Freddie Mac
SINGLE-FAMILY

Green MBS Impact Report

2022

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Executive Letter

Freddie Mac's corporate strategic priorities and mission focus are supported by integrating environmental, social, and governance (ESG) considerations into our business and operations. We are expanding on the work we started in 2019 with our GreenCHOICE Mortgage® offering to promote environmentally sustainable single-family housing to help reduce climate-related risks and increase affordability. These efforts were magnified with our initial issuance of Green mortgage-backed securities (MBS) in 2021.

In 2022, we expanded our eligible collateral for Green MBS to include loans backed by newly constructed homes with a qualifying Home Energy Rating System (HERS) rating, enabling us to support additional borrowers through this program. We believe including mortgages backed by energy efficient new construction homes in Green MBS could bolster the emerging ecosystem of builders and raters of green homes by bringing investor focus to the product. This could, in turn, bring down costs through favorable mortgage pricing and potentially create more supply of and demand for these energy-efficient homes, reducing the environmental impact of the building sector overall.

As a company we are joining a growing movement of investors and other capital markets participants working to develop a more robust market for ESG-focused investments. The size of our Green MBS issuance doubled from 2021 to 2022, with our growth reflecting growing market demand for this type of product. We are paying attention to the needs of our stakeholders so we can effectively make home possible for more individuals and families.

We will continue to grow our presence and help establish standards in this market for the benefit of those we serve and our planet, while managing enterprise risks and opportunities. Our activities in this space make Freddie Mac a leader in a growing market, help borrowers save money by reducing energy bills over time, and help the environment through reduced energy consumption and lower greenhouse gas (GHG) emissions.

Mark Hanson
Senior Vice President – Securitization

Mark Hanson

About Us

Freddie Mac's mission is to make home possible for families across the nation. Since 1970, we have helped tens of millions of families buy, rent or keep their home.

What We Do

We are a congressionally chartered corporation with a public mission to promote liquidity, stability and affordability in the housing market throughout all economic cycles.

- **Liquidity:** We keep mortgage money flowing through the housing market in communities from coast to coast, including cities, rural areas and underserved areas.
- **Stability:** Our support for the housing market in all economic environments helps families rent, buy and keep homes they can afford.
- **Affordability:** We are committed to creating a more affordable, sustainable and equitable housing finance system. We are also working on ways to address the lack of affordable housing supply through creation, preservation and rehabilitation.

Freddie Mac operates in the U.S. secondary mortgage market, buying responsible, sustainable loans from approved single-family and multifamily lenders. We then pool the mortgages into securities and sell them to a diverse set of investors from all over the world. This process enables us to buy more loans from lenders who can in turn help more families buy or rent a home. We serve this role throughout the cycle, in good times and bad.

Our Mission and Strategic Priorities

Freddie Mac has four strategic priorities, each of which was created to ensure we fully serve our mission:

- Deliver on affordable housing.
- Identify, assess and manage our risks.
- Grow, develop and empower talent – for today and tomorrow.
- Build financial strength to serve our mission.

These strategic priorities help us create a more liquid, stable, affordable and equitable housing finance system that serves lenders, families and the housing market. And, as with any mission-driven company, our people are at the center of all we do.

Our 2022 Impact

In a year with significant volatility and a challenging macroeconomic environment, Freddie Mac made home possible for 2.5 million families, while delivering solid financial results. Looking ahead, we will implement our affordable, sustainable and equitable housing plans without compromising safety and soundness. Specifically, Freddie Mac:

- Provided $614 billion in liquidity to the housing market through more than 1,000 lenders.
- Financed approximately one million home purchases, with more than half of the owner-occupied homes affordable to low- and moderate-income families.
- Financed 695,000 rental units, 96 percent of which were affordable to families earning no more than 120 percent of area median income (AMI).

Our Business

Since 2008, Freddie Mac has been operating in conservatorship, with the Federal Housing Finance Agency (FHFA) as conservator. FHFA is also our regulator. For more information, see "Conservatorship and Related Matters" in our 2022 Annual Report on Form 10-K (2022 Annual Report).

We execute on our mission and ESG strategy through two business segments:

Freddie Mac SINGLE-FAMILY

Freddie Mac MULTIFAMILY

For more information, see "Our Business Segments" in our 2022 Annual Report.

Additional information about the ESG activities in our Multifamily segment can be found in our Multifamily 2022 Impact Bonds Report

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 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 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 reviews 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" in our 2022 Annual Report.

Freddie Mac Sustainability Strategy

Freddie Mac's mission is to provide liquidity, stability, and affordability to the housing market. We interpret that mission expansively, including integrating ESG strategies into our business and operations, which we accomplish through four areas of focus. These focus areas are informed by a robust materiality assessment completed in 2020 to identify and prioritize ESG issues of importance to our stakeholders, long-term business, and mission. Consistent with best practices, we periodically refresh our materiality assessment to ensure we are focusing on our most significant ESG risks and opportunities and are doing so again in 2023.

As of 2022, our focus areas were as follows:

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

People

Diversity, Equity, and Inclusion: 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

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

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 Single-Family 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. The Light Green rating is allocated to transition activities that do not lock in emissions. These projects reduce emissions or have other environmental benefits in the near term rather than representing low carbon and climate resilient long-term solutions. More information on CICERO ratings can be found at https://cicero.green/green-bonds.

In its second opinion on our Framework, CICERO noted that, "the framework supports investment in new and existing homes with installed renewable energy systems … helping to align the U.S. housing stock's energy usage with a 1.5-degree climate scenario." CICERO 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." In relation to our homes with an energy efficiency rating CICERO said, "Improving building energy efficiency is an important aspect of the low carbon transition."

The Framework addresses the four core components of ICMA's Green Bonds Principles:

- Use of Proceeds
- Process for Project Evaluation and Selection
- 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 company supporting the 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-efficient home improvements, helping more families attain and maintain affordability and reduce environmental impacts.

In April 2021, Single-Family issued our first Green MBS. Each Single-Family Green MBS issued in 2021 was 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.

With the publication of our Framework in January 2022, we expanded the Single-Family Green MBS eligibility criteria to include

new construction with a renewable energy source or a qualifying energy efficiency rating. In the Single-Family Green MBS issued in 2022, we included mortgages backed by newly constructed homes with a HERS Index Score of 60 or less, in addition to refinance mortgages that paid off existing debt that was used to finance the purchase and installation of solar panels.

The HERS Index was created and is maintained by the Residential Energy Services Network (RESNET). The HERS Index is an industry standard for measuring a home's energy efficiency and is recognized by the U.S. Department of Energy (DOE) and the Environmental Protection Agency (EPA). As of February 2023, approximately 3.7 million homes in the United States have been issued a HERS Index Score.

The process for obtaining a HERS Index Score includes a certified RESNET HERS Rater assessing the energy efficiency of a home using energy modeling software which produces a relative performance score. The lower the number, the more energy-efficient the home. A home built to the 2006 International Energy Conservation Code (IECC) is awarded a rating of 100. A home with a HERS Index Score of 60 is roughly 40% more energy efficient than the reference home built to the 2006 IECC.

The HERS Index was chosen because of its industry recognition and the foundational basis it serves for other energy certifications. In addition to being recognized by the DOE and EPA the rating is used as an input for Energy Star certification. RESNET also maintains a national registry of all HERS ratings and can connect with entities to share that information, so the standard is scalable. Freddie Mac chose the HERS Index level of 60 because it is comparable to the efficiency associated with the Energy Star v3.1 certification, which has a target range that generally corresponds to HERS scores between 55 and 65[1].

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. In 2022, we issued approximately $1.4 billion in Single-Family Green MBS, bringing our total issuance to almost $2 billion.

Process for Project Evaluation and Selection

All Green MBS issued in 2022 were backed by mortgages secured by newly constructed homes with a qualifying HERS score or 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.

- For mortgages with an eligible HERS score, the sellers represented to Freddie Mac that the home received a qualifying score. Before we pool and issue new Green MBS, we validate the required HERS scores on the properties securing each of the mortgages to be pooled in a Single-Family Green MBS.
- For GreenCHOICE mortgages, the sellers represented to Freddie Mac that the refinance proceeds were used to pay off debt used to finance renewable energy improvements. Similar to the process we use to confirm HERS scores, we validate the presence of a renewable energy source installed on the properties securing each of the mortgages included in Single-Family Green MBS.

[1] Raising the Bar: Advancing the Versions of the ENERGY STAR Residential New Construction Programs

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. Like all of our MBS offerings, our Single-Family Green MBS only contain mortgages that comply with 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 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.

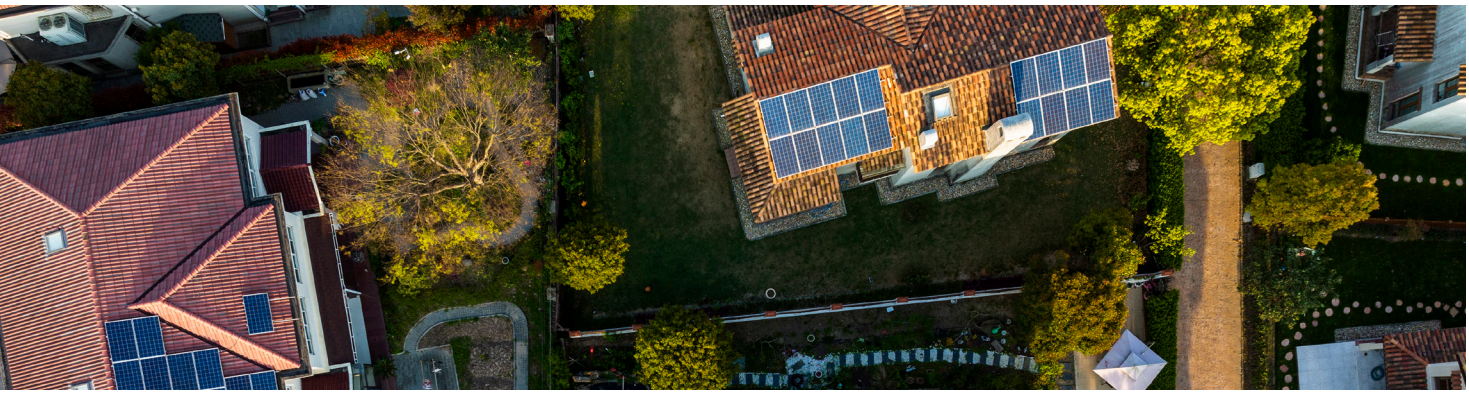
2022 Freddie Mac Single-Family Green MBS Issuance

	Number of Securities	Number of Loans	Original Unpaid Principal Balance ($M)
January-22	11	701	$201
February-22	3	603	$211
March-22	7	598	$207
April-22	8	433	$142
May-22	0	0	$0
June-22	8	314	$104
July-22	3	286	$104
August-22	2	123	$46
September-22	6	458	$167
October-22	7	215	$87
November-22	0	0	$0
December-22	7	251	$103
Total 2022	**62**	**3,982**	**$1,372**
Total 2021	84	2,454	$617
% Change	-26%	62%	122%
Grand Total	**146**	**6,436**	**$1,989**

Summary of Estimated Impact[2]

208,972 MMBtu of estimated source energy saved annually. This is enough energy to power 2,057 homes and represents an estimated 30% average decrease in total source energy consumed by these homes.[3]	**11,793 metric tons of estimated GHG emissions avoided annually.** This is equivalent to removing 2,624 cars from the road for a year and represents an estimated 37% decrease in total GHG emissions resulting from energy consumption at these homes.[4]	**$716 of estimated average annual utility cost savings for homeowners.** This represents an estimated 31% average decrease in total annual utility bills for these borrowers.

In our first year of Green MBS issuance including mortgages backed by newly constructed homes with a qualifying HERS score, the actual energy efficiency of these HERS-rated homes exceeded the threshold set forth in our framework. Across all 3,164 homes with qualifying HERS scores backing mortgages included in Green MBS issued in 2022 the average HERS score was 53.8, 48% of loans had a score of 55 or better, and 25% had a score of 52 or better.



[2] Estimated impacts related to Single-Family Green MBS issued in 2022. All estimated impact statistics are calculated using the methodology described in the Appendix. Previously reported estimates for energy savings, greenhouse gas emissions reductions and utility cost savings have been updated to reflect the correct inputs to the calculation of these estimates.

[3] In 2021, the average annual electricity consumption for a U.S. residential utility customer was 10,632 kilowatt hours (kWh), an average of about 886 kWh per month (https://www.eia.gov/tools/faqs/faq.php?id=97&t=3).

[4] Calculated using EPA GHG Equivalencies Calculator (https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator).

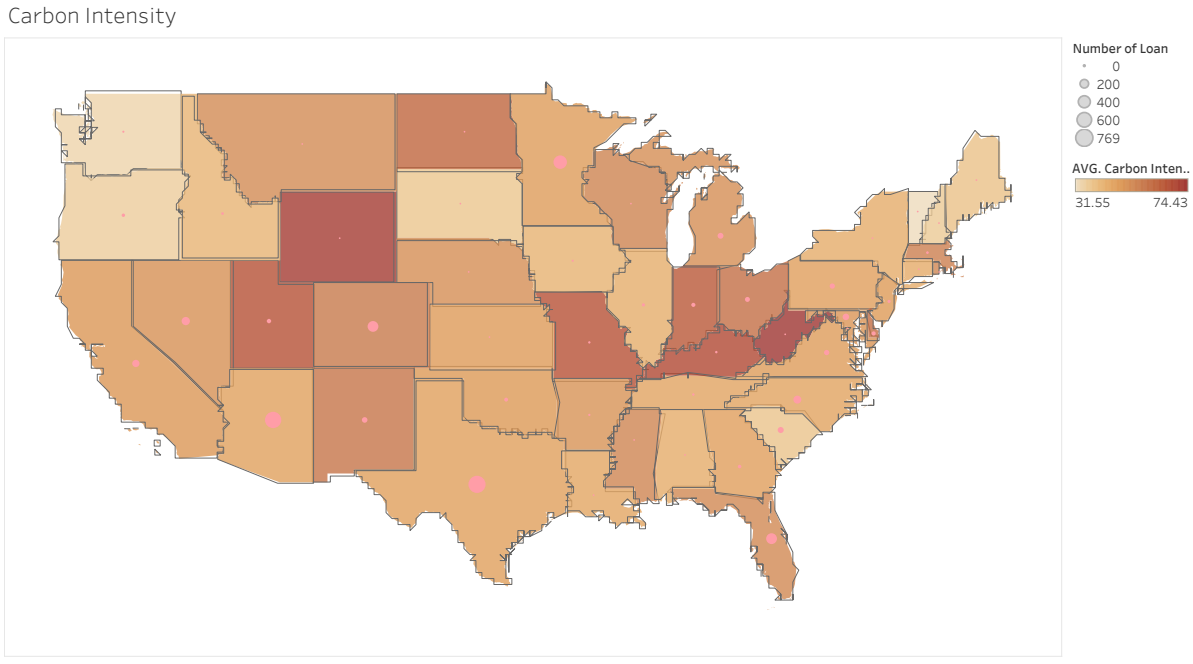
Benefits of Green Improvements

While 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 in cases where the property's source energy comes from a more carbon-intensive generation mix, such as coal or natural gas. The utility cost savings of home energy improvements for individual families can also be greater in markets where energy costs are higher.

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 to generate energy 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 2022, relative to the carbon intensity of the energy supply within that state. States with a more carbon-intensive energy supply are shaded in dark brown and states with a less carbon-intensive energy supply are shaded in light brown. 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 2020 U.S. Energy Information Administration Energy-Related Carbon Dioxide Emissions by State data, https://www.eia.gov/environment/emissions/state/excel/table6.xlsx

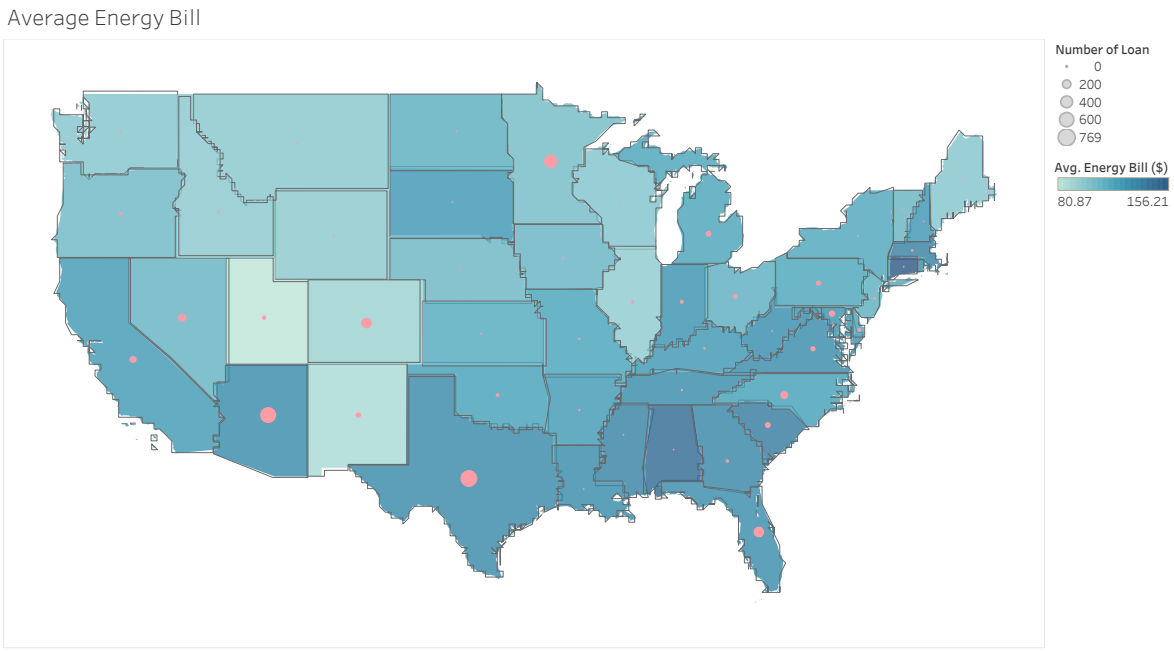
This map does not include six loans on properties located in Hawaii

We found that 1,316 properties, representing 33% of properties with mortgages included in Green MBS issued in 2022, were in states with a carbon intensity of energy supply greater than the national average of 49.5 kg of C02 per million Btu (kg C02/MMBtu). In addition, 230, or 5.8%, of these properties were in states that were among the 10 highest in terms of carbon intensity of energy supply, with an average carbon intensity of energy supply over 59.5 kg C02/MMBtu. For comparison, 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 and 19.8% were in states that were among the 10 highest in terms of carbon intensity of energy production. Improvements made on properties in these states can be expected to have a

greater contribution to the community's overall health and provide a greater impact on GHG emissions than improvements made on properties in states where the carbon intensity of the energy supply is lower.

Utility Cost 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 2022. 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 2021 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

This map does not include six loans on properties located in Hawaii

The national average electric utility bill is $121 per month. By comparison, the average electric utility bill for the 10 states with the most expensive electricity bills is $142 per month, or 17% higher than the national average. A total of 58% (2,310 loans) of the mortgages included in Green MBS issued in 2022 were made to borrowers who live in states with above average electricity bills. Our analysis shows that 1,613 mortgages, or 40.5% of mortgages included in Green MBS issued in 2022, were made to borrowers in the 10 states with the highest average electricity bills. For comparison, 40% of properties with mortgages included in Green MBS issued in 2021 were in states with above average energy bills and 31.4% were in states that were among the 10 highest in terms of average electricity bills.

Transparency to Investors

To maintain transparency for the investment community, Freddie Mac provides securities disclosures, including detailed pool-level and loan-level disclosures. Freddie Mac's Single-Family Green MBS website serves as a centralized source of information related to our Single-Family Green MBS program. This web page contains an overview of eligible collateral, links to our Framework and second opinion, as well as a list of securities issued under the Green MBS Program.

Freddie Mac is also making available the estimated impacts by security for all of our Single-Family Green MBS issued in 2022 in a downloadable Excel format (Estimated Impact File). For each Green MBS security, the Estimated Impact File provides:

- Estimated annual savings in source energy (based on estimated energy produced by photovoltaic (PV) systems or estimated energy saved due to the energy efficiency of properties with HERS scores);
- Estimated annual GHG emissions avoided; and
- Estimated annual utility cost savings for borrowers.

Appendix - Methodology[5]

To calculate the metrics described in this report, Earth Advantage® developed a methodology in consultation with Freddie Mac. Earth Advantage also developed a web-based tool to calculate the metrics at the individual property and security level for all of the Freddie Mac Single-Family Green MBS issued in 2022. Since last year's report, the methodology has changed with the addition of a new methodology to calculate the estimated impact of new construction homes with a qualifying HERS score.

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 20,000 multifamily residences and has provided professional training to over 19,000 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.

Our methodology analyzed and calculated the estimated impact of (i) solar energy production systems located at single-family residential properties for which a mortgage has been originated that repaid a consumer loan that had financed the homeowner-owned system and (ii) energy efficiency features on single-family new construction homes with a qualifying HERS rating. 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 2022 by ICMA, we are making the methodology publicly available and transparent.

Estimation of the Energy Production and Energy Savings in kWh and Dollar Value of Estimated Utility Cost Savings for Borrowers

To estimate the amount of energy produced by the solar systems on the relevant homes, the methodology used calculations from PVWatts®, a tool developed by the National Renewable Energy Laboratory (NREL)[6] , which has become a standard of the solar industry to estimate the annual energy production from a solar installation given the system's location and basic description. PVWatts considers the physical characteristics of a solar array, including the rated capacity of the solar array in kW, the tilt of the panels, the azimuth of the array, any shading affecting the array, and the efficiency of the system. Additionally, PVWatts accounts for the amount of solar energy that reaches a given geographical area on an average basis. Solar installers in the U.S. generally utilize PVWatts to predict solar energy production 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 the estimated amount of energy actually produced by the system divided by the nameplate production capacity of the system in kW.

For some properties, detailed solar system information was available from the Green Building Registry (GBR), a database sourced from solar incentive programs that records certain characteristics of solar installations. For these properties, system age and energy production estimates were taken directly from GBR or the solar system's capacity was processed through PVWatts to calculate the estimated energy production for the system.

[5] 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.
[6] NREL is a national laboratory of the U.S. Department of Energy

In the absence of detailed information on a solar system, the average power factor provided by the Berkeley Tracking the Sun Program was used to estimate the energy production of the installed solar system. The Tracking the Sun public data file contains the characteristics of over 2.2 million residential PV systems. For regions of the country where an average power factor was not reported by Tracking the Sun, the PVWatts tool was utilized with the default values for tilt, azimuth, and efficiency provided by NREL. Due to the lack of verified information on the characteristics of the solar systems, the estimate of energy production for each solar system was discounted to provide a conservative value.

The age of the system was used to calculate the degradation of the system's energy production capacity as part of the PVWatts tool's calculation. PVWatts estimates system degradation at 1.5% of the system's 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 the closing of the mortgage and that a large percentage of the systems 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 energy production 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 the size of the solar system. This, again, is a conservative assumption, as the Tracking the Sun data indicates that system sizes have generally increased over time.

The estimated annual energy production value for each solar system was capped at the estimate of the annual electricity consumption for the home. Although it is possible that homeowners could install solar systems that are sized to produce more electricity than their home will consume, this would be rare because electric utility programs and net metering contracts typically do not offer additional financial incentives for installed systems that produce more energy than the home consumes.

For HERS-rated homes, the estimated energy savings was calculated by comparing (i) the HERS rating of the home with (ii) the estimated HERS rating of a "prototype" home built to the code of the same state. State-specific energy savings values for improvements in HERS ratings were computed, with separate values computed for all-electric and gas-heated homes. That savings rate was applied to the HERS index differential. i.e., the difference between the home's HERS rating and the estimated HERS rating of the prototype home in the same state. This was then multiplied by the projected energy usage for each home as reported from the RESNET registry to estimate the energy savings for each home created by being built to be more efficient than the state's energy code requirements.

To assess the estimated dollar value of the utility cost savings for borrowers of the estimated solar energy production and the estimated energy savings from energy-efficient homes, the energy production estimate for homes with solar panels and the energy savings estimate for energy-efficient homes was multiplied by the local price of electricity based on average energy prices provided by NREL's Utility Rates Database (URDB). The URDB contains average utility rates and time of use rates from over 3,700 utilities across the U.S.

All energy production and savings estimates are expressed as source energy, as described below.

Estimation of the Relative Energy Savings from Each Solar Installation

In order to estimate the relative energy savings from each solar installation, the methodology used annual energy consumption estimates provided by the NREL-Energy Cost Estimator (ECE) tool to provide baseline estimates of the energy consumption of the home, as if there were no solar panels on the home. The NREL-ECE tool was developed as a service that the appraisal, real estate, and finance industries could use to estimate the annual energy consumption of any home in the U.S. given a few data points about the home that those industries typically have available to them.

The tool provides estimates of (i) the annual energy consumption of the home in kWh and (ii) the annual amount of fuel used by the home 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 energy production from the PVWatts tool are provided as site energy values for each home. While the solar energy production value is always provided as units of electricity (kWhs), the energy consumption estimated by the NREL-ECE tool provides values for each fuel known to be used in the home. Each fuel type has its own unit of measurement which can be converted to Btus for comparison using these conversion factors:

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 estimate of the total site energy consumption for each home was calculated as the sum of the estimated amounts of each type of fuel used in the home, with each fuel converted to Btus.

Source Energy:

Different fuels consumed at a home are obtained through different systems. Some of those systems have higher rates of overall energy loss than others. Historically, the U.S. 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 United States for use within the Energy Star Portfolio Manager tool and that figure was used by the methodology. The EPA figures for site/source conversion factors of other fuels were also used.

The dollar value of energy consumption of other fuels was calculated in a similar fashion to the calculation of the dollar value of solar production. Local prices were used when available. Otherwise, state or national prices were used. 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 costs were calculated utilizing average local fuel cost data from GBR, if available, or 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 savings in source energy, estimated annual GHG emissions avoided, and estimated annual utility cost savings for borrowers. These percentages were computed using the solar production value in the numerator and the total baseline home consumption value in the denominator.

Estimation of the Relative Energy Savings for Each HERS-rated Home

In order to estimate the relative energy savings of each HERS-rated home, a code reference HERS index value for each state was established by modeling a prototype home in each state to the 301-2019 ANSI/RESNET/ICC standard, which provides a consistent, uniform methodology for evaluating and labeling the energy performance of residences. The prototype was the 3-bedroom, 2-bath home used by Pacific Northwest National Lab for standard analysis of energy code performance. The energy-related characteristics controlled by state-level codes in effect for 2021 were identified and input into the REM/Rate modeling tool. This software tool has been approved by RESNET for use by certified HERS raters to rate homes. Using this information, the tool calculated a HERS rating for a prototypical home built to code in each state and also generated the associated estimated energy consumption of that prototype home.

A code reference HERS index rating provided a comparison against the performance of a reference home built to the 2006 IECC. In general, the assumed HERS index value of a home built to the 2006 IECC is 100. For this methodology, a 3-bedroom model home was modeled to the 2006 IECC efficiency requirements and a heating-fuel-specific 2006 IECC HERS index value was created for a model home built to code in each state, along with estimated energy consumption figures. The HERS index value measures relative energy performance, where a home with a HERS of 60 is thought to have energy performance that is 40% better than the 2006 IECC. That does not necessarily translate to 40% energy savings. The level of energy savings, and the associated carbon emission reductions, will vary by the state's climate zone and the carbon intensity of the electricity supplied to the home. This methodology used the projected energy savings between the state and fuel-specific 2006 IECC reference home and the state and fuel-specific code reference home to estimate a sliding scale of energy savings by fuel type by state that can be associated with HERS index values of 60 or below. These state and fuel-specific savings coefficients were applied to estimate the savings of each home included in Green MBS by multiplying the applicable coefficient against the HERS index differential between the state code HERS reference index value and the home's confirmed HERS index value.

The relative energy savings for each home was calculated using the coefficients, described above, for each fuel type used in the home, combined with the estimated energy usage for each home from the RESNET registry. Percentage savings measures were then calculated for the same metrics as those calculated for homes with solar installations using projected consumption savings due to energy efficiency as the numerator.

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 and the construction of energy-efficient homes. 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 the Avoided Emissions and Generation Tool (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 U.S. 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 residential 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 and baseload EE programs. For each installation of solar panels and each HERS-rated home, the calculation for estimated avoided GHG emissions was modeled as:

For homes with solar panels:

> Annual Avoided GHG (Metric Tons CO2e) = Annual Solar Production (kWh) x Emission Rate (Metric Tons CO2e/kWh)[7]

For HERS-rated homes heated by electricity:

> Annual Avoided GHG (Metric Tons CO2e) = Annual Electric savings (kWh) x Emission Rate (Metric Tons CO2e/kWh)

For HERS-rated homes heated by natural gas:

> Annual Avoided GHG (Metric Tons CO2e) = Annual Electric savings (kWh) x Emission Rate (Metric Tons CO2e/kWh) + Annual gas savings (therm) x Emission Rate (Metric Tons CO2e/therm)

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. 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. This issue did not exist for homes with a qualifying HERS rating because, by definition, energy efficiency measures could never result in avoided GHG emissions in excess those associated with a home's baseline energy consumption.

Contact Us

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

Disclaimers

The metrics provided in this report and in the Estimated Impact File related to estimated source energy savings, GHG emissions avoided, and utility cost savings for borrowers were calculated using a methodology developed in coordination with Earth Advantage. The methodology uses tools that were developed by third parties and provided or recommended to us by Earth Advantage. Similarly, much of the data used in the methodology was developed or created by third parties and provided or recommended to us by Earth Advantage. We had no role in the creation of these third-party tools and data and can make no representations or warranties concerning the proper operation or design of the tools or the accuracy or completeness of the data. We may fail to properly calculate the metrics in accordance with the methodology, due to process or human error or otherwise.

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