Environmental Impact Overview

An important measurement of success for the Connecticut Green Bank (Green Bank) and its programs is how our investment activity improves the air quality of the state. This will be measured by the decrease in the amount of nitrogen oxides (NO_x), sulfur dioxide (SO_2) and carbon dioxide (CO_2) and particulate matter emitted by the region's fossil fuel electric generation or transportation due to Green Bank projects.

The Green Bank will use the US Environmental Protection Agency's (EPA) Avoided Emissions and Generation Tool (AVERT) to calculate and report on the environmental benefits of the Green Bank's clean energy investment activity in Connecticut.

Estimated Generation/Savings for 2016 is calculated by using the Avert emissions factors in **Table 1**:

Table 1: AVERT Factors

Technology	CO_2 tons / MWh	NO_x lbs / MWh	SO_2 lbs / MWh
Solar PV	0.5621	0.5754	0.4107
Energy Efficiency	0.5432	0.4803	0.3397
Energy Efficiency/PV	0.5528	0.5285	0.3754
Wind	0.5372	0.4284	0.3333

Using this method, the following is an example of changes to emissions based on 60 MW additions of either clean generation or improved energy efficiency:

Table 2: AVERT Examples

Capacity:	60 MW			
Technology	Annual expected generation change (MWh)	CO_2 savings (tons)	NO_x savings (lbs)	SO_2 savings (lbs)
Solar PV	79,220	44,520	45,580	32,480
Energy Efficiency	63,090	34,260	30,300	21,430
Wind	104,930	56,370	44,920	34,980

Using the type of calculation outlined above, the Green Bank will include Societal Perspective benefits as well as the environmental impact of its programs in its Comprehensive Annual Financial Report, green bonds issuances, and other communications. Further information about AVERT is available at:
https://www.epa.gov/sites/production/files/2015-08/documents/avert_decision_makers_fact_sheet_2-13-14_final_508.pdf
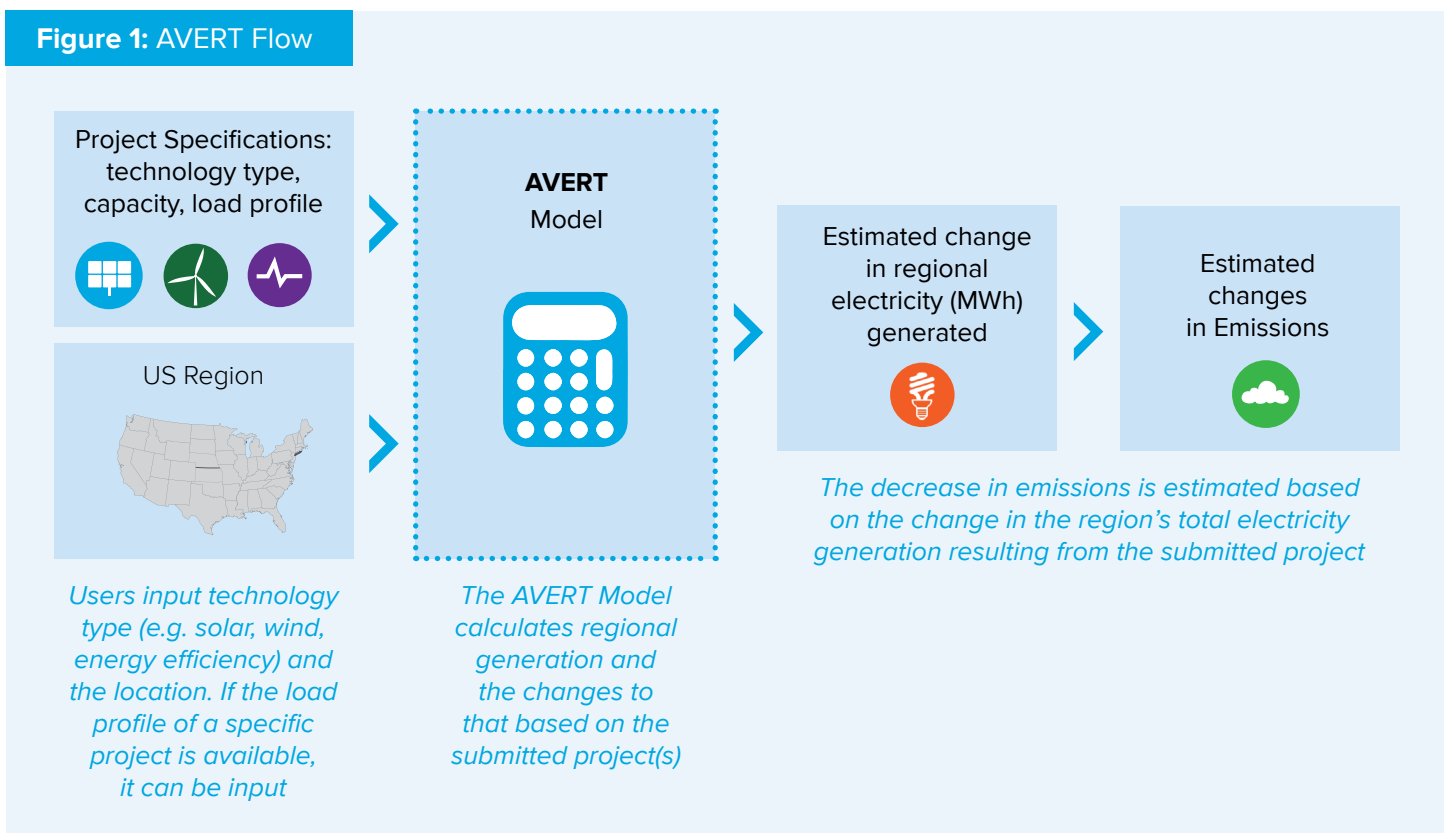
Methodology

Previously, the Green Bank and its predecessor, the Connecticut Clean Energy Fund, estimated these impacts by using the results of the 2007 New England Marginal Emission Rate Analysis to calculate the expected annual and lifetime kWh savings of energy and production of clean energy. After working with the Connecticut Department of Energy and Environmental Protection (DEEP) and the US Environmental Protection Agency, the Green Bank has adopted the EPA's Avoided Emissions and Generation Tool (AVERT) to calculate the air quality benefits associated with Green Bank projects.

AVERT is a complex model that represents the dynamics of electricity dispatch based on the history of actual generation in a selected year for a specified region. For Green Bank purposes, the model generates the expected annual change to regional electricity generation based on a specific clean energy project or projects, then calculates the decline in emissions based on the reduction in resources required. The graphic below is a simplified representation of the model.
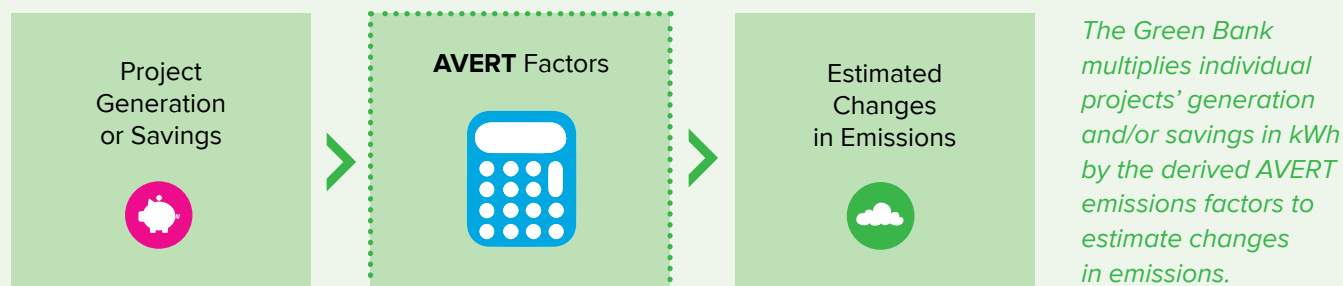

Figure 1: AVERT Flow

Project Specifications: technology type, capacity, load profile

US Region

AVERT Model

Estimated change in regional electricity (MWh) generated

Estimated changes in Emissions

Users input technology type (e.g. solar, wind, energy efficiency) and the location. If the load profile of a specific project is available, it can be input

The AVERT Model calculates regional generation and the changes to that based on the submitted project(s)

The decrease in emissions is estimated based on the change in the region's total electricity generation resulting from the submitted project

To maximize the model's accuracy, the Green Bank has derived average project emissions factors by technology (solar, wind, EE) from its completed projects. It then applies these factors to the annual projected generation for individual projects to calculate the estimates of the expected NO_x, SO_2, and CO_2 savings. The Green Bank will update these factors annually based on changes to the regional generation profile and typical project sizes.

Figure 2: Green Bank AVERT Operationalized Flow

Project Generation or Savings

AVERT Factors

Estimated Changes in Emissions

The Green Bank multiplies individual projects' generation and/or savings in kWh by the derived AVERT emissions factors to estimate changes in emissions.

Example of Environmental Equivalencies

The Green Bank uses the EPA's AVERT tool to translate the contributions made by Green Bank projects to the region's air quality. The decreases in CO_2 and NO_x in the example in **Table 2** above can also be demonstrated through common activities or environmental equivalencies as shown in **Table 3** below.

Table 3: Environmental Equivalencies

Capacity:	Equivalencies							
60 MW	**Greenhouse gas emissions from:**		**CO₂ emissions from:**				**Carbon sequestered by:**	
Technology	**Miles driven by an average passenger vehicle**	**Tons of waste recycled instead of landfilled**	**Gallons of gasoline consumed**	**Pounds of coal burned**	**Homes' energy use for one year**	**Incandescent lamps switched to**	**Tree seedlings grown for 10 years**	**Acres of U.S. forests in one year**
Solar PV	96,795,798	12,817	4,544,600	43,097,690	4,265	1,431,686	1,046,698	38,231
Energy Efficiency	74,488,411	9,863	3,497,260	33,165,473	3,282	1,101,742	805,478	29,421
Wind	122,560,178	16,229	5,754,248	54,569,111	5,400	1,812,761	1,325,300	48,407

Further information about the EPA equivalency Calculator is available at:
https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

In the examples above, the Connecticut Green Bank would apply the Societal Perspective to report the environmental impact results in its Comprehensive Annual Financial Report in the following manner: "In FY 2016 there was a total deployment of nearly 60 MW of Residential Solar PV in Connecticut. Through the Connecticut Green Bank's support, about 44,520 tons of CO_2, 45,580 pounds of NO_x, and 32,480 pounds of SO_2 emissions were saved, which is equivalent to 4,544,600 gallons of gasoline consumed, 1,431,686 incandescent lamps switched to LEDs, or carbon sequestered from 38,231 acres of U.S. forests in a year."

About the Connecticut Green Bank

The Connecticut Green Bank was established by the Connecticut General Assembly on July 1, 2011 as a part of Public Act 11-80. As the nation's first full-scale green bank, it is leading the clean energy finance movement by leveraging public and private funds to scale-up renewable energy deployment and energy efficiency projects across Connecticut. The Green Bank's success in accelerating private investment in clean energy is helping Connecticut create jobs, increase economic prosperity, promote energy security and address climate change. For more information about the Connecticut Green Bank, please visit www.ctgreenbank.com.

About the Department of Energy and Environmental Protection

The Connecticut Department of Energy and Environmental Protection (DEEP) was established on July 1, 2011 with the consolidation of the Department of Environmental Protection, the Department of Public Utility Control, and energy policy staff from other areas of state government. It is charged with conserving, improving and protecting the natural resources and the environment of the state of Connecticut as well as making cheaper, cleaner and more reliable energy available for the people and businesses of the state. The agency is also committed to playing a positive role in rebuilding Connecticut's economy and creating jobs – and to fostering a sustainable and prosperous economic future for the state. For more information about the Connecticut Department of Energy and Environmental Protection, please visit www.ct.gov/deep.

About the United States Environmental Protection Agency

The mission of the EPA is to protect human health and the environment. For more information about the United States Environmental Protection Agency, please visit www.epa.gov.