

Green MBS Impact Report 2021



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Executive Introduction



Since its inception, Freddie Mac has been a mission-oriented company – providing liquidity, stability, and affordability to the U.S. housing market. Our sustainability strategy strengthens our commitment to our mission and helps us drive long-term value for our stakeholders while making a difference in our communities.

Today, our mission extends to promoting environmentally sustainable single-family housing to help reduce climate-related risks and increase affordability. We started this work in 2019, with the introduction of our Single-Family GreenCHOICE Mortgages® offering solution, which allows borrowers to use refinance proceeds to finance energy efficient home

improvements. Improving the energy efficiency of homes may provide savings to our borrowers, increase the value of homes, and positively impact our environment.

Following the success of our Multifamily Impact Bonds and to attract capital to help support our GreenCHOICE Mortgages offering, we issued our first Single-Family Green Mortgage-Backed Security (Green MBS) to investors in April of 2021. Through our Green MBS, we're financing energy-efficient homes and home improvements to help more families achieve and maintain affordable homeownership while reducing the housing sector's environmental impact. Since the Single-Family Green MBS launch, we have sold bonds totaling over \$600 million, and we do not intend to stop there. In our 2021 Green MBS issuance, each one of the loans is secured by a home where solar panels produce renewable energy, reduce greenhouse gas emissions, and decrease the reliance on energy sources that may have a much more harmful impact on the environment.

Earlier this year, we expanded the Green MBS offering through the launch of our Single-Family Green Bond Framework, which broadened the criteria of eligible mortgages available for securitization. Mortgages backed by newly constructed homes with a renewable energy source and some mortgages backed by newly constructed homes with a Home Energy Rating System (HERS) score now meet Freddie Mac's requirements for our Green MBS program. This expansion of eligible energy efficient mortgages will help encourage green construction and energy efficiency home improvements.

This is our first Single-Family Impact Report covering our inaugural year of Green MBS issuance. But instead of a summary and conclusion, this report is just the beginning of our journey. We will continue to innovate in this space and foster a market for these loans. We welcome you to join us.

Mark Hanson

Mark Hanson
Senior Vice President
Single-Family Securitization

We are leading the U.S. housing market forward, making homeownership and rental housing more accessible and affordable nationwide.

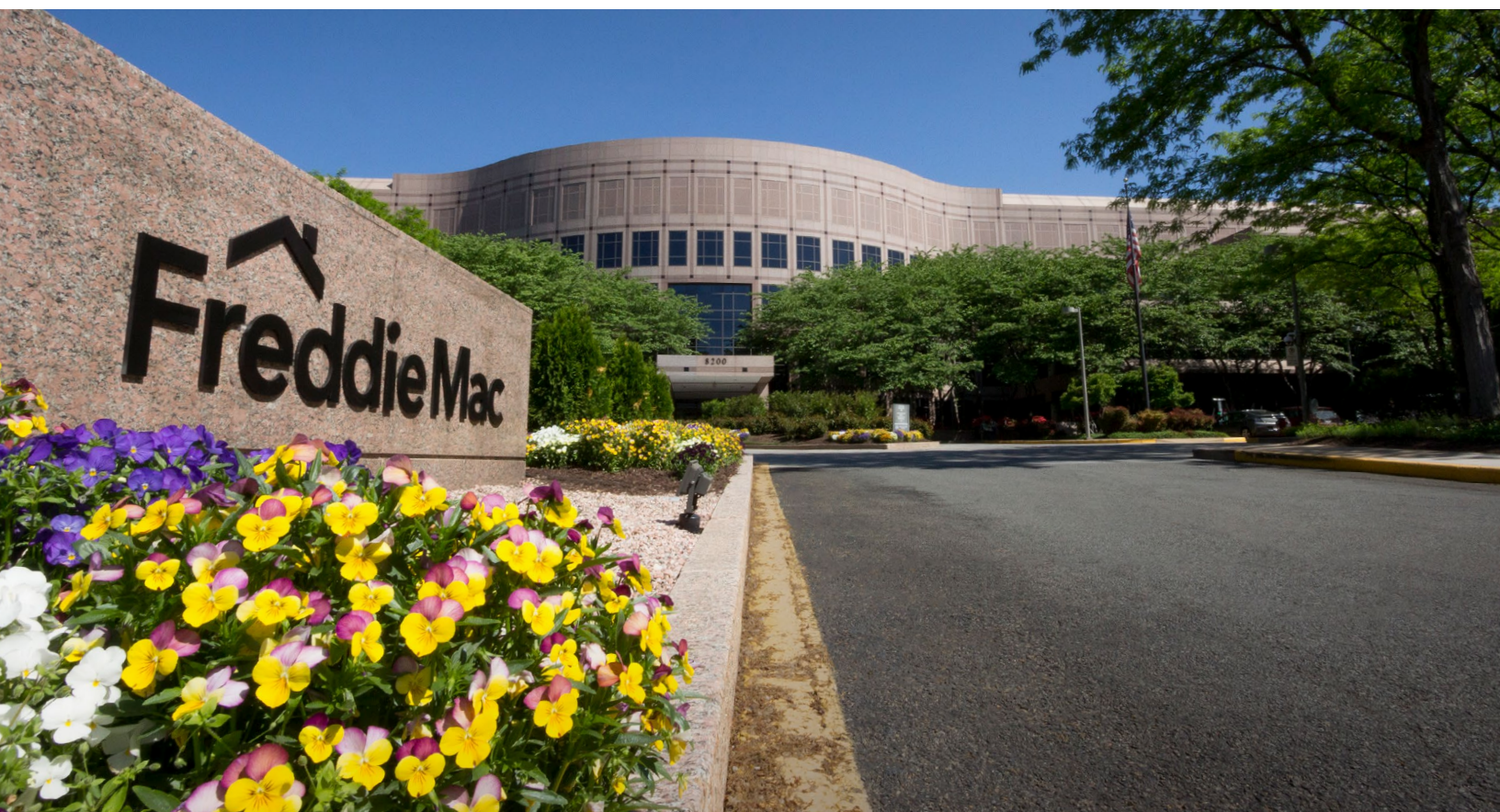
What We Do

Freddie Mac was chartered by Congress in 1970 to support the U.S. housing finance system and to help ensure a reliable and affordable supply of mortgage funds across the country.

We serve America's homebuyers, homeowners, and renters by providing liquidity, stability, and affordability to the housing market.

Rather than lending directly to borrowers, Freddie Mac operates in the U.S. secondary mortgage market, buying loans that meet our standards from approved lenders. Those lenders are then able to provide more loans to qualified borrowers and keep capital flowing into the housing market. Freddie Mac then pools the mortgages it buys into securities, which are sold to investors around the world.

Since 2008, Freddie Mac has been operating in conservatorship, with FHFA as Conservator. FHFA is also our regulator. The conservatorship significantly affects our business and activities. For more information, see "Conservatorship and Related Matters" on pages 111-115 of [our 2021 Annual Report on Form 10-K](#).



Our Business

We conduct business through two business segments that are integral to our ESG strategy and our ability to make an impact through our mission:



For more information, see “Our Business Segments” on page 29 of our [2021 Annual Report on Form 10-K](#).

Single-Family Segment

Our Single-Family segment provides liquidity and support to the single-family market through a variety of activities that include the purchase, securitization, and guarantee of single-family loans originated by lenders. Central to our mission is our commitment to helping more families attain affordable and sustainable housing and to increasing equitable access to housing finance.

The U.S. residential mortgage market consists of a primary mortgage market that links homebuyers and lenders, and a secondary mortgage market that links lenders and investors. The size of the U.S. residential mortgage market is affected by many factors, including changes in interest rates, unemployment rates, homeownership rates, house prices, the supply of housing, lender preferences regarding credit risk, and borrower preferences regarding mortgage debt.

In accordance with our [Charter](#), we participate in the secondary mortgage market. The mix of loan products we purchase is affected by several factors, including the volume of loans meeting the requirements of our Charter, the volume meeting our risk appetite and originated according to our purchase standards, and the loan purchase and securitization activity of other financial institutions.

Our primary business model is to acquire loans that lenders originate and then pool those loans into guaranteed mortgage-related securities that transfer interest-rate, prepayment, and liquidity risk to investors and can be sold in the capital markets. We consolidate most of our single-family securitization trusts and, therefore, we recognize the loans held by the trust and the debt securities issued by the trust on our balance sheet and recognize the guarantee fees we receive as net interest income. To reduce our exposure under our guarantees, we transfer credit risk on a portion of our single-family mortgage portfolio to the private market in certain instances. The returns we generate from these activities are primarily derived from the guarantee fees we receive in exchange for providing our guarantee of the principal and interest payments of the issued mortgage-related securities.

Freddie Mac Governance

We are committed to best practices in corporate governance. Our [Board of Directors](#) adopted [Corporate Governance Guidelines](#) that embody many of our long-standing practices, policies, and procedures. Our Board of Directors revisits the Guidelines annually and regularly assesses them against the regulatory and legislative environment in which we operate, as well as evolving best practices.

For more information, see “Corporate Governance” on pages 245-252 of our [2021 Annual Report on Form 10-K](#).



Our Corporate ESG Strategic Framework

Freddie Mac’s mission is to provide liquidity, stability, and affordability to the housing market. We view effective management of sustainability — otherwise known as environmental, social, and governance (ESG) issues — as a business fundamental that supports our mission and our corporate strategic priorities: deliver results, practice risk management excellence, and grow talent for today and tomorrow.

Freddie Mac established its Corporate Sustainability Office in 2020 to serve as an integration point for ESG-related initiatives across the company. We have since conducted a materiality analysis and developed an ESG Strategic Framework. The Corporate Sustainability Office reports to the Chief Financial Officer.

ESG Strategic Framework



We are focused on managing risks and opportunities that arise from our material ESG issues, along with executing our mission. This includes integrating our sustainability strategy into our business and operations, which we accomplish through our ESG Strategic Framework centered on four pillars and initial focus areas: Purpose, Planet, Practices, and People.



Purpose

Mission: Deliver solutions to meet the country’s housing needs in good times and bad, promoting greater access to affordable and sustainable homes and rental properties

- Address longstanding issues of inequity in housing
- Provide liquidity, stability, and affordability to the housing market, particularly in underserved communities across the country



Planet

Climate: Promote environmentally sustainable single-family and multifamily housing to help reduce climate-related risks and increase affordability

- Attract impact capital to the housing market
- Increase resilient, efficient, and environmentally sustainable housing



Practices

Sustainable Operation: Provide stability to the housing industry through outstanding risk management

- Further integrate sustainability in our business and operations
- Reduce carbon emissions from our operations

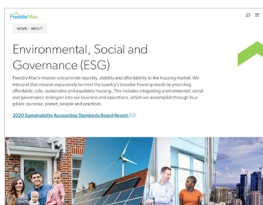


People

Diversity, Equity, Inclusion, and Talent: Develop our future workforce and strengthen the housing market through diversity, equity, and inclusion (“DEI”)

- Build greater DEI at Freddie Mac
- Promote DEI among our partners and suppliers throughout the industry and community

This approach is intended to protect and create long-term value for our stakeholders and benefit underserved communities from coast to coast. As our ESG strategy evolves, we pledge continued collaboration with our internal and external partners to drive greater impact.



More information about Freddie Mac’s approach to ESG can be found on our [ESG website](#), including our ESG disclosures and reports. The launch of our ESG website, and the release of our ESG related reports, demonstrates our commitment to transparency in how we achieve our mission.

Single-Family Green Bond Framework

Freddie Mac's Single-Family Green MBS program finances the purchase of mortgages that align with the International Capital Market Association's (ICMA) Green Project categories, including renewable energy and energy efficiency that contribute to climate change mitigation and adaptation.

Launched in early 2022, our [Green Bond Framework](#) ("Framework") received a Light Green Second Opinion rating from CICERO Shades of Green ("CICERO"). CICERO provides second opinions on institutions' frameworks and independent reviews of green bonds. CICERO noted that "the Framework supports investment in new and existing homes with installed renewable energy systems, which are a key aspect of improving the net zero readiness of residential buildings, helping to align the US housing stock's energy usage with a 1.5-degree climate scenario." CICERO also noted that

"allowing consumers to use mortgage proceeds to pay for or refinance renewable energy systems helps them overcome the barrier of upfront costs. Consumers' alternative would be to finance renewable energy systems with personal loans or through leasing arrangements, which could be inaccessible or very expensive if consumers do not have high enough credit ratings."



The Framework addresses the four core components of ICMA's Green Bonds Principles, as listed below.



**Our use of
proceeds**



**The process for
project evaluation
and selection**



**The management
of proceeds**



**Transparency
through regular
reporting**

Promoting housing affordability is fundamental to Freddie Mac's mission and reducing the environmental impact of housing further aligns with our mission focus. Freddie Mac has a team of experts across the Single-Family segment supporting this framework. The [Single-Family Green Bond Framework](#) and associated [CICERO Second Opinion](#) are available at FreddieMac.com.

Use of Proceeds



In 2019, Single-Family created the GreenCHOICE Mortgage offering to finance energy- and water-efficient home improvements, helping more families attain and maintain affordability and reduce environmental impacts. In 2020, Freddie Mac purchased \$462 million in GreenCHOICE Mortgages, providing financing to support energy efficient improvements for approximately 1,685 families.

In April 2021, Single-Family issued its first Green MBS. Each Single-Family Green MBS issued in 2021 is backed by Freddie Mac's GreenCHOICE Mortgages, where borrowers used refinance proceeds to finance energy efficient home improvements. Specifically, the proceeds or a portion thereof from each refinance mortgage backing these Single-Family Green MBS paid off existing debt that was used to finance the purchase and installation of solar panels as a renewable energy source. By refinancing a consumer loan into a mortgage loan, borrowers are likely to achieve cost savings with less expensive, more efficient financing. Our initial Single-Family Green MBS issuances focused on financing energy efficient improvements made to existing homes. In 2021, we issued approximately \$617 million in Single-Family Green MBS.

Freddie Mac's Single-Family Green MBS issuance is a natural extension of our role in providing standards and scale to the nation's housing markets. By devoting resources specifically to encourage green construction and energy efficiency home improvements, we believe we can help expand availability and market demand.

Process for Project Evaluation and Selection



All Green MBS issued in 2021 were backed by GreenCHOICE Mortgages where the proceeds or portion thereof from each refinanced mortgage paid off existing debt that was used to finance the purchase and installation of solar panels as a renewable energy source. For all of these mortgages, the seller represented to Freddie Mac that the refinance proceeds were used to pay off debt used to finance renewable energy improvements. Prior to MBS issuance, Freddie Mac confirmed the presence of a renewable energy source installed on the properties securing each of the mortgages included in a Single-Family Green MBS.

Management of Proceeds



The management of proceeds for Freddie Mac Single-Family Green MBS is consistent with the management of proceeds across all of Freddie Mac's Single-Family MBS. Our Single-Family Green MBS only contain mortgages that satisfy the criteria set forth in the Freddie Mac [Single-Family Seller/Servicer Guide](#) ("Guide").

The mortgages backing our Single-Family Green MBS leverage Freddie Mac's existing mortgage purchase process to ensure adherence to the Guide. Once the mortgages are acquired, they are securitized into Single-Family Green MBS per the criteria described in the Single-Family Green Bond Framework and the securitized mortgages are sold to the MBS investment community. Freddie Mac's proceeds from sales of Single-Family MBS (including Single-Family Green MBS) are used to help finance additional purchases of mortgages that meet the criteria described in the Guide, including additional purchases of GreenCHOICE Mortgages or other mortgages to be used for future issuances of Single-Family Green MBS.

2021 Freddie Mac Single-Family Green MBS Issuance

	Number of Securities	Number of Loans	Original Unpaid Principal Balance (\$M)
April	8	435	\$104
May	8	510	\$117
June	11	248	\$59
July	14	239	\$60
August	2	55	\$19
September	16	282	\$66
October	13	355	\$98
November	6	210	\$61
December	6	120	\$33
Total	84	2,454	\$617

More information related to our Green MBS offerings can be found in our [Single-Family Green MBS website](#).

Summary of Estimated Impact¹



192,168 MMBtu

**of estimated
source energy
saved annually**

This is enough energy to power 1,877 homes and represents an estimated 47% average decrease in total source energy consumed by homes securing mortgages backing Green MBS issued in 2021.²



9,828 metric tons

**of estimated
GHG emissions
avoided annually**

This is equivalent to removing 2,117 cars from the road for a year and represents an estimated 60% decrease in total GHG emissions resulting from energy consumption at these homes.³



\$1,027

**of estimated
average annual utility cost
savings for homeowners**

This represents an estimated 50% average decrease in total annual utility bills for these borrowers.

¹ Estimated impacts related to Single-Family Green MBS issued in 2021. All estimated impact statistics are calculated using the methodology described in the Appendix. Previously reported estimates for greenhouse gas emissions reductions have been updated to reflect the correct inputs to the calculation of these estimates.

² In 2020, the average annual electricity consumption for a U.S. residential utility customer was 10,715 kilowatt hours (kWh), an average of about 893 kWh per month <https://www.eia.gov/tools/faqs/faq.php?id=97&t=3>.

³ Calculated using EPA GHG Equivalencies Calculator <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>.



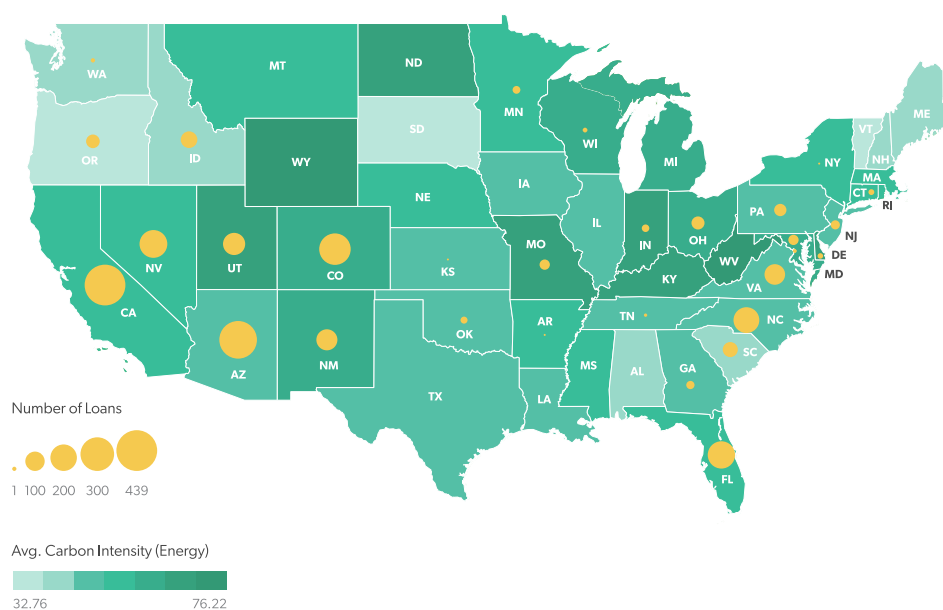
Targeted Benefits of Green Improvements

While all energy efficiency improvements reduce environmental impact regardless of where the property is located, the impact from such improvements will be greater in certain markets. For example, GHG emissions reduction due to energy-saving improvements will be greater when the property is in an area with more carbon-intensive energy supplies.

Environmental Impact based on Carbon Intensity of Energy Supply

Each state has a unique profile of the types of fuel sources used to produce energy. Carbon-producing fuel sources such as coal, petroleum, and natural gas vary in the amount of carbon produced and will directly impact a state's energy-related carbon dioxide (CO₂) emissions.

The map below shows the location of properties related to mortgages backing the Single-Family Green MBS issued in 2021, relative to the carbon intensity of the energy supply within that state. States with a more carbon-intensive energy supply are shaded in dark green and states with a lower carbon-intensive energy supply are shaded in light green. The circle within each state represents the number of properties within that state that relate to loans included in Green MBS.



Source: Freddie Mac tabulation of 2019 U.S. Energy Information Administration Energy-Related Carbon Dioxide Emissions by State data, eia.gov/environment/emissions/state/excel/table6.xlsx

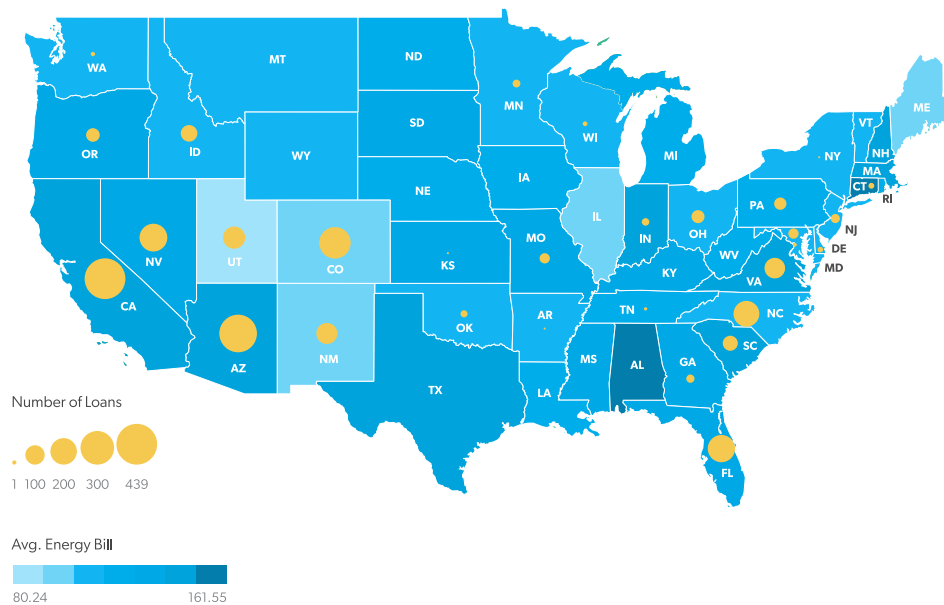
We found that **1,043** properties, representing **42.5%** of properties with mortgages included in Green MBS issued in 2021, were in states with a carbon intensity of energy production greater than the national average of **51.4 kg** of CO₂ per million Btu (kg CO₂/MMBtu). In addition, **486**, or **19.8%**, of these properties were in states that were among the **10** highest in terms of carbon intensity of energy production, with an average carbon intensity of energy production over **59.8 kg** CO₂/MMBtu.



Improvements made on properties in these states can be expected to have a greater impact than improvements made on properties in states where the carbon intensity of the energy supply is lower.

Utility Savings in Areas of High Electricity Costs

The map below shows the average monthly electric utility bills by state, relative to the location of the properties related to mortgages backing our Green MBS issued in 2021. States with the most expensive electricity bills are shaded in dark blue and those with the least expensive bills are shaded in light blue.



Source: Freddie Mac tabulation of 2020 U.S. Energy Information Administration Residential Energy Bill by State-by-State data
https://www.eia.gov/electricity/sales_revenue_price/xls/table5_a.xlsx

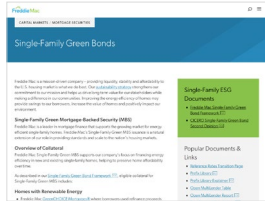
The national average electric utility bill is **\$117** per month. By comparison, the average electric utility bill for the **10** states with the most expensive electricity bill is **\$137** per month, or **17%** higher than the national average. Just over **40%** (990 loans) of the mortgages included in Green MBS issued in 2021 consisted of mortgages made to borrowers who live in states with above average electricity bills.



Our analysis shows that 770 mortgages, or 31.4% of mortgages included in Green MBS issued in 2021, were made to borrowers in the 10 states with the highest average electricity bills.

Transparency to Investors

To maintain transparency for the investment community, Freddie Mac provides disclosures including detailed pool-level and loan-level disclosure.



Freddie Mac's Single-Family [Green MBS website](#) serves as a centralized source of information related to our Green MBS program. This page contains an overview of eligible collateral, links to our framework and second opinion, as well as a list of pools issued under the Green MBS Program.

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Freddie Mac is also making available the estimated impacts by security for all of its Single-Family Green MBS issued in 2021 in a downloadable excel format (Estimated Impact File). For each Green MBS security, the [Estimated Impact File](#) provides:

- Annual estimated energy savings (energy generated by photovoltaic (PV) systems)
- Annual estimated GHG emissions avoided
- Estimated annual utility cost savings for borrowers



Appendix - Methodology⁴

To calculate the metrics described in this report, a methodology was developed in coordination with Earth Advantage®, which also developed a web-based tool to calculate the metrics at the individual property and security level for all of the Green MBS issued in 2021 by Freddie Mac.

Earth Advantage is a 501(c)(3) nonprofit focused on accelerating the adoption of high-performance and green residential renovation and construction. Founded in 2005 as a spin-off from the electric utility Portland General Electric, the organization provides certification, training, research, and IT product development for the building industry. To date, Earth Advantage has green-certified over 20,000 single-family and 14,000 multifamily residences and has provided professional training to over 10,000 real estate agents, appraisers, builders, home performance contractors, and architects across the country. Since its inception, Earth Advantage has also consulted with federal, state, and local municipalities on green home valuation, residential energy labeling, and Home Energy Score delivery. In 2017 Earth Advantage launched the Software-as-a-Service (SaaS) platform Green Building Registry® to provide a single source for building performance data across the U.S.

The methodology analyzes and calculates the estimated impact of solar generation systems located at single-family residential properties for which a mortgage (e.g., a GreenCHOICE Mortgage) has been originated that repaid a consumer loan that had financed the homeowner-owned system. As there is no single standard for GHG accounting, in keeping with best practices outlined in [Handbook: Harmonized Framework for Impact Reporting](#) published in June 2021 by ICMA, we are seeking to make the methodology publicly available and transparent.

⁴ The discussion in this section is based on materials provided to us by Earth Advantage. Freddie Mac has not independently verified any of the information provided in this section.



Tools, Resources, and Data Used

The methodology described in this report is designed to conservatively estimate the capacity and annual energy production of residential solar systems and convert those estimates into different forms, including an estimate of the GHG emissions reductions associated with the energy production of the solar systems. The methodology also utilizes a standard method to calculate an estimate of the total annual energy consumption of each home as a baseline that can be used to estimate the baseline GHG emissions of each home. The following tools were used to conduct the needed calculations:

Tool	Description
PVWatts API	Used to estimate the annual energy production from a solar installation given the system’s location and basic description (e.g., system size, module type, array type, tilt, and azimuth).
National Renewable Energy Laboratory (NREL) Energy Cost Estimate (ECE) API	Used as a standard method to estimate the total annual energy consumption of a home given the home’s location and basic characteristics.
Green Building Registry (GBR) API	Used to provide third-party verified information of some solar systems.



In most cases, the information available did not contain the detailed solar system characteristics needed to run the PVWatts tool with field-verified data. Therefore, it was necessary to make assumptions about those system characteristics to create estimates of impact. Given the unknown variability in solar system sizes, the methods used are designed to consistently assume suboptimal characteristics. Those discounted system characteristics were used to provide estimates of impact that are strongly biased towards estimating lower levels of impact.

The following data sources were used in this project:

Data Source	Description
Uniform Collateral Data Portal (UCDP) House Characteristic Data	This data is provided by the appraiser in their reports. UCDP was developed by Fannie Mae and Freddie Mac to facilitate the electronic delivery of appraisal report data to the Government Sponsored Entities.
Additional Appraisal Information from Form 10-04 Addenda	This data was reviewed as needed for cross verification of solar system existence, including photographs showing solar systems and appraiser comments referring to solar systems.
Green Building Registry (GBR) Solar Installation Data	This data is sourced from solar incentive programs that record solar installation characteristics.
Earth Advantage Solar Industry Survey	This survey was circulated to a sample of leading solar installers distributed around the US. The results of this survey provide average production values for residential solar systems in different regions of the US and for different vintages of solar systems. This data was used in lieu of actual solar system characteristics when those were unavailable. Survey data included: average nameplate capacity of system by age and US region for the last five years and the average estimated power production factor in kWh/kW by age and US region based on installers' use of PVWatts for each system when installed.
NREL Utility Rates Database (URDB)	Local-level, standard residential rates from this database were used to estimate the energy cost savings of the estimated solar energy production.
US EPA's Avoided Emissions and Generation Tool (AVERT) regional emission rate data	This data is based on statistical analysis of actual hourly data reported by individual electric utilities to the EPA.

Energy Production in kWh and Dollar Value of Estimated Energy Cost Savings

The estimated energy production of each solar system used calculations from PVWatts®, a tool developed by NREL which has become a standard of the solar industry. PVWatts considers the physical characteristics of a solar array including the rated capacity of the solar array in kW, the tilt of the panels (which in residential applications are typically mounted flush to the roof surface), the azimuth of the array, any shading affecting the array, and the efficiency of the system equipment. Additionally, PVWatts accounts for the amount of solar energy, insolation, that reaches a given geographical (zip code) area on an average basis. PVWatts also considers the age of a solar system because the capacity of solar systems is known to degrade over time. Solar installers in the US generally utilize PVWatts to predict solar generation for their customers as part of the system design and sales activity of a solar installation. Installers then track the power factor of systems in kWh/kW; kWh of estimated production divided by the nameplate capacity of the system in kW. In the Earth Advantage Solar Industry Survey, solar installers were asked for the average power factor of the systems they have installed in each of the last five years.

For properties where detailed solar system information exists in the GBR database, system age and power production estimates were taken directly from GBR or the solar system capacity was processed through PVWatts to calculate the power production estimate.

In the absence of detailed solar system information, the average power factor provided by the Earth Advantage Solar Industry Survey was used to estimate the power production from systems. For regions of the country where that factor was not reported, the PVWatts tool was utilized with the default values for tilt, azimuth, and efficiency provided by NREL. Due to the lack of verified solar system characteristics, the estimate of energy production for each solar system was discounted to provide a conservative value. All energy production and savings estimates are expressed as source energy, as described below.

The age of the system was used to calculate the degradation of the system's capacity as part of the PVWatts tool's calculation. PVWatts estimates system degradation at 1.5% of the panel nameplate capacity in year one and then a 0.5% degradation for each year thereafter. With the knowledge that some solar systems will be less than one year old at the time of mortgage closing and that a large percentage will be less than two years old, this methodology used a typical age of four years to supply a conservative margin of error for the calculation. The four-year age assumption will cause the PVWatts tool to degrade the nameplate capacity of each system by 3%. This four-year age assumption was also used to determine system size. This again is a conservative assumption, as the Earth Advantage Solar Industry Survey indicates that system sizes have generally increased over time.

The annual system production value was capped at the estimate of annual electricity consumption for the home. Although it is possible that some homeowners may install solar systems that are sized to produce more electricity than their home will consume, this would be a rare instance because electric utility incentive programs typically limit financial incentives for residential solar to system sizes that will produce no more than the annual electricity consumption of a home. In addition, the net metering contracts that allow homeowners to connect their solar systems to the grid generally will not provide any financial benefit if the system produces more electricity in a year than the home consumes.

To assess the estimated dollar value of the energy cost savings of the estimated solar energy production, the kWh power production estimate returned by PVWatts was multiplied by the local price of electricity based on average energy prices provided by NREL's URDB.

Estimation of the Relative Energy Savings for Each Solar Installation

In order to estimate the relative energy savings for each solar installation, the methodology used annual energy use estimates provided by the NREL-ECE tool to provide baseline estimates of energy use for the home, if there were no solar panels. The NREL-ECE tool was developed as a service that the appraisal, real estate, and finance industries could use to estimate the annual energy use of any home in the US given a few home data points that those industries typically have available to them. The tool provides an estimate of annual energy consumption in kWh and in the fuel provided as the heating fuel. The tool assumes the heating fuel is used for space heating and water heating. Those annual fuel use estimates were converted to British thermal units (Btus)/year as estimates of site energy for use as a common energy metric. The conversion to source energy used the site/source conversion factors described below.

Site Energy: The estimations of the total annual energy consumption from the NREL-ECE tool and the annual solar production from the PVWatts tool are provided as site energy values for each home. While the solar production value is always provided as units of electricity (kWhs), the energy use estimated by the NREL-ECE tool provides values for each fuel known to be present in the home. Each fuel type has its own unit of measurement which can be commonly converted to Btus for comparison.

Electricity: 1 kWh = 3,412 Btus

Gas: 1 therm = 99,976 Btus

Oil: 1 gallon = 131,890 Btus

Propane: 1 gallon = 91,500 Btus

The estimation of the total site energy consumption for each home was calculated as the sum of each fuel use estimate multiplied by that fuel's Btu conversion factor.

Source Energy: Different fuels consumed at a home are connected to different systems. Some of those systems have higher rates of overall energy loss than others. Historically, the US electrical grid has used about three units of energy in order to deliver one unit of energy to a customer. The ratio of that energy relationship is referred to as the site/source conversion factor. Currently, the EPA uses an estimated site/source conversion factor of 2.80 for electricity in the US for use within the [Energy Star Portfolio Manager](#) tool. There are certainly differences in site/source conversion factors across the regions of the US, but since there are no databases of those factors being consistently maintained across the country, the methodology used the national figure of 2.80 for electricity as found in Figure 1 of the EPA report.

The EPA figures for site/source conversion factors of other fuels were also used.

The dollar value of energy usage of other fuels was calculated in a similar fashion to how the dollar value of solar production was calculated. Local prices were used when available. Otherwise, state or national prices were used. For other fuels, costs were calculated utilizing average fuel cost data from GBR. GBR has costs for propane, natural gas, and fuel oil. The default electricity rate is obtained for an individual address from NREL, if available. If not, state averages of electricity rates are obtained from the [U.S. Energy Information Association](#). Natural gas, propane, and fuel oil rates are based on state averages from the U.S. Energy Information Administration.

To provide an estimate of the relative energy savings of the solar system, percent savings were estimated for three metrics that were computed for each home: estimated annual source energy, estimated annual GHG emissions, and estimated annual energy cost. These percentages were computed using the solar production value in the numerator and the total baseline home consumption value in the denominator.

Methodology for Project GHG Accounting

The methodology estimated the scope 2 (indirect) GHG emission reductions from avoided electricity purchases due to the installation of residential solar photovoltaic systems. The GHG methodology used was based on emission-related data from the EPA.

To estimate emissions avoided from a variety of energy savings methods, the EPA has developed AVERT which uses statistical analysis of recent emissions data from electricity generation plants as reported to the EPA's Air Markets Program Data and National Emissions Inventory. AVERT provides emission rates for each subregion of the US. With the greater insight that hourly analysis provides, AVERT is able to provide estimates of avoided emission rates for six different categories of energy savings: onshore wind energy, offshore wind energy, rooftop-scale photovoltaic installations, utility-scale photovoltaic installations, portfolio energy efficiency (EE) programs, and baseload EE programs. The carbon profile of each category is different because the time of day of the electricity production offset varies for each category. The methodology used the subregional emission rates for rooftop-scale photovoltaic installations.

For each installation the calculation for estimated avoided GHG emissions was modeled as:

Annual Avoided GHG (Metric Tons CO₂e) = **Annual Solar Production** (kWh) × **Emission Rate** (Metric Tons CO₂e/kWh),

Where the "Emission Rate" is the Annualized AVERT Emission Rate for the subregion where the solar system was installed.

The Annualized AVERT Emission Rate for any subregion is typically higher than the average emission rate for electricity in that region. This means that a solar system could be sized to produce less than a home's estimated electricity usage and the solar system could have avoided emissions that are higher than the emissions associated with the home's electricity consumption. Although that GHG impact may be a real impact at the societal level when taking into account the complex ways in which the electrical grid is managed, the methodology capped the estimated avoided GHG emissions for any given residential solar system at the estimated GHG emissions associated with electricity usage at the home where the system was installed.



Contact Us

For additional information, please contact the Freddie Mac Investor Inquiry team at investor_inquiry@freddiemac.com

Disclaimers

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