498
Derby	473.59	62	131599	25796
Ansonia	540.00	105	223396	42272
Groton	130.61	57	128034	23652
Norwich	81.49	55	117054	9293

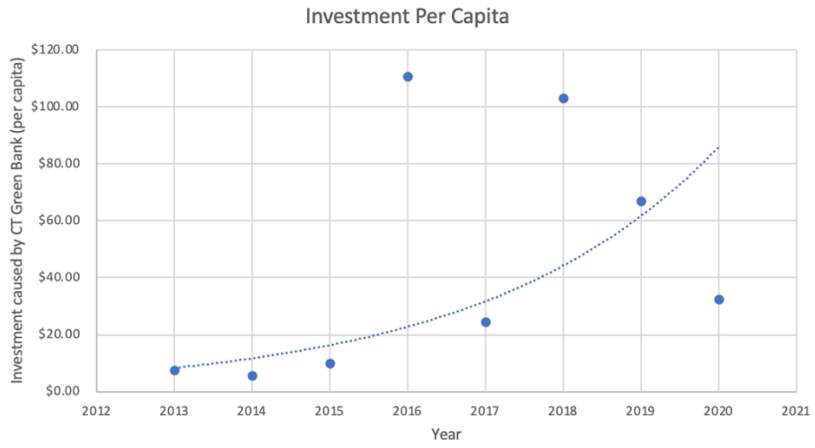
(Sparks 2020)

Figure 6. Connecticut Green Bank Renewable Energy Projects in Hartford.



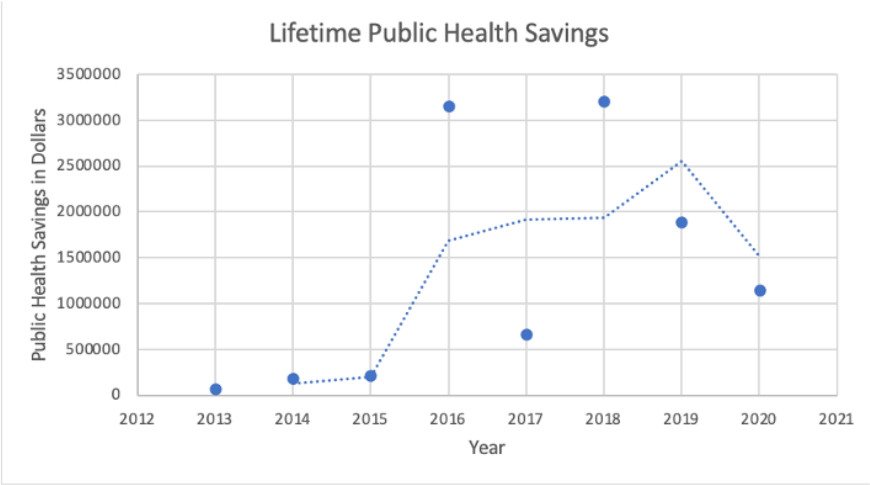
(Connecticut Green Bank 2020)

Figure 7. Investment Per Capita in Hartford caused by Connecticut Green Bank.



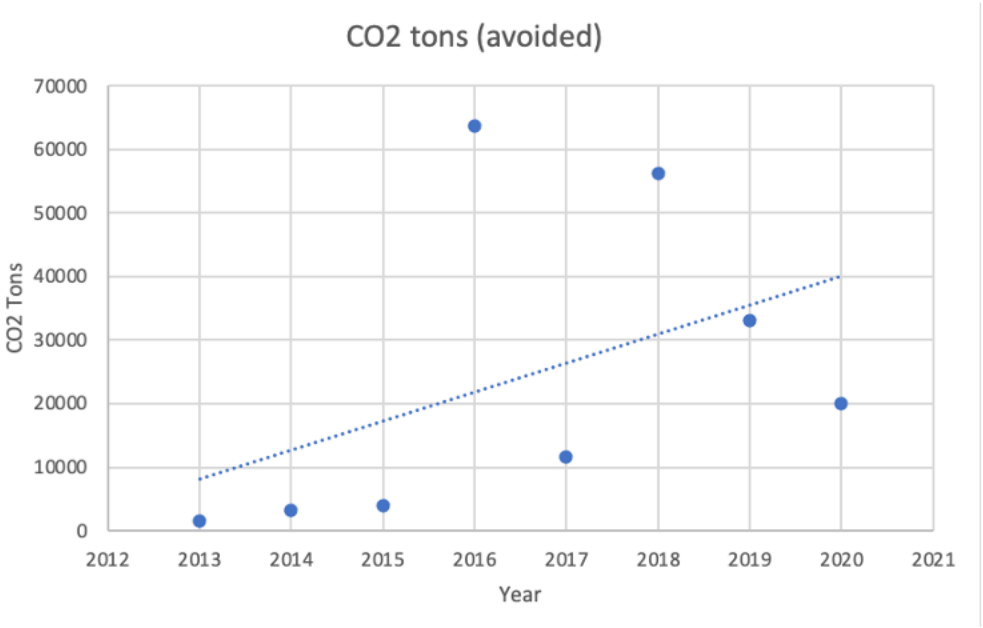
(Connecticut Green Bank 2020)

Figure 8. Lifetime Public Health Savings in Hartford caused by Connecticut Green Bank.



(Connecticut Green Bank 2020)

Figure 9. CO2 Tons avoided in Hartford by Connecticut Green Bank in thousands.



(Connecticut Green Bank 2020)

Figure 10. CO2 Emissions Avoided as a Result of Connecticut Green Bank.

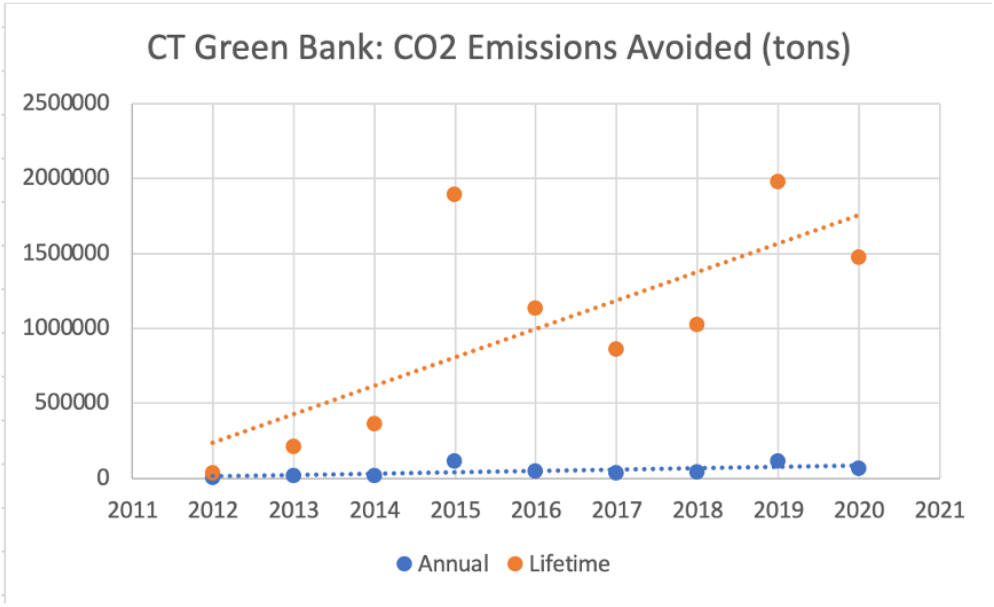
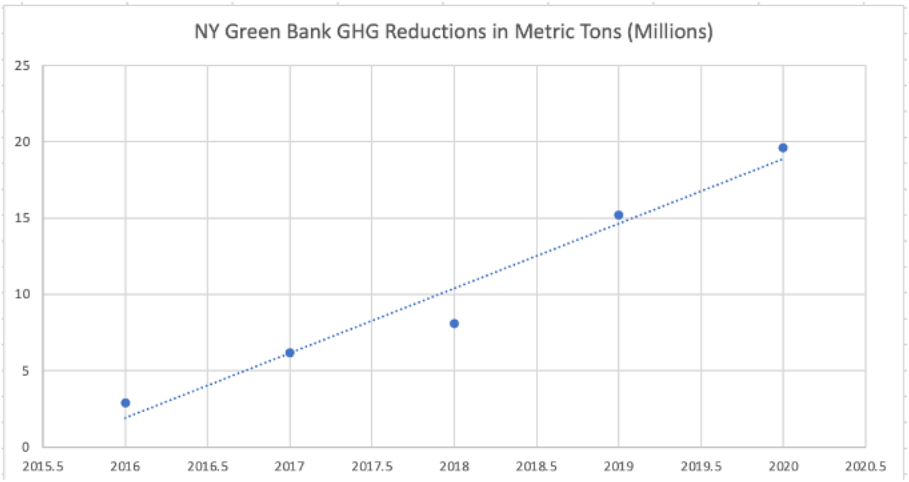


Figure 11. New York Greenhouse Gas Emissions Reductions caused by New York Green Bank.



(New York Green Bank 2020)