



# Build Back Better Homes

How to Unlock America's Single-Family Green Mortgage Market

Report / March 2021



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# About Us



## About Earth Advantage

Earth Advantage is a 501(c)(3) nonprofit organization based in Portland, Oregon, that addresses the environmental impacts of residential buildings by developing and promoting green home standards, conveying green home data to the residential real estate market, and supplying training to building professionals and a growing energy efficiency workforce.



## About RMI

RMI is an independent nonprofit founded in 1982 that transforms global energy systems through market-driven solutions to align with a 1.5°C future and secure a clean, prosperous, zero-carbon future for all. We work in the world's most critical geographies and engage businesses, policymakers, communities, and NGOs to identify and scale energy system interventions that will cut greenhouse gas emissions at least 50 percent by 2030. RMI has offices in Basalt and Boulder, Colorado; New York City; Oakland, California; Washington, D.C.; and Beijing.

# Table of Contents

<b>5</b>	<b>Executive Summary</b>
<b>7</b>	<b>Introduction</b>
<b>10</b>	<b>Background</b>
<b>16</b>	<b>Green Mortgages as a Scalable, Cross-Cutting Tool</b>
<b>19</b>	<b>Recommendations to Structure Single-Family Green Mortgage-Backed Securities (MBS)</b>
<b>24</b>	<b>Methods to Scale Single-Family Green Mortgages</b>
<b>29</b>	<b>Opportunities for Federal Policymakers</b>
<b>32</b>	<b>Conclusion</b>
<b>35</b>	<b>Appendices</b>
36	Appendix A: Calculations and Assumptions
39	Appendix B: Proposed Calibration Framework for Green Mortgages
43	Appendix C: Existing Green Mortgage Origination Process Map
44	Appendix D: NREL Home Energy Cost Estimator Methodology
49	Appendix E: ResStock Representative State-Level Information
50	Appendix F: Additional Green Mortgage Product/Process Recommendations
51	Appendix G: Model Language for the GSEs' 2022-2024 Duty to Serve Plans
54	Appendix H: Residential Green and Energy-Related Data Sources
<b>56</b>	<b>Endnotes</b>



# Executive Summary



# Executive Summary

The vast majority of America's housing stock is in need of improvements—not for cosmetics, but for performance, health, and safety. Over the next decade, shifts in utility models, energy and climate policy, weather events, and recognition of health and resilience priorities will greatly expand this need. This is especially true for low- to moderate-income (LMI) households and communities of color. And yet, because the upfront costs for these kinds of improvements largely fall on homeowners, they are not likely to happen fast enough without scalable low-cost financing solutions.

Concurrently, there is growing interest and demand among capital markets investors for environmental, social, and governance (ESG) investment options and “green” securities. Financial institutions representing over \$18 trillion globally recently committed to align their portfolios with the goals of the Paris Agreement,<sup>1</sup> but they lack sufficient market-ready green investments to fully make this shift. The mortgage industry is well positioned to help fill this gap.

Mortgages can become a primary investment vehicle for deploying billions of dollars to meet this investor demand while also fulfilling consumer demand for green home improvements. Although the market for multifamily green mortgage-backed securities has grown tremendously (making Fannie Mae the largest green bond issuer in the world for the fourth consecutive year in 2020<sup>2</sup>), the single-family market has only just begun to emerge as a destination for green capital.

Innovations in housing data analysis, mortgage processing and automation, and low-interest financing products can facilitate this market transformation through the existing real estate transaction process.

**This report proposes practical solutions to reduce friction in originating and securitizing single-family green mortgage products already offered by government-sponsored enterprises Fannie Mae and Freddie Mac (the “GSEs”) to create a new \$2+ trillion market within a decade. Specifically, this report offers:**

- A framework and qualification criteria for the GSEs to structure single-family green mortgage-backed securities. This would allow green mortgages for retrofitting existing homes and for high-performing new construction to be converted into a massive new green bond market.
- Methods for the GSEs and lenders to scale single-family green mortgages. These include leveraging green home data in underwriting and appraisal processes to enable greater market efficiency (targeting dedicated additional proceeds to higher-opportunity homes and borrowers to pay for improvements) and automating systems to reduce existing burdens on lenders and appraisers.
- Opportunities for federal regulators and policymakers to support these goals, including by ensuring information transparency to correct major market failures and by climate-aligning GSE lending activities.

As the primary engines in US housing finance, Fannie Mae and Freddie Mac offer the scale and the mechanisms for market transformation. The GSEs and other housing finance leaders can capitalize on favorable market and policy trends and other key windows of opportunity underway to position this market for success.

# Introduction





The US housing market faces a dynamic set of interrelated challenges: affordability, equity, health and safety, and resilience, all in the face of an increasingly urgent climate crisis. These challenges disproportionately affect low- to moderate-income (LMI) households and communities of color. Housing market actors are not yet effectively directing resources toward addressing these issues. However, scaling readily available mortgage products can help change that by increasing access to green home improvements. This report recommends targeted interventions to scale up single-family green mortgage products offered by Fannie Mae and Freddie Mac through pathways that protect both borrowers and lenders.

A robust single-family green mortgage market can deliver significant benefits and investor-ready environmental, social, and governance (ESG) impacts. Fannie Mae and Freddie Mac could generate more than \$2 trillion of new green mortgage-backed securities (MBS) within a decade by streamlining and scaling up their existing green mortgage products to comprise 15% of their annual single-family mortgage volumes (half the penetration level achieved on the multifamily side). This would improve nearly 9 million homes across the country, generate net cost savings

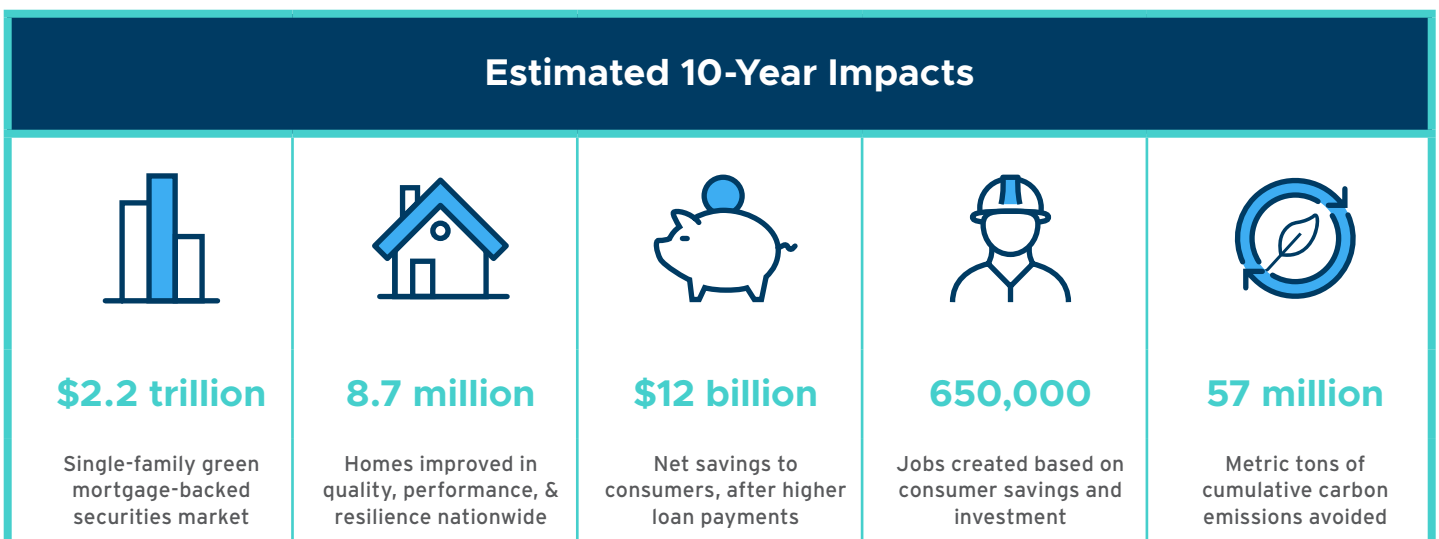
of \$12 billion for consumers, create roughly 650,000 domestic jobs, and avoid 57 million metric tons of carbon emissions (see *Appendix A* for calculation and assumption details).<sup>3</sup>

## Why Now?

Different market actors have attempted to scale versions of green or energy-efficient mortgages in the past, without much success at a national level. In recent years, however, supply-side motivation and consumer demand have become better aligned toward common goals.

Capital markets have been seeing ESG demand from investors continue to outpace supply, resulting in a modest premium (or “greenium”) for green and ESG investments like green bonds.<sup>4</sup> In the spring of 2020, Fannie Mae launched its first single-family green MBS, in part to meet such demand, sending a powerful market signal. By the end of 2020, Fannie Mae had issued \$111 million in these green bonds,<sup>5</sup> backed only by loans on ENERGY STAR® Version 3.0 certified new construction homes. However, this program can go further to include pathways for millions of existing single-family homes to benefit from green improvements.

## Exhibit 1 Estimated 10-year impacts of scaling up single-family green mortgages

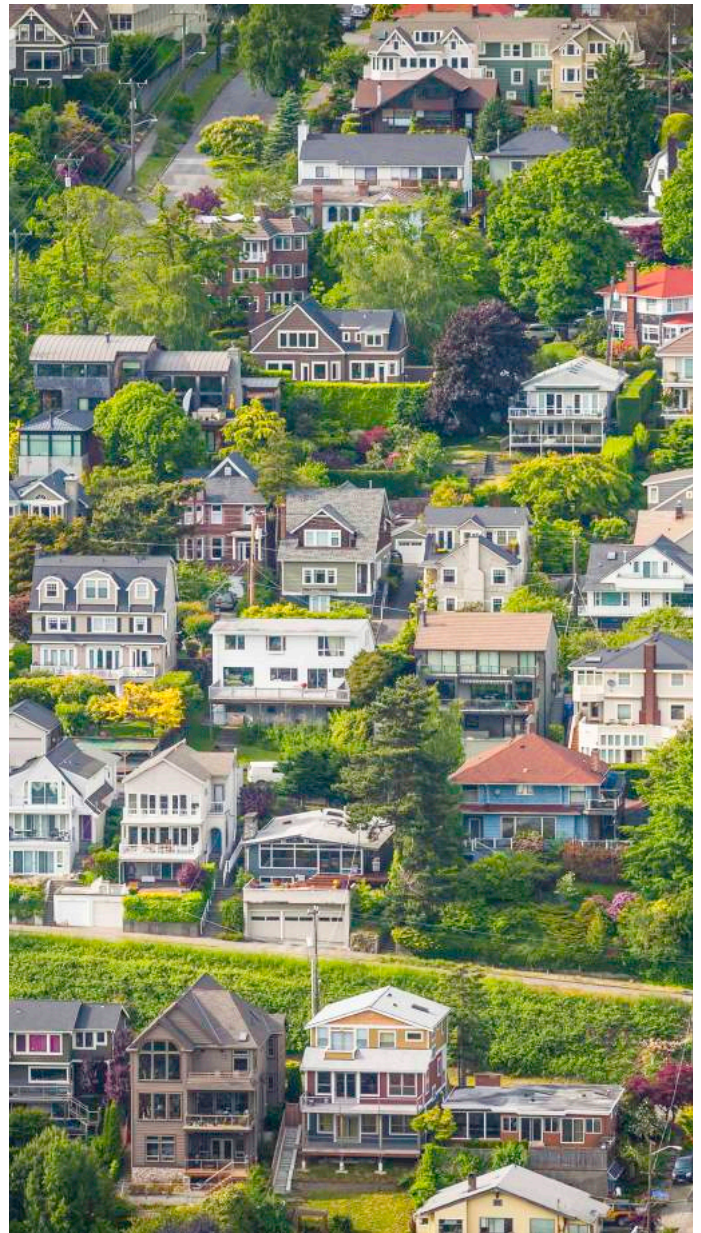




Streamlining mortgage financing for green home upgrades will also support the efforts of many large financial institutions (including some of America's top mortgage lenders) that have committed to "climate-align" their portfolios with the goals of the Paris Agreement through greener lending and investment activities.<sup>6</sup>

Additionally, there are now sophisticated, credible, and readily available home energy data systems and tools that can integrate into increasingly automated mortgage underwriting and appraisal processes. The GSEs have a timely opportunity to leverage these tools and pursue tactical policy updates to streamline single-family green mortgage adoption. The GSEs can integrate these objectives into their upcoming Duty to Serve plans (see *Appendix G*) and ensure that their ongoing Uniform Appraisal Dataset (UAD) redesign captures critical green data fields for all homes to facilitate market development.<sup>7</sup>

Now is the time to spur green products in the mortgage market: historically low interest rates are driving record high refinancing activity and can offer attractive financing terms for green upgrades that improve overall home quality and value. Finally, this opportunity aligns well with key priorities of the new Biden Administration to address inequities, housing, and the climate crisis (including stated plans to weatherize 2 million homes, retrofit 4 million buildings, and build 1.5 million affordable new homes<sup>8</sup>), which can be mutually tackled by unlocking a fair and data-driven single-family green mortgage market.



# Background



## Concurrent Housing Crises

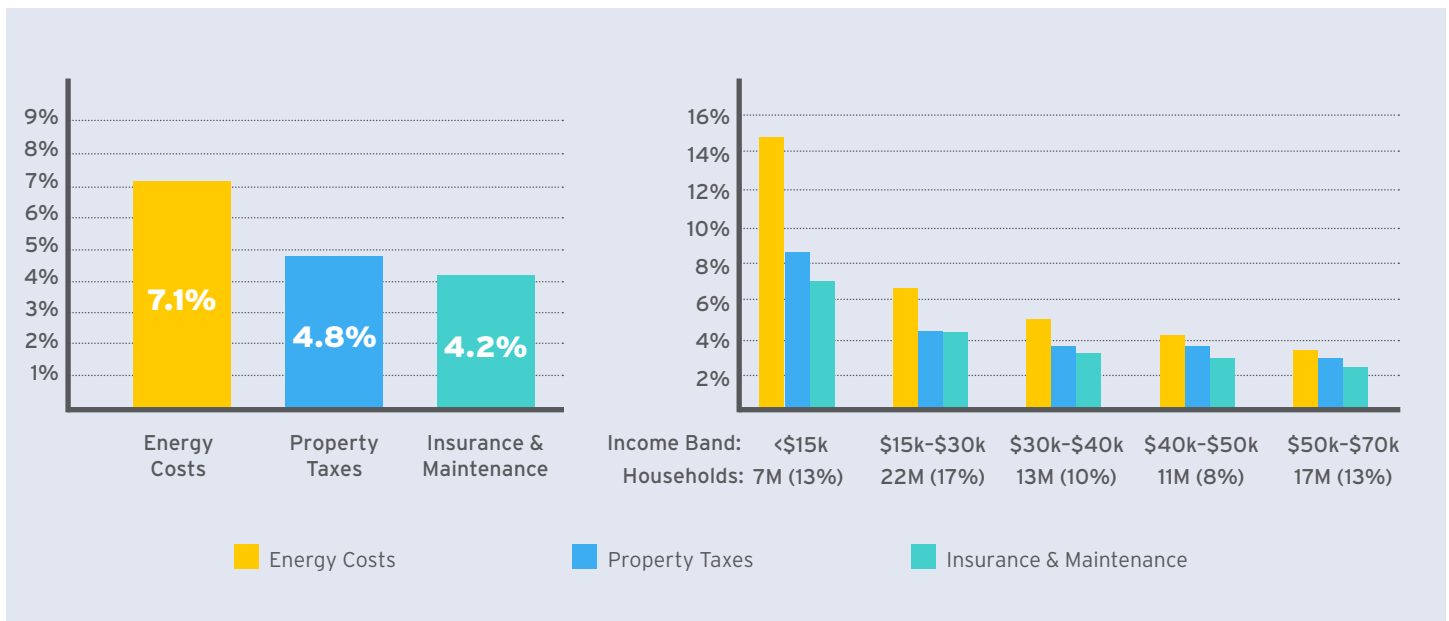
When attempting to fundamentally shift how the mortgage market works at scale, it is important to fully understand the current market's impacts and ripple effects across the economy. The solutions posed in this report will not solve every housing crisis mentioned in this section. Rather, the aim of this report is to propose solutions that can help and that, at minimum, do not exacerbate these crises. The goal of this section is to acknowledge the array of complex and interrelated housing issues affecting homeowners and residents today for consideration by the GSEs and other mortgage industry leaders, as well as policymakers, regulators, and program designers.

For most households in America, energy costs are higher than either property taxes or home insurance (as shown in the graphs below), yet these costs are not systematically included in mortgage affordability calculations.<sup>9</sup> Energy costs amount to significant

financial burdens for many Americans. Barriers to funding and financing for cost-effective housing improvements have led to persistent underinvestment in housing infrastructure, resulting in too many Americans living in substandard housing that is expensive to operate. There are more than 98 million single-family homes in the United States, roughly half of which were built before building energy codes were introduced over 40 years ago.<sup>10</sup>

Poor energy performance is really a symptom of larger housing crises concurrently impacting American homeowners and renters. Today's housing affordability crisis, often concentrated in densely populated urban areas, is due in large part to a lack of supply.<sup>11</sup> This issue is especially pronounced in rental housing, where in recent decades, the real income of renters has not risen at the same rate as rental costs.<sup>12</sup> Although housing prices have increased over time, asset quality of existing homes has largely stalled or declined due to aging features and typical wear and tear.

### Exhibit 2 Average expenditures as % of net income for the 80 million households earning <\$70k/year



Source: US Bureau of Labor Statistics, Consumer Expenditure Survey 2019



This creates situations where both a home's upfront costs and maintenance costs rise, compounding the cost pressure on home buyers and renters.<sup>13</sup> In addition, inefficient homes are not only more expensive to operate, but on average also have worse indoor air quality that can increase occupants' healthcare costs. Without convenient and affordable capital investments, these properties face higher risks in terms of energy costs, health threats, and loan performance.

Increasingly frequent extreme weather events pose additional risks. Older homes with deferred maintenance may be more susceptible to significant damage from high winds, heavy rainstorms, smoke from wildfires, and extreme temperatures during heat waves and cold snaps. According to the National Oceanic and Atmospheric Administration (NOAA), 2020 was the sixth consecutive year with ten or more billion-dollar weather and climate disaster events in the United States.<sup>14</sup> In 2020 alone these disasters caused \$95 billion in damage nationwide, almost doubling the damage in 2019.<sup>15</sup> As a result, insurance costs to cover damages have been increasing or becoming entirely unavailable to some homes.<sup>16</sup>

A recent report commissioned by the Commodity Futures Trading Commission issued stark warnings about the impacts of climate change on financial markets for these same reasons.<sup>17</sup> Fortunately, the most exhaustive cost-benefit analysis of natural hazard mitigation to date found that every \$1 invested in home retrofits to protect against floods and hurricanes can save \$6 (every \$1 invested in retrofits to protect against fires and earthquakes can save \$2 and \$13 respectively).<sup>18</sup>

These housing risks disproportionately impact lower-income households and households of color. Nearly 31 million US households face high energy burdens (i.e., spend more than 6% of their income on utility bills, roughly double the national average). And a staggering 16 million US households face severe energy burdens (i.e., spend more than 10% of their income on energy).<sup>19</sup> Approximately 25 million households have reported foregoing necessities like food or medicine to pay their energy bills (7 million of which face that decision on a monthly basis).<sup>20</sup>

High energy burdens can also lead households to dangerous situations, such as using ovens for heat or risking unsafe indoor temperatures. These burdens are particularly concentrated in communities of color: the median energy burden for Black households is 43% higher, and for Hispanic households 20% higher, than for non-Hispanic White households.<sup>21</sup>

There has been a long history of racist housing and lending policies and practices (including but not limited to: New Deal enforced segregation, redlining, restrictive covenants, biased appraisals, and real estate agent steering). This has resulted in households of color disproportionately making up lower-income households and occupying lower quality housing in the United States.<sup>22</sup> Intergenerational wealth is often generated in families through homeownership (and the financial security that assets can provide). Thus, strategies that can upgrade existing housing and reduce the costs of, while increasing access to, homeownership can be particularly beneficial for households that have been precluded from such wealth accrual opportunities.

It has been found that the median White household has nearly 20 times more wealth than the median Black household.<sup>23</sup> And although 73% of White households own their home, only 41% of Black households do.<sup>24</sup> Additionally, communities of color are more geographically concentrated in regions where land prices have been increasing rapidly, contributing to displacement as property taxes rise. These communities are also often more exposed to, and harder hit by, the fallout from natural disasters and extreme weather, and are more likely to live close to power plants and high-pollution areas.<sup>25</sup> This leads to higher rates of health complications and particularly asthma, which affects Black children at more than double the rate of White children (16% versus 7%).<sup>26</sup>

Meanwhile, the backdrop behind all these challenges is an increasingly urgent climate crisis. The scientific consensus is clear: to avoid the catastrophic effects of climate change, we must limit global temperature rise to 1.5°C, which will require a 50% reduction in global emissions by 2030 compared with 2010 and net-zero global emissions by 2050.<sup>27</sup>



Household energy use accounts for roughly 20% of all US greenhouse gas emissions. However, our homes represent a critical segment of the economy that is not decarbonizing at nearly the rate required.<sup>28</sup> A lack of information transparency and awareness, market signals and incentives, and scalable low-cost financing solutions all contribute to stagnant residential sector progress on climate and equity issues. Failure to change this trajectory will mean substantial risk to both the housing stock and the mortgage and insurance industries in the years ahead.

## Single-Family Market Context

Together, Fannie Mae and Freddie Mac back nearly half of all single-family mortgage originations, to the tune of approximately \$1 trillion per year.<sup>29</sup> The GSEs are federally backed home mortgage companies that buy single-family and multifamily mortgages originated by lenders across the country, guarantee their principal and interest payments, and then repackage and sell them as mortgage-backed securities (MBS) on the secondary market. This makes the mortgage market more liquid, stable, and affordable. To that end, they also standardize requirements to which lenders and appraisers nationwide conform.

Between 2009 and 2019, annual mortgage origination volume averaged \$1.8 trillion for one- to four-unit residential buildings, split roughly equally between refinance and purchase products.<sup>30</sup> Yet only a tiny fraction of this volume prioritized getting families into homes with low energy costs or improving the housing stock. In 2018, only 3% of the total mortgage loan volume was in home improvement financing products, and limited data suggests only a small portion of these are dedicated to green home improvements.<sup>31</sup>

Fannie Mae and Freddie Mac both offer green mortgage products that finance energy (and other green) improvements, but neither have been

effectively adopted by lenders at scale to allow widespread access. Furthermore, neither GSE has yet identified a full framework for green improvement financing of *existing* homes to be included in single-family green MBS; Fannie Mae's new single-family green MBS program currently only covers ENERGY STAR certified new construction homes.

Although the percentages of mortgage loan volume including home improvement costs so far are small, the total potential for financing green home improvements is compelling. To put this market in context, the total annual budget of the Weatherization Assistance Program (WAP)—the US government's energy improvement assistance program for low-income families—is \$1.1 billion, less than 2% of the annual volume of home improvement mortgage loans.<sup>i</sup> Adding in the total annual amount spent on residential energy efficiency through all utility-funded programs nationwide, this volume of annual spending is still only about 6% of the existing home improvement mortgage loan market size, or only 0.18% of the total annual mortgage market by volume.<sup>ii</sup>

Unlocking even a fraction of the existing single-family mortgage market to enable streamlined access to low-interest financing for green improvements will help millions more residents access the benefits of higher-performing homes. Given the significant potential for cost-effective green home upgrades, a substantial portion of the GSEs' single-family mortgage issuance could become green within 10 years.

Today, homeowners are spending money on home improvements, but typically need to seek out upgrade packages, financing, and products on their own. According to Harvard's Joint Center for Housing Studies report, *Improving America's Housing 2019*, US homeowners spent \$68 billion in 2017 on improvements to roofing, siding, windows, doors, HVAC systems, and insulation—all projects that could generate meaningful home energy savings if more

<sup>i</sup> 2018 home improvement loans were \$60 billion; WAP in FY18 totaled \$1.1 billion (\$250M from DOE, \$453M from LIHEAP, \$407M from nonfederal sources).

<sup>ii</sup> Utility energy efficiency program spending on residential programs was slightly under \$3 billion in 2018: <https://www.eia.gov/todayinenergy/detail.php?id=42975>

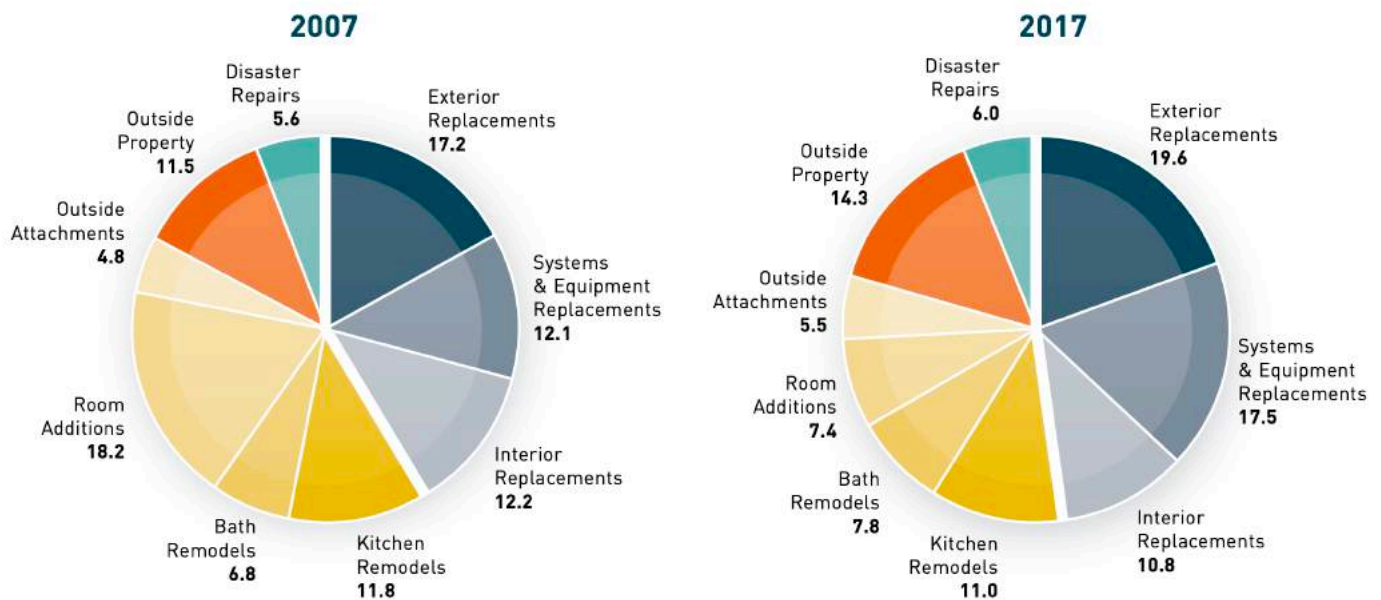
efficient options are installed. Such systems and equipment replacements were the fastest growing segment of the home improvement market in recent years (see pie charts below).

Notably, US homeowners used cash from savings to pay for 77% of home improvement projects, with the next largest sources being credit cards or retail store charge cards. This paradigm disproportionately

excludes lower-income households that do not have the savings or credit to pay for these upgrades. The report concludes that the share of replacement projects is likely to remain high in the coming decade as the housing stock ages, and that offering homeowners additional financing options (in lieu of cash savings) would likely lead to significantly stronger growth in improvement expenditures.<sup>32</sup>

### Exhibit 3 Replacement projects take up a growing share of homeowner improvement budgets

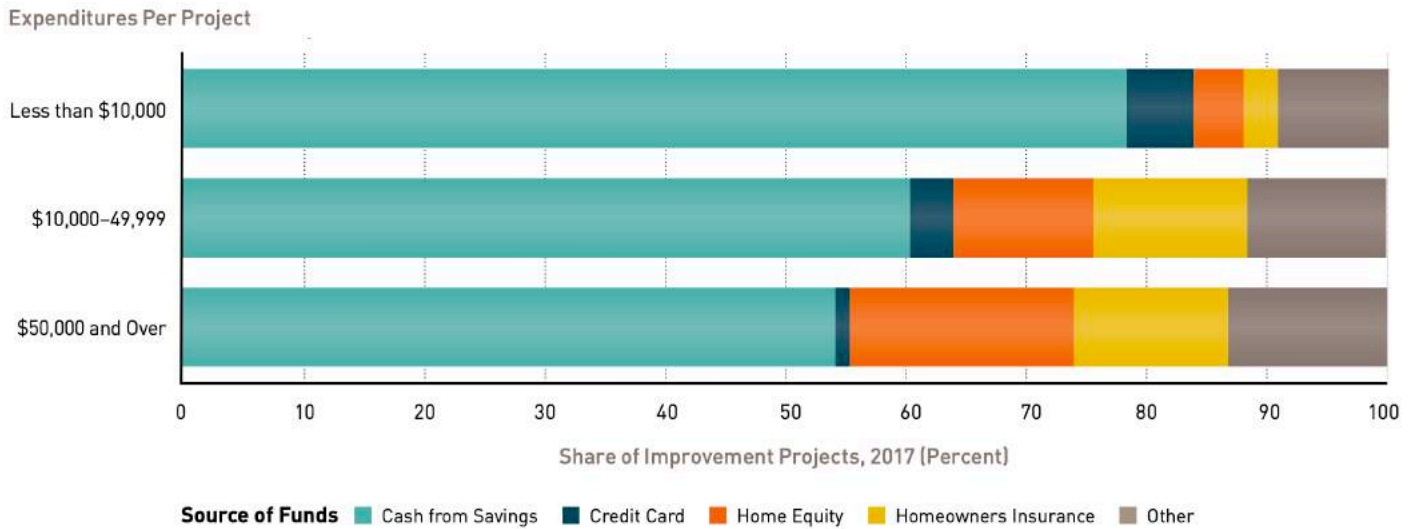
Share of Home Improvement Spending (Percent)



**Notes:** Replacements include exterior, systems and equipment, and interior projects. Discretionary projects include kitchen and bath remodels, room additions, and outside attachments. See Table A-1 in Harvard’s Joint Center for Housing Studies report, *Improving America’s Housing 2019*, for more detailed definitions of project categories. Homeowner improvement spending totaled \$220 billion in 2007 and \$233 billion in 2017.

**Source:** *Improving America’s Housing 2019*, Joint Center for Housing Studies of Harvard University.

## Exhibit 4 Most homeowners rely on cash from savings to finance improvements



**Notes:** Credit Card category includes retail store charge cards. Home Equity includes cash from refinancing, home equity loans, and home equity lines of credit. Other includes contractor-arranged financing and all other funding sources, including those not reported.

**Source:** *Improving America's Housing 2019*, Joint Center for Housing Studies of Harvard University.

In addition to replacements, national surveys show that consumers want energy efficiency in their homes but the market is not yet meeting that demand. In a Demand Institute survey of more than 10,000 households, increased energy efficiency was the number one housing desire, ranked according to the size of the “satisfaction gap.” In other words, 71% of respondents thought energy efficiency is important but only 35% were satisfied with their current home. Increased energy efficiency was ranked higher than updated kitchens and finishes, safe streets, privacy, and more.<sup>33</sup>

Key findings from the National Association of REALTORS’ latest annual survey of its members include that: 70% of agents and brokers reported that energy efficiency promotion in listings is valuable and 61% found that consumers are interested in sustainability. Yet 61% were not confident connecting clients with green lenders, and the highest ranked market issue (from a list of 13 issues) is “understanding lending options for energy upgrades or solar installations.”<sup>34</sup>

# Green Mortgages as a Scalable, Cross- Cutting Tool





These trends point to a compelling opportunity for green mortgages to overtake a substantial market share in the years ahead, if the delivery process can be sufficiently streamlined and scaled. A viable solution requires the right mortgage products and the right processes to make delivering those products easy, targeted, and scalable. The right products are largely in place now, but process improvements are still needed so that these products can become standard offerings to borrowers. The following sections of this report discuss how to better activate the market for deployment.

Fannie Mae's HomeStyle® Energy mortgage and Freddie Mac's GreenCHOICE® mortgage allow borrowers to use mortgage proceeds to finance the cost of green single-family home improvements when purchasing or refinancing a home, up to 15% of its "as-completed" value. Eligible improvements within their "green" scope include energy efficiency measures (e.g., air sealing, insulation, high-efficiency windows and HVAC equipment), water efficiency measures (e.g., low-flow fixtures), renewable energy

(e.g., solar panels), and also resilience improvements (e.g., hazardous brush and tree removal in fire zones, storm surge barriers and retaining walls, foundation retrofitting for earthquakes).

They also permit homeowners to finance certain pre-existing debt related to green improvements (e.g., from residential PACE,<sup>iii</sup> utility efficiency programs, consumer loans), rolling those pre-spent dollars into the new mortgage. This takeout mechanism can enable the GSEs to play a role in providing liquidity for other green home financing providers in the marketplace. This can free up more capital for those actors to redeploy within their programs while affording borrowers the lower interest rates of a mortgage product.

These types of green home improvements are not a comprehensive solution for all the housing crises described above. However, when well-implemented, they can meaningfully improve affordability and health and safety outcomes for borrowing households, while also reducing loan performance risk and climate risk at scale. Given the housing and energy burdens that



<sup>iii</sup> Property-assessed clean energy, a loan product financed through the property's tax assessment.

LMI households and households of color often face, these groups can benefit significantly from well-designed and consumer-protected financing products. At current historically low interest rates, mortgage products offer what may be the most affordable financing available for such projects. When offered through standard real estate transaction and refinance processes, these mortgage products can scale to impact millions of homes each year.

*Appendix A* includes an example of project-level financial benefits for households that finance energy- and/or water-saving green home improvements through green mortgages at a basic level (15% savings) and deeper level (25% savings). In practice these figures will vary depending on the measures and technologies installed. A household could realize average annual net savings (i.e., utility cost savings offset by slightly higher mortgage payments, assuming the full project size is added to the mortgage balance) of \$314 after a basic retrofit and \$326 after a deeper retrofit based on the assumptions in *Appendix A*. The GSEs and/or lenders can set up automated checks to confirm that expected net savings are estimated to be positive for borrowers upfront to better protect consumers. Note that these examples do not take into account other potential value streams, such as reduced health and safety costs or increased home value.

Green homes offer more than just utility cost savings. Residents also benefit from improved comfort and indoor air quality, increased resilience to environmental disasters, and reduced carbon emissions.<sup>35</sup> Green homes also have the potential to experience reduced loan default rates: one study covering a time period that included the Great Recession found 32% lower default rates for energy-efficient homes than non-energy-efficient homes.<sup>36</sup>

Freddie Mac's own analysis found that RESNET's Home Energy Rating System (HERS) rated homes sold for 2.7% more than comparable unrated homes, and that better-rated homes sold for 3%-5% more than lesser-rated homes. Additionally, the study showed that loans with high debt-to-income ratios (45% or above) with ratings appear to have lower delinquency rates than unrated homes.<sup>37</sup> A separate meta-analysis of dozens of valuation studies found a 4.3% value premium for certified green homes.<sup>38</sup> Given that appraisal standards do not yet explicitly account for home performance, this premium is likely based on perception and may be understated.



# Recommendations to Structure Single- Family Green Mortgage-Backed Securities (MBS)



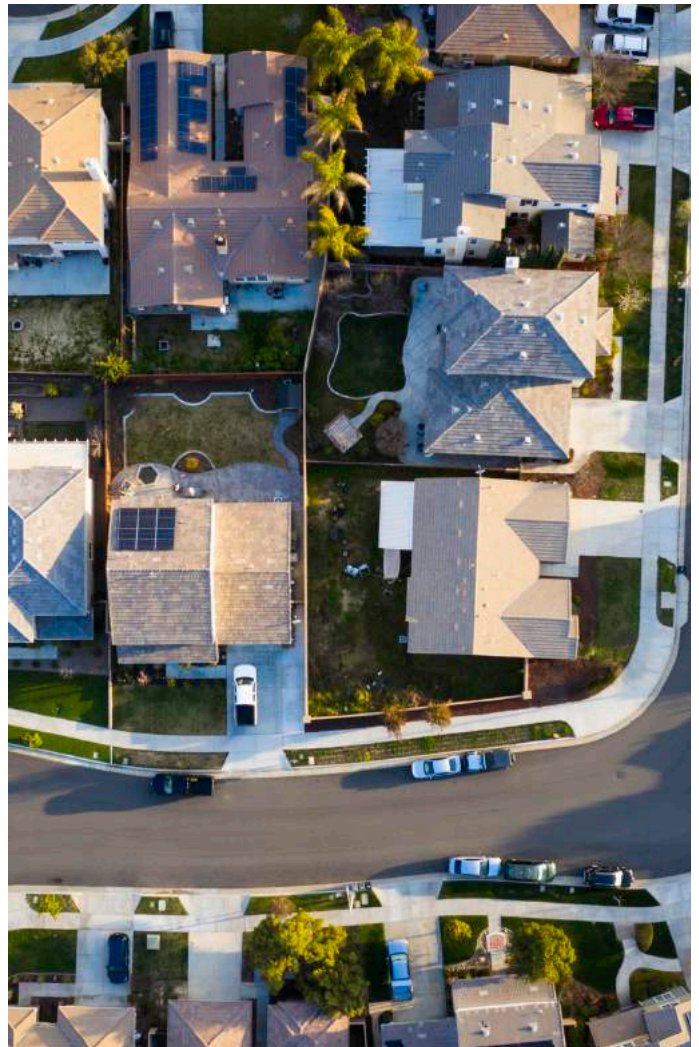


The ability to pool and securitize a sufficient volume of eligible mortgages that can be sold in the secondary market as green MBS is key to keeping capital flowing to finance green homes and improvements. This value chain can generate mutually reinforcing benefits for the GSEs, lenders, and borrowers. Studies have found that capital markets investors pay a premium for green bonds, particularly for those that are government issued and investment grade, and that follow defined governance and reporting procedures. For example, an average “greenium” up to 9 basis points has been observed on the secondary market.<sup>39</sup>

The additional cash flow stream from such premiums can benefit market participants in different ways, depending on the type of securitization. In the case of lender swap transactions (the most common type), this can be a significant incentive for lenders and, in turn, can enable lenders to offer discounted interest rates to borrowers of green mortgages, bolstering demand. In the case of portfolio securitization transactions, this can be a significant incentive for the GSEs themselves, which could be partially passed on to the benefit of lenders and/or borrowers of green mortgages.<sup>40</sup>

The GSEs’ single-family green MBS business can take lessons learned from their successful multifamily counterparts, which began issuing green MBS in 2012 and grew substantially—likely in part thanks to the use of incentives. Although it took five years for the multifamily market to achieve multibillion dollar scale, existing performance standards and access to data in the single-family market means there does not need to be such a long period for a robust and viable single-family green MBS market. Although single-family loan sizes are inherently smaller and more fragmented with more participants, adding complexity to the securitization process relative to the multifamily business, this can also offer advantages for investors in terms of risk diversification across MBS pools.

As mentioned above, the securitization of single-family green MBS started in 2020 with Fannie Mae’s new program. At time of writing, that program only uses one method to identify properties for inclusion: the EPA’s ENERGY STAR Certified Homes program for new construction. Expanding the single-family green MBS market to include homes that are already green, as well as homes that can access financing to become green, is necessary for equitable distribution of benefits and achieving scale. This report proposes a framework and qualification criteria to that end.



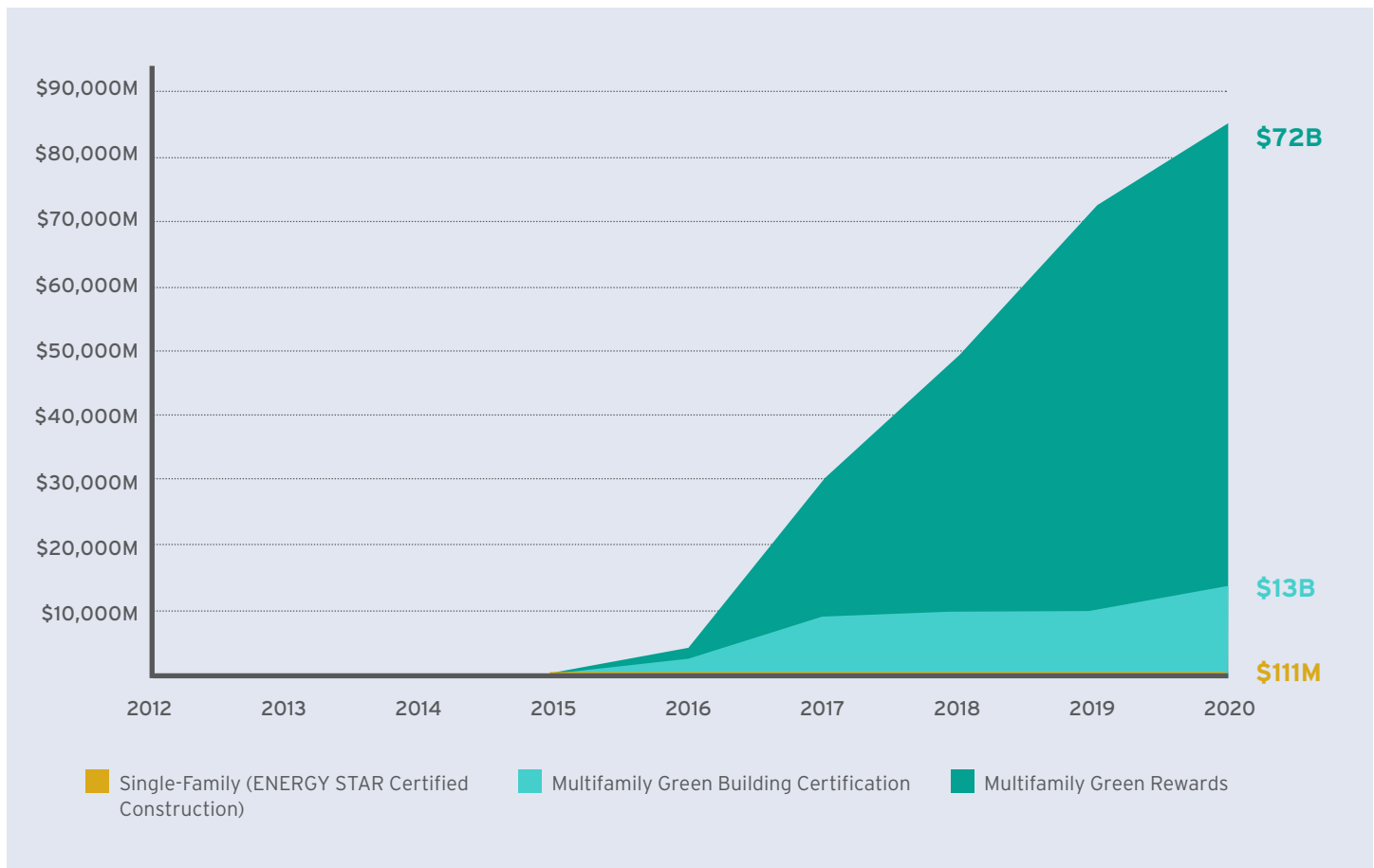


## Multifamily Green MBS Context

Fannie Mae offered its first multifamily green mortgage loans in 2011 and issued its first multifamily green MBS in 2012. These were initially based on multifamily new construction projects. In 2014, Fannie Mae and the EPA announced the ENERGY STAR Score for multifamily buildings, creating a consistent method to measure performance of existing multifamily buildings. In 2018, Fannie Mae established a Green Bond Framework. By the end of 2020, Fannie Mae had issued over \$85 billion in multifamily green bonds,

making it the world's largest green bond issuer for four straight years.<sup>41</sup> On average over those four years, Fannie Mae's multifamily green MBS represented over 30% of its total multifamily mortgage volume.<sup>42</sup> Although Freddie Mac started this effort after Fannie Mae, its multifamily green business has also been growing. It has purchased \$63 billion in multifamily green mortgages since 2016 and issued over \$3 billion in multifamily green MBS since 2019. In the multifamily market, the large majority of green MBS volume has been for green improvements to existing buildings, primarily through Fannie Mae's Green Rewards program.

### Exhibit 5 Fannie Mae's cumulative green MBS issuance



Source: Fannie Mae Capital Markets, "Multifamily Green MBS," 2021; excludes retired Fannie Mae green programs.

## Methods to Scale Single-Family Green MBS

Given the needs of much of the single-family housing stock, there is a significantly larger market opportunity for single-family green mortgages. Single-family green MBS achieving market penetration of 15% of total GSE single-family mortgage volumes (half the level achieved by Fannie Mae’s multifamily green business) would equate to over \$150 billion per year as shown in *Appendix A*, with most of that financing existing homes.

The single-family green MBS market can expand into both new and existing homes simultaneously by continuing to identify and securitize more new green homes, and by developing a framework to identify and categorize green improvements for existing homes. The discussion below provides a summary of this proposal, which follows the logic of Fannie Mae’s Multifamily Green Bond Framework. Further details

can be found in *Appendix B*, along with a discussion of the importance of leveraging rating systems in addition to certification programs.

Single-family green mortgages can be categorized for three types of homes: new construction that meets varying levels of above-code criteria, comprehensively retrofitted existing homes, and existing homes that have had basic (yet impactful) upgrades. We propose a framework to establish these qualifications for evaluation into green MBS with five tiers of related performance and impact (details on specific certifications, ratings, and other criteria are included in *Appendix B*).

Existing homes that undergo improvements should achieve a rating or certification with appropriate designation based on the level of savings or impact. This framework can be used to give green designations to homes with mortgages that finance energy- or water-saving improvements with independent third-

### Exhibit 6 Methods to measure required achievement for single-family green mortgage tiers

Qualifying Home Types	Towards Zero	Group 1: High Performance + Ventilation	Group 2: High Efficiency	Group 3: Base Certifications/ Ratings	Group 4 Basic Retrofits
High-Performance New Construction Homes	Via Certification	Via Certification	Via Certification or Rating*	Via Certification or Rating*	N/A
Comprehensive Retrofits and/or Solar	Via Certification	Via Certification	Via Certification or Rating*	Via Certification or Rating*	N/A
Basic Retrofits and/or Solar	N/A	N/A	Via Rating	Via Rating	Via Rating

\* Note on certifications versus ratings: green home certifications such as LEED, ENERGY STAR, and Passive House establish that a home has achieved a target level of high performance and/or met other criteria. Home energy ratings such as HERS and Home Energy Score can assess any home’s assets (equipment, envelope, etc.) and model energy consumption, assigning a score and recommending cost-effective improvements that save energy and money. At a practical level, ratings can be more easily leveraged to gauge retrofit impacts while more comprehensive certifications will typically apply to higher tiers.

party verified or modeled savings of at least 15% on a whole-home basis, measured against the home's current performance. This 15% savings threshold is based on the GSEs' multifamily green criteria and aligns with existing Duty to Serve criteria for single-family green mortgages.

In cases where the green mortgage allows for basic improvements without an energy report (currently up to \$6,500 for Freddie Mac or \$3,500 for Fannie Mae—which we recommend increasing to at least \$5,000), those basic improvements should be chosen from prequalified lists of cost-effective measures that have been determined to reliably deliver cost-effective savings. Such eligible measure lists can be curated, short, easily verifiable (as better than existing conditions), and reevaluated annually based on studies of a sampling of homes to verify that expected savings are being realized. For reference, the DOE's Weatherization Assistance Program achieves average energy cost savings of 13% with basic measure packages that cost on average \$4,695 per home.<sup>43</sup>

The expansion of multifamily green MBS to handle existing buildings required the development of a rating system for existing multifamily buildings. In the single-family market there are already two energy rating systems in use nationally: HERS® and Home Energy Score™. These programs deliver energy reports (each with a score or rating of the home's current condition) that can be used to qualify improvements financed by the GSEs' green mortgage products. The scores produced from these two rating systems can also be used on their own to categorize loans into the lower tiers of the proposed single-family green mortgage designation framework.

As part of the final certification of completion process, the GSEs could require that lenders have qualified third parties inspect each completed project and provide a final rating. This step will ensure the work is verified by an energy professional, protecting consumers and mitigating the risk of fraud. Additionally, a "test out" score can be used

to determine relative performance and inform green MBS disclosures and tracking. The large and growing number of trained green raters nationwide can supply updated score reports through established business models. A benefit of requiring a rating after work is completed is that some homes may qualify for higher green tiers, which could offer lower interest rates for those borrowers. Another benefit is that the rating will generate a verified energy cost estimate, which can facilitate an automated valuation adjustment of the property based on its relative energy performance.

A critical component of updated processes is to capture green mortgage loan designations in loan delivery data. The GSEs use the Uniform Loan Delivery Dataset (ULDD),<sup>44</sup> an aligned format for lenders to communicate details about each mortgage loan sold. The ULDD informs the key characteristics needed by the GSEs in order to pool and securitize loans into MBS. Several green home databases now exist that document third-party home certifications and ratings (see *Appendix H* for more detail). The automated integration of such data can enable lenders and the GSEs to identify both qualifying green properties that are already in their portfolios and new green properties as loans are acquired.

The GSEs' next update of the ULDD should include the necessary data fields for green mortgage loans. In the interim, an industry working group can be formed to recommend how existing green home data sources (including those recommended in this report) can be leveraged for this purpose.






# Methods to Scale Single-Family Green Mortgages




Before the single-family green MBS market can reach its potential, single-family green mortgage processes must be improved. Adoption of the GSEs' existing single-family green mortgage products remains extremely low to date because of a lack of awareness and demand from consumers and specific operational pain points that add complexity, time, and cost for lenders.


The GSEs provide favorable terms for lenders, giving a \$500 credit per loan for green mortgage origination and allowing lenders to close and deliver these loans without recourse before the improvements are completed. There is no rate premium for green mortgages, and they can be bundled with other GSE products (e.g., low down payment mortgages) that further improve affordability and access to capital. But along with these perks come additional process steps and considerations that have made them more challenging than conventional mortgage originations. For reference, *Appendix C* includes a high-level diagram illustrating the single-family green mortgage origination workflow based on existing GSE guidelines for lenders.

Single-family green mortgage products will inevitably involve some level of additional process steps compared with a standard mortgage. However, these need not be obstacles because innovations in housing data analysis and automation can be leveraged. Below are the top three operational pain points that can be addressed in the immediate term (additional recommendations can be found in *Appendix F*):

-  Lack of awareness/demand and inability to effectively sell green mortgage products
-  Burdensome project evaluations for lenders
-  Limited market of green appraisers and lack of comps for as-completed valuations

Data and automated solutions available today, in combination with updates to GSE policies and lender guidelines, can help overcome these process barriers to scale up adoption. Below are brief descriptions of these significant but surmountable lender **process pain points**, followed by **recommendations** for the GSEs, FHFA, and market-leading lenders to consider as part of broader efforts to unlock the single-family green mortgage market:

 **Lack of awareness/demand and inability to effectively sell green mortgage products:** Home energy information has been largely invisible to most homeowners and residents, except for a handful of jurisdictions in the United States with residential energy disclosure policies. Without access to this information, lenders have been unable to account for energy costs in mortgage underwriting and appraisal standards, leaving them no way to identify borrowers and homes that can meaningfully benefit from green home improvements through green mortgages. Because of these information barriers, both lenders and borrowers miss opportunities to pursue green mortgage products.

 **Leverage home energy cost data to increase visibility of home performance and drive demand:** Data exists today—high-quality, nationally standardized data from trusted sources such as the US Department of Energy (DOE)—that can be leveraged to auto-populate home energy cost estimates and other performance metrics into the underwriting process. This data can enable lenders to initiate conversations about green mortgage products with borrowers and more effectively target homes that may be costly to operate. Adding a data field for “home energy cost estimate” (ECE) through the GSEs’ ongoing Uniform Appraisal Dataset (UAD) redesign initiative

can effectively capture this information for all homes nationwide.

Existing tools and databases can allow lenders to capture ECEs from home ratings (e.g., HERS or Home Energy Score) and green certifications when they are available, or capture a baseline ECE for the majority of homes with no third-party rating. This same data field can be leveraged in two use cases: by lenders to better target and sell green mortgage products, and by automated valuation models (AVMs) and appraisers as a baseline for calculating appraised value adjustments.

The DOE's National Renewable Energy Laboratory (NREL) recently developed a Home Energy Cost Estimator tool to generate home-specific energy cost estimates for this context and use case, presenting an automated solution aligned with the use of automated underwriting systems and AVMs. This tool is built on **ResStock™**, NREL's comprehensive database of national housing stock characteristics that leverages advanced energy modeling and high-performance computing.

The data is post-processed via six common appraisal fields: home size, age, location, utilities, cooling type, and foundation type. This tool could be integrated with the GSEs' automated underwriting software (Fannie Mae's Desktop Underwriter® and Freddie Mac's Loan Product Advisor®) as an additional third-party vendor, similar to how credit scores are imported from external sources. This would introduce a key data point that can jumpstart the green mortgage origination process. For more detail on the NREL tool and its methodology, please see *Appendix D*.



#### **Burdensome project evaluations for lenders:**

Currently, lenders must verify the eligibility and cost-effectiveness of itemized energy technologies for green mortgage products (including to receive credit under Duty to Serve). However, lenders lack the expertise in energy technologies and building science to conduct this work confidently. Due to a lack of underwriting system integration, this typically also involves manual calculations outside of largely automated loan origination processes, adding complexity, time, cost, and confusion to the process for lenders.



#### **Leverage eligible measure lists to simplify and streamline project evaluations for lenders:**

State- or region-specific eligible measure lists for cost-effective measures can be used to streamline eligibility and cost-effectiveness determinations for lenders. This concept is permitted by FHFA's Duty to Serve regulation,<sup>45</sup> but it is not being used in practice. At minimum, the GSEs' seller guidelines should be updated to permit the use of such lists. ResStock has data that could be used to create lists for this purpose,<sup>46</sup> and further analysis could allow for prequalified eligible measure lists at a state or regional level for use by lenders.

Additional resources like state- and utility-led residential efficiency programs can be leveraged to establish regionalized eligible measure lists for upgrades that will most reliably deliver energy and cost savings to homes, with added potential to align with state policy goals. These lists can be curated and updated annually based on independent verifications of a sampling of homes to ensure that savings estimates maintain accuracy over time. For a representation of ResStock's state-level information, see *Appendix E*.





### Limited market of green appraisers and lack of comps for as-completed valuations:

The GSEs' current green mortgage products require appraisers to determine the home's as-completed value (i.e., after the improvements are made) for every project before the financing has been approved. This adds time and cost to the process and presents a challenge for appraisers to attest to market reaction to green features that have not yet been installed. Today, only a small subset of appraisers are trained to perform green appraisals, and these appraisers do not have access to widespread comps for green features. Again, the green mortgage market is stymied because standard processes do not capture the necessary data.



### Leverage automation to simplify and streamline as-completed valuations:

The GSEs can mitigate the as-completed appraisal challenge by recognizing the value added by efficiency improvements using automated methods based on the income valuation approach. Automating this step in the process, for example via the GSEs' automated appraisal tools, will remove a significant barrier to help jumpstart the market for green mortgages. With available data like home energy cost estimates and the use of prequalified measure lists for basic improvements as described above, the opportunity exists to change the system of valuation into one of evaluation (i.e., AVM-based value adjustments confirmed by human appraisers) rather than full manual appraisals in all cases.

This approach also helps protect consumers by requiring the energy savings to be higher than the cost of improvements, thus creating positive cash flow for the borrower. If no efficiency-related improvements are made, then there is no attribution of value, mitigating the risk of devaluing homes and/or limiting access to credit. Basic improvements should only require automated evaluations, which can open up the market to borrowers that need smaller—but still valuable—energy upgrades. More comprehensive retrofits will still benefit from the analysis that comes with full as-completed appraisals.

Additional recommendations to address other operational challenges are detailed in *Appendix F*. Given the needs of the US housing market, we also recommend expanding the scope of the GSEs' single-family green mortgage program to include the following activities:

- **Expand eligible measures to further improve health and safety outcomes:** The pandemic has shined new light on the importance of healthy indoor air quality. There are increasingly understood and well-documented risks to respiratory health from combustion-based appliances in homes, which release toxic pollutants that can increase indoor air pollution to levels that would be illegal outdoors.<sup>47</sup> Related health risks exacerbated by poor housing infrastructure are also gaining attention from policymakers and consumers. These health risks disproportionately affect lower-income households, and especially children. Therefore, green mortgage products should also be able to finance home electrification upgrades and other health improvements.

Replacing combustion-based appliances and equipment with cost-effective, clean electric alternatives (e.g., heat pumps, heat pump water heaters, induction stoves) can not only improve health, it can also save money. And it is a critical part of meeting climate targets—decarbonizing the economy requires solutions for the 70 million homes and buildings that burn fossil fuels on-site.<sup>48</sup>

- **Develop plans to increase access, affordability, and consumer protection for communities of color:** The mortgage industry has an opportunity to improve racial equity and ensure communities of color can access the benefits of higher-performance homes through green mortgages. These products can be used to help correct some of the racial inequities historically driven by the mortgage industry, such as disparate housing quality and energy burdens.

For example, the GSEs can develop plans and partner with lenders and community organizations to more effectively deliver green mortgages in the highest energy-burdened zip codes of the

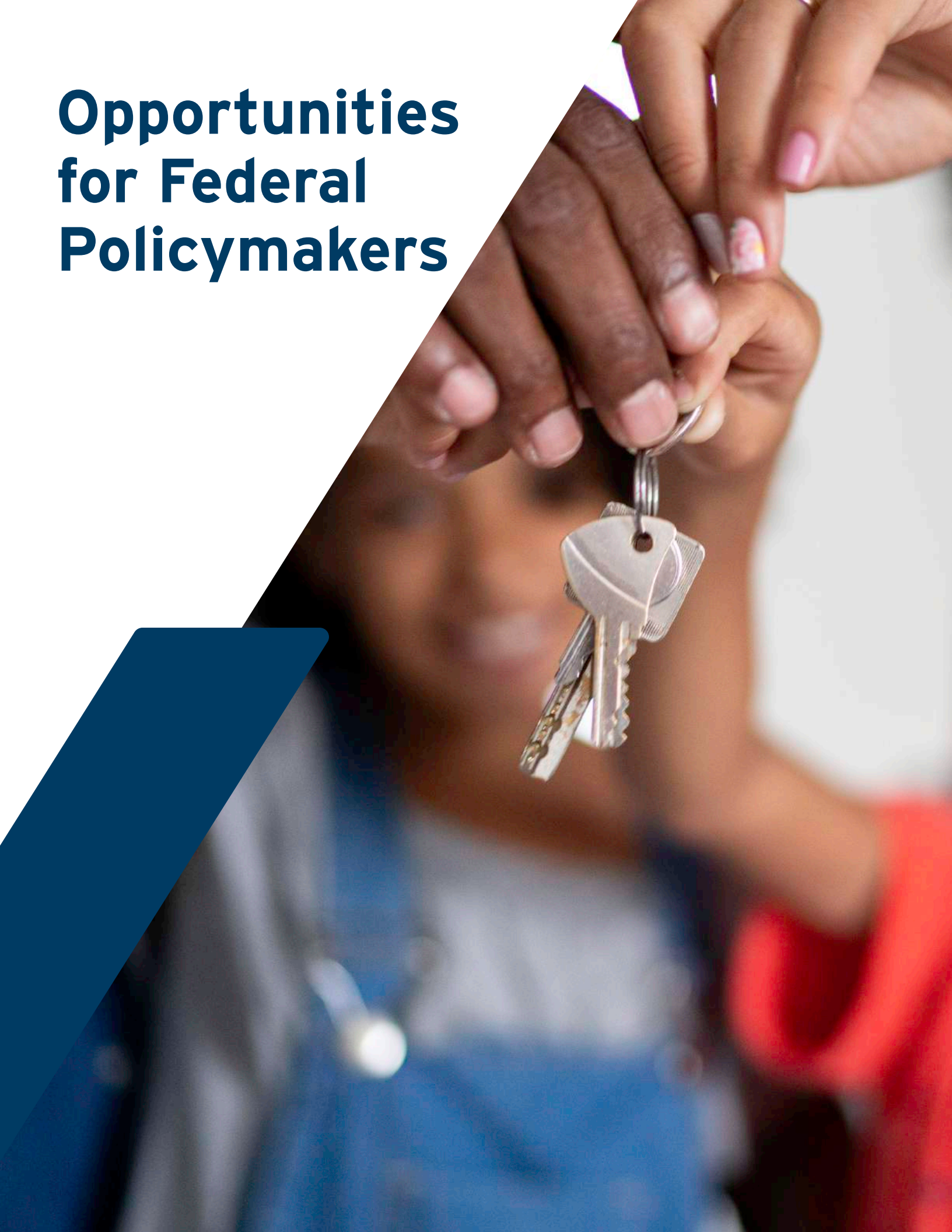
United States. These mortgages can finance green improvements for low-performance homes that have lacked access to capital in the past. This could be integrated into efforts to support first-time homeownership in these communities, including by educating consumers about green mortgage products in combination with other GSE affordable lending products and down payment assistance.

As use of AVMs continues to grow in the mortgage industry, the GSEs should also take steps to assess impacts in majority-Black neighborhoods. New research has shown that AVMs can produce larger errors in these neighborhoods that may reinforce the impacts of past racial discrimination.<sup>49</sup> FHFA and the GSEs should work with counseling agencies, community organizations, industry experts, and other stakeholders to develop actionable plans designed to meet the needs of these underserved communities.

These solutions can be tested by the GSEs, market-leading lenders, and other partners through pilot projects to track and quantify the impacts. Pilot projects and ambitious green mortgage targets can be incorporated into the GSEs' next Duty to Serve plans for the period 2022-2024, as proposed in *Appendix G*, and/or developed outside of Duty to Serve. Better designed processes through automated and data-driven solutions means these efforts can scale with only limited training and education needs for lenders and appraisers.

Various consumer protection measures are key to delivering benefits to both borrowers and lenders. Consumer protection measures include activities like automated checks to confirm positive net savings expectations for borrowers, curated cost-effective eligible measure lists, qualified contractor networks, post-completion independent third-party verification ratings, and quality control systems that include follow-up evaluations for a sampling of completed projects to verify savings. The GSEs can work with industry experts, consumer advocates, and other key stakeholder groups to ensure that consumer protections are sufficiently incorporated into efforts to scale up this market. Ultimately, the GSEs must ensure that financed home performance improvements actually translate into increased asset value for homeowners. This work can redirect consumer spending away from utility bills and toward their own home's value.

# Opportunities for Federal Policymakers





The federal government can also take action to better align housing finance with its economic, equity, and climate goals, including by scaling up the single-family green mortgage market. There are many reasons to take on this effort: to improve the US housing stock, correct market failures, protect consumers, address inequities, and create durable green home retrofit jobs at scale. Since the New Deal, the federal government has used the credit system to shape the housing market. Policymakers enabled the expansion of the suburbs starting in the 1930s, in part using mortgage subsidies through the GSEs and the tax code. The federal government has new opportunities today to start building back a better housing market through finance.

In support of the new Biden Administration's broader agenda focused on economic recovery, racial justice, housing, health, and climate (which includes stated plans to weatherize 2 million homes, retrofit 4 million buildings, and build 1.5 million affordable new homes<sup>50</sup>), the federal government can pursue the following:

- **Enable home performance labeling and disclosure nationwide:** Residents have a right to know about the energy benefits or burdens of a home based on its inherent physical assets before they move in. Home energy labels highlight key information about expected energy costs and cost-effective improvement recommendations. Nationally standardized ratings based on professional on-site assessments—such as RESNET's HERS for new construction or DOE's Home Energy Score for existing homes—can be disclosed to prospective buyers and occupants at time of listing and time of rental.

The federal government can prioritize mandatory home energy labeling nationwide and provide resources and technical support for local government implementation. This would enable consumers to have better information when budgeting and making housing choices, which can especially help lower-income households identify and avoid less tenable living situations.

Strengthening the link between these labels and financing also enables borrowers to more easily finance energy and other green home improvements as part of their mortgages. Some local governments have already established these policies.<sup>51</sup> These can provide a model for scaling access to energy labels nationally, which would also drive up demand for green mortgage products to complement supply-side efforts by the GSEs and lenders. The costs of professional home energy ratings could also be subsidized by the federal government for LMI households.

- **Incorporate green home data fields into GSE underwriting and appraisal standards:** With or without a national home performance disclosure policy, FHFA can call on the GSEs to incorporate key home energy and other green data fields for all homes nationwide (not just for those with certifications and ratings). This will help lay the foundation for greater market efficiency. This would be possible by, for example, adding a data field for home-specific energy cost estimates into the Uniform Appraisal Dataset (UAD) redesign initiative (underway through 2021). The UAD could be auto-populated for all homes by tools like NREL's Home Energy Cost Estimator, including homes that do not have third-party ratings or certifications.

This tool is described in greater detail in *Appendix D*. This one metric could then be used by lenders to identify good candidates for green mortgages and by appraisers and AVMs as a baseline for value adjustments for home efficiency. This would also allow for the collection of data over time that can be aggregated and analyzed to better measure the benefits of green homes for lenders, borrowers, and capital markets investors.

- **Measure, disclose, and reduce GSE portfolio emissions and climate risk exposure:** Many of the world's largest banks and financial institutions have committed to climate-align their portfolios (i.e., bring lending and investment activities into alignment with 1.5°C-consistent emission pathways).<sup>52</sup> Similarly, the federal government

through FHFA can call on the GSEs to start measuring and disclosing carbon emissions estimates for their portfolios, establish reduction targets in line with federal climate goals, and develop programs to reduce those emissions accordingly. Existing DOE and market-available tools can be leveraged to accelerate this measurement process.

In addition, FHFA can work with other federal agencies (e.g., NOAA, FEMA) to invest in or start developing asset-level data that would enable the GSEs to assess and disclose their portfolios' climate risk exposure to increasing floods, wildfires, winds, sea-level rise, and other sources.<sup>53</sup> Scaling single-family green mortgages can be a key tool for both mitigation and adaptation.

- **Position mortgages to become a primary vehicle for financing home performance and resilience upgrades:** FHFA could push the GSEs to provide stronger incentives for lenders to market and include their single-family green mortgage products as built-in, opt-out options in all new and refinance mortgage transactions. The resulting market size and impacts could double or triple earlier estimates as many more consumers could be reached with information about cost-effective upgrades. This would also drive broader market adoption as non-agency and government mortgage lenders would likely follow suit in offering similar product designs.

At a minimum, this mechanism could offer the basic improvement financing by utilizing AVM-based evaluations instead of full as-completed appraisals to streamline origination for lenders. The GSEs can help build out the green home improvement market in this way, with the labor need met quickly (as was the experience in Portland and Austin with rating disclosure ordinances). This would help meet the needs of most US homes to make upgrades while also aligning with the climate and ESG goals of major lending institutions and capital markets investors.

- Although not the focus of this report, the Departments of Housing and Urban Development, Agriculture, and Veterans Affairs already require newly built homes with FHA loans and other federally assisted mortgages to meet building energy codes (roughly a quarter of mortgages for new homes). However, the criteria are mostly still at 2009 code levels and should be updated to 2021 code levels, which would cut energy use of these buildings by at least a third.<sup>54</sup> These agencies should adopt the 2021 code and the GSEs can be required to do the same, ensuring that even more new homes are built to high performance standards.

# Conclusion





What could this market look like in practice when fully up and running? Below are three hypothetical stories of borrowers benefiting from a robust green mortgage and MBS market:



## Borrower Story #1:

A young couple was looking to buy a newly built townhome as their first home, but they were unsure that would be possible. When they found a new townhome certified to the DOE Zero Energy Ready Home standard, they were pleasantly surprised to see how low the utility bills were estimated to be on the real estate listing. They were even more surprised when their loan officer told them the energy savings compared to a standard new home could be considered funds available to be spent on their mortgage payments. Additionally, the high performance certification on this home would qualify them for a discounted interest rate.

The energy cost and interest savings amounted to \$100 per month—enough to allow them to afford the home. Their mortgage was bundled as part of a top-tier green MBS pool, enabling their lender and Fannie Mae to claim ESG credit for the transaction.



## Borrower Story #2:

To get ready for a comfortable retirement, an older couple living in a rural area added insulation to their 1950s home and replaced their furnace with a high-efficiency heat pump (both paid for with cash savings). Through a local utility program they received a Home Energy Score (HES) report that rated their home an 8 out of 10.

After her husband died a few years later, the widow decided to move closer to family and listed her home for sale. When the eventual buyer informed their loan officer of the home, the loan origination software confirmed this home was a high performer that would qualify as Group 3 green mortgage. The buyer received preferential mortgage terms and paid a slightly higher price for the home, allowing the widow to more than recoup her investment in the upgrades because the appraised value took into account the high HES.



### Borrower Story #3:

A middle-income family was buying a move-up house that needed some work. They were not first-time home buyers so they felt they understood the mortgage process. But they were pleased when the loan officer saw that this home might have higher utility bills and asked if they were interested in financing green or energy-related improvements.

By this point they knew the house they were buying had an old, inefficient water heater, was missing crawlspace insulation, and had almost no insulation in the attic. They were able to take advantage of the basic eligible measures offered through Freddie Mac to finance a new heat pump water heater and new insulation. And they worked with a contractor to have both projects installed within six months after closing. They felt better knowing they had created a more comfortable living environment for their children.

Unlocking the single-family green mortgage and MBS market is not only possible today—given advances in data and automation as well as favorable financial market and policy trends—it is also *necessary*. Five years from now, conversations between friends and neighbors about green home improvements financed by mortgages and recognized in the transaction process can become mainstream all over the country. Time is of the essence to advance readily deployable solutions capable of addressing the dynamic, intersectional crises facing the housing market. Done correctly, single-family green mortgage products can shift capital and resources at scale to make living situations more affordable, healthy, equitable, and resilient—better serving American households and especially those who stand to benefit disproportionately.

Scaling access to low-cost green improvement financing is also in the mortgage industry’s best interests: it offers an enormous new market opportunity catering to both consumer and investor demand, while also helping to future-proof the mortgage business itself by mitigating ever-increasing climate risk. Mortgages, through their inherent role in financing America’s housing, can soon become a primary vehicle for deploying billions of dollars toward these goals each year. This report highlights targeted interventions toward this end, but is also intended to serve as a starting point in this continuously evolving space. A coalition of home performance experts and other key partners already collaborating with ambitious state and local governments stands ready to support Fannie Mae, Freddie Mac, FHFA, and other mortgage market leaders in this important and timely pursuit.



# Appendices



# Appendix A

## Calculations and Assumptions

### Exhibit A1 10-year impact estimates

	Certified New Construction High-Performance	Deeper Retrofits Avg 25% Savings	Basic Retrofits Avg 15% Savings					Avg Loan Amount	10-Yr Avg GSE Volume
Avg Project Cost		\$12,500	\$5,000					\$250,000	\$1,069,000,000,000
Growth	5%	10%	10%						
Year	# New Homes	# Existing Homes	# Existing Homes	Total Homes	Mortgage Volume	Project Financing	Green Mortgage Volume	% of GSE Volume	
1	70,000	90,000	450,000	610,000	\$152,500,000,000	\$3,375,000,000	\$155,875,000,000	14.6%	
2	73,500	99,000	495,000	667,500	\$166,875,000,000	\$3,712,500,000	\$170,587,500,000	16.0%	
3	77,175	108,900	544,500	730,575	\$182,643,750,000	\$4,083,750,000	\$186,727,500,000	17.5%	
4	81,034	119,790	598,950	799,774	\$199,943,437,500	\$4,492,125,000	\$204,435,562,500	19.1%	
5	85,085	131,769	658,845	875,699	\$218,924,859,375	\$4,941,337,500	\$223,866,196,875	20.9%	
6	89,340	144,946	724,730	959,015	\$239,753,777,344	\$5,435,471,250	\$245,189,248,594	22.9%	
7	93,807	159,440	724,730	977,977	\$244,494,171,211	\$5,616,653,625	\$250,110,824,836	23.4%	
8	98,497	175,385	724,730	998,611	\$249,652,767,146	\$5,815,954,238	\$255,468,721,384	23.9%	
9	103,422	192,923	724,730	1,021,074	\$255,268,593,491	\$6,035,184,911	\$261,303,778,403	24.4%	
10	108,593	212,215	724,730	1,045,538	\$261,384,441,827	\$6,276,338,652	\$267,660,780,479	25.0%	
<b>Total</b>	880,452	1,434,368	6,370,943	8,685,763	\$2,171,440,797,895	\$49,784,315,176	\$2,221,225,113,071		

**Notes:** Market size assumes year 1 green mortgages comprising 450,000 basic retrofits or 5% of all ~9 million annual single-family mortgage loans, 90,000 deeper retrofits conservatively assumed at 1% of all loans, and 70,000 green new construction homes per proposed framework. Combined this is just under 15% of GSE volume (half the level achieved by Fannie Mae's multifamily green business), reaching 25% by year 10. Basic and deeper retrofits are assumed to grow 10% per year (for basic, leveling off after year 5) and new construction at 5%. Other project-level assumptions are detailed below. Cumulative impacts are based on weighted average savings (weighted by market share) for existing home retrofits.



	Weighted Average Savings	Weighted Average Net Cost Savings	Weighted Average Household CO <sub>2</sub> Savings
	16.7%	\$316	1.45 metric tons
Year	Retrofitted Homes	Cumulative Net Savings	Cumulative CO <sub>2</sub> Avoided (Metric Tons)
1	540,000	\$1,706,400,000	7,803,000
2	594,000	\$1,689,336,000	7,724,970
3	653,400	\$1,651,795,200	7,553,304
4	718,740	\$1,589,852,880	7,207,055
5	790,614	\$1,499,004,144	6,854,623
6	869,675	\$1,374,087,132	6,283,405
7	884,170	\$1,117,590,867	5,110,503
8	900,114	\$853,308,109	3,901,994
9	917,652	\$579,956,376	2,652,016
10	936,945	\$296,074,554	1,353,885
<b>Total</b>	<b>7,805,311</b>	<b>\$12,357,405,262</b>	<b>56,507,755</b>

Jobs Created	
8	jobs per \$ million of consumer savings
11	jobs per \$ million of investment
<b>\$12,357</b>	million of consumer savings
<b>\$49,784</b>	million of investment
<b>98,859</b>	jobs from savings
<b>547,627</b>	jobs from investment
<b>646,487</b>	<b>total jobs created</b>

**Sources:** Household carbon footprint based on US EPA data (8.67 metric tons per home x 16.67% weighted average savings) <https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references>; job creation estimates based on *Assessing National Employment Impacts of Investment in Residential and Commercial Sector Energy Efficiency: Review and Example Analysis*, Pacific Northwest National Laboratory, 2014, [https://www.pnnl.gov/main/publications/external/technical\\_reports/PNNL-23402.pdf](https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23402.pdf).

## Exhibit A2 Example project-level financial benefits

NET SAVINGS	Basic Retrofit	Deeper Retrofit
Estimated Project Cost	\$5,000	\$12,500
National Average Home Utility Costs/Year	\$2,646	\$2,646
Average Project Savings	15%	25%
Average Utility Cost Savings	\$397	\$662
Present Value of 30-Year Savings*	\$16,536	\$27,559
Estimated GSE Conventional Mortgage Amount	\$250,000	\$250,000
Estimated Interest Rate	2.5%	2.5%
Average Mortgage Payments/Year	\$11,854	\$11,854
Average Green Mortgage Amount	\$255,000	\$262,500
Green Mortgage Payments/Year	\$12,091	\$12,446
Incremental Green Mortgage Payment/Year	\$237	\$593
Sum of Incremental Payments (30 Years)	\$7,112	\$17,780
Average Annual Household Net Savings*	\$314	\$326

\*Assumes 2% annual energy price escalation; net savings remain the same regardless of original mortgage size

**Notes:** Examples for illustrative purposes only and results will vary depending on measures installed. Green mortgage balance assumes loan-to-value ratio enables 100% of project costs to be financed. Example does not account for incremental income tax benefits from higher interest payments, or other potential value streams such as reduced household health and safety costs or increased home value. (A meta-analysis of several studies found a 4.3% value premium for certified green homes,<sup>55</sup> which is likely based on perception given that appraisal standards do not yet explicitly account for home performance and thus may be understated.)

Average utility costs include energy and water. The assumed average loan size of \$250,000 is based on actual 2019 average single-family loan size of \$246,222 for Freddie Mac and \$259,897 for Fannie Mae. The assumed \$5,000 basic retrofit project size is based on Freddie Mac and proposed Fannie Mae thresholds, and the \$12,500 deeper retrofit project size is based on 5% of average loan amount; 15% and 25% savings are assumed based on field experience relative to these project costs. The assumed 2.5% interest rate is based on current market rates for 30-year fixed mortgages. The analysis assumes 2.0% annual energy price escalation based on actual 1981-2011 average retail electricity price increase.

**Sources:** Bureau of Labor Statistics, Consumer Expenditure Survey 2019; US Energy Information Administration Electricity Data Browser <https://www.eia.gov/electricity/data/browser/>; Fannie Mae 2019 10-K (page 77) <https://www.fanniemae.com/sites/g/files/koqyhd191/files/migrated-files/resources/file/ir/pdf/quarterly-annual-results/2019/q42019.pdf>; Freddie Mac Single-Family Origination Summary <https://clarity.freddiemac.com/historical/origination/origination-summary>; [www.bankrate.com](http://www.bankrate.com) accessed 2/14/2021.

# Appendix B

## Proposed Calibration Framework for Green Mortgages

This appendix proposes a framework and methods similar to those used by the GSEs in Form 4250,<sup>56</sup> which groups and details various green building certifications approved by the GSEs to qualify as a green mortgage loan for green MBS. Below are group definitions from Fannie Mae's Multifamily Green Bond Framework for reference.<sup>57</sup>

The multifamily framework only references certifications, but our suggested groupings for single-family include the use of qualifying ratings from either RESNET's Home Energy Rating System (HERS) or DOE's Home Energy Score system. The use of both ratings aligns with the policy guidance developed by the National Association of State Energy Officials in the **EMPRESS project**, which aimed to harmonize the usage of these two scoring systems. In our proposed format these ratings could align with either Group 2 or Group 3, as defined below, but they would not qualify a home for either of the top groups because they do not have ventilation requirements. With a few edits (in italics) this single-family framework would align with the multifamily framework.

**"Towards Zero" Group:** This group recognizes buildings aiming for net-zero energy (NZE) or water use, or energy use reductions at NZE-ready levels. An NZE-ready building is one that is sufficiently energy efficient such that if solar photovoltaic (PV) were added, it could operate at NZE.

### **Group 1: High Performance + Ventilation**

**Requirements:** Group 1 is for green building certifications that require projected energy savings of at least 20% relative to *federal model codes*, plus ventilation requirements for new construction projects. Proper ventilation is a particularly important consideration in energy-efficient buildings that typically have tight building envelopes and, thus, more limited outdoor air exchange.

**Group 2: High-Efficiency Buildings:** These certifications must require projected energy savings of more than 15% relative to *federal model codes*. This group does not *necessarily* have ventilation requirements.

**Group 3: Base Green Building Certifications:** Group 3 certifications must require projected energy savings of 10% or more relative to the national baseline *or a score improvement akin to at least a 25% reduction in energy use*. This group does not *necessarily* have ventilation requirements.

These same group definitions can largely apply to designate single-family green mortgages (as adjusted below), and in addition we recommend one more grouping for the single-family market context:

**Group 4: Basic Retrofits:** These would encompass all green mortgages that financed basic improvements deemed to deliver at least 15% savings without the need for an energy report. The GSEs' underwriting requirements cap these amounts at small levels. We propose providing green designation status for mortgages that include at most \$5,000 for this use (assuming Fannie Mae increases its current \$3,500 threshold; Freddie Mac's threshold is currently \$6,500).

In addition to the four tiers borrowed from Fannie Mae's Multifamily Green MBS Framework, we propose adding this fifth tier (Group 4: Basic Retrofits) for projects using the green mortgage criteria for basic improvements. These projects will have completed improvements selected from prequalified eligible measure lists (see page 26) that are deemed to deliver at least 15% whole-home savings. These projects represent a lighter shade of green, but it is still critical to include them in the single-family framework for their capacity to scale loan volumes and realize the benefits of ample green data for more accurate valuation while also supporting borrowers

with thinner margins for loan amounts. Including basic retrofits in Group 4 creates the opportunity for nearly any home or borrower to qualify and participate in this market. This includes opportunities for serving borrowers and homes with a few “low hanging fruit” projects for improvements.

The size of single-family loans is much smaller than those for multifamily buildings, and single-family homeowners will not have the same capacities as multifamily landlords for ongoing measurement, verification, and reporting. In recognition of this, we recommend incorporating score improvements (i.e., point changes) into the framework, which translate into estimated energy savings. The proposed score improvement levels required to qualify for Group 3 translate to more than 25% savings and will be much simpler to track for all parties involved. This would also mean homeowners would not be required

to submit utility bills annually, as is required for multifamily buildings. There have been studies of both HERS and Home Energy Score that show they work well on average to estimate annual energy usage.<sup>58</sup> The GSEs can leverage these asset rating tools to estimate streams of energy savings. Score improvements can be measured using HERS or Home Energy Score as follows:

- Any home with a HERS rating above 100 must reduce the HERS score by 35 points to qualify.
- Any home with a Home Energy Score of 1, 2, or 3 must increase the score by 4 points (i.e., to at least 5, 6, or 7, respectively) to qualify.

Placement in the following framework is our best estimate and subject to further analysis and refinement:

**Exhibit B1** Table of qualifying certifications and rating values for single-family homes

TOWARDS ZERO CERTIFICATIONS			
ORGANIZATION	CERTIFICATION	VERSION	LEVEL
International Living Future Institute	Living Building Challenge	2, 3, 3.1, 4	Certified Living
	Zero Carbon Certification	1	Certified Zero Carbon
	Zero Carbon Certification	Not Applicable	Zero Energy Certified
Passive House Institute (PHI)	Certified Passive House	2016	Classic, Plus, Premium
	EnerPHIT Certified Retrofit	2016	Classic, Plus, Premium
Passive House Institute US (PHIUS)	PHIUS+ Certified	2015	PHIUS+ 2015, PHIUS+ Source Zero
		2018	PHIUS+ Core, PHIUS+ 2018, PHIUS+ Source Zero
USGBC	LEED Zero	LEED Zero	Zero Energy, Zero Water
Home Innovation	National Green Building Standard (NGBS) Green	2020 NGBS	Emerald + Zero Energy



GROUP 1 CERTIFICATIONS			
ORGANIZATION	CERTIFICATION	VERSION	LEVEL
Build It Green	GreenPoint Rated	1.9-2.1	Certified, Silver, Gold, Platinum
		6	Certified, Silver, Gold, Platinum
		7	Certified, Silver, Gold, Platinum
		8	Certified, Silver, Gold, Platinum
US Dept. of Energy	Zero Energy Ready Home		Certified
US Environmental Protection Agency	ENERGY STAR Certified Homes	3	Certified
		3.1	
		3.2	
Earth Advantage	Earth Advantage Home Certification		Earth Advantage Zero Energy Ready
USGBC	LEED BD+C: Homes	3	Certified, Silver, Gold, Platinum
		4	Certified, Silver, Gold, Platinum

GROUP 2 CERTIFICATIONS/RATINGS			
ORGANIZATION	CERTIFICATION	VERSION	LEVEL
Build It Green	GreenPoint Rated Existing Home Whole Home	2.1	Certified, Silver, Gold, Platinum
Built Green	Built Green		4-star, 5-star, Emerald
Earth Advantage	Earth Advantage Home Certification		Silver, Gold, Platinum
Southface	EarthCraft	2012	Certified, Silver, Gold, Platinum
		2014	Certified, Silver, Gold, Platinum
		1	Certified, Silver, Gold, Platinum
		2	Certified, Silver, Gold, Platinum
Home Innovation Research Lab	NGBS Green Home Certification	2015	Bronze, Silver, Gold, Emerald
		2020	Bronze, Silver, Gold, Emerald
US Dept. of Energy	Home Energy Score		10
RESNET	HERS Rating		55 or less

**GROUP 3 CERTIFICATIONS/RATINGS (Delivering 25% Whole-Home Energy Savings)**

ORGANIZATION	CERTIFICATION	VERSION	LEVEL
<b>Home Innovation Research Lab</b>	NGBS Green Home Remodeling Certification	2012, 2015	Bronze, Silver, Gold, Emerald
<b>US Dept. of Energy</b>	Home Energy Score		8-9 or 4-point improvement
<b>RESNET</b>	HERS Rating		56-65 or 35-point improvement

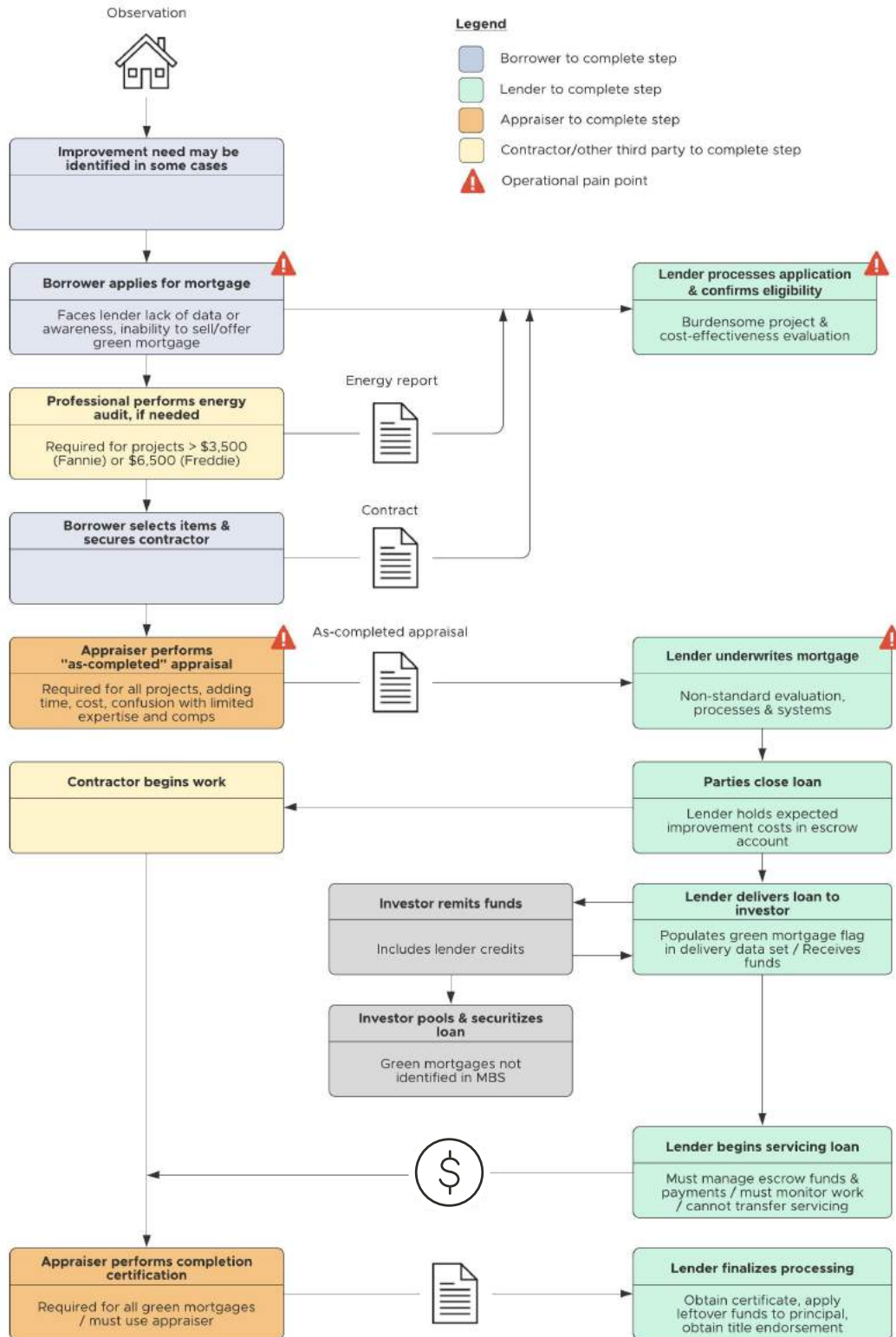
**GROUP 4 BASIC RETROFITS (Delivering 15% Whole-Home Energy Savings)**

ORGANIZATION	CERTIFICATION	VERSION	LEVEL
<b>Fannie Mae</b>	HomeStyle Energy without energy report		Installation of prequalified improvements with a minimum 15% deemed savings (aligns with at least \$5,000 spent; requires Fannie Mae to increase from current limit of \$3,500)
<b>Freddie Mac</b>	GreenCHOICE without energy report		Installation of prequalified improvements with a minimum 15% deemed savings (aligns with at least \$5,000 spent)

# Appendix C

## Existing Green Mortgage Origination Process Map

**Exhibit C1** Existing green mortgage origination process map based on the GSEs' selling guides<sup>59</sup>



# Appendix D

## NREL Home Energy Cost Estimator Methodology

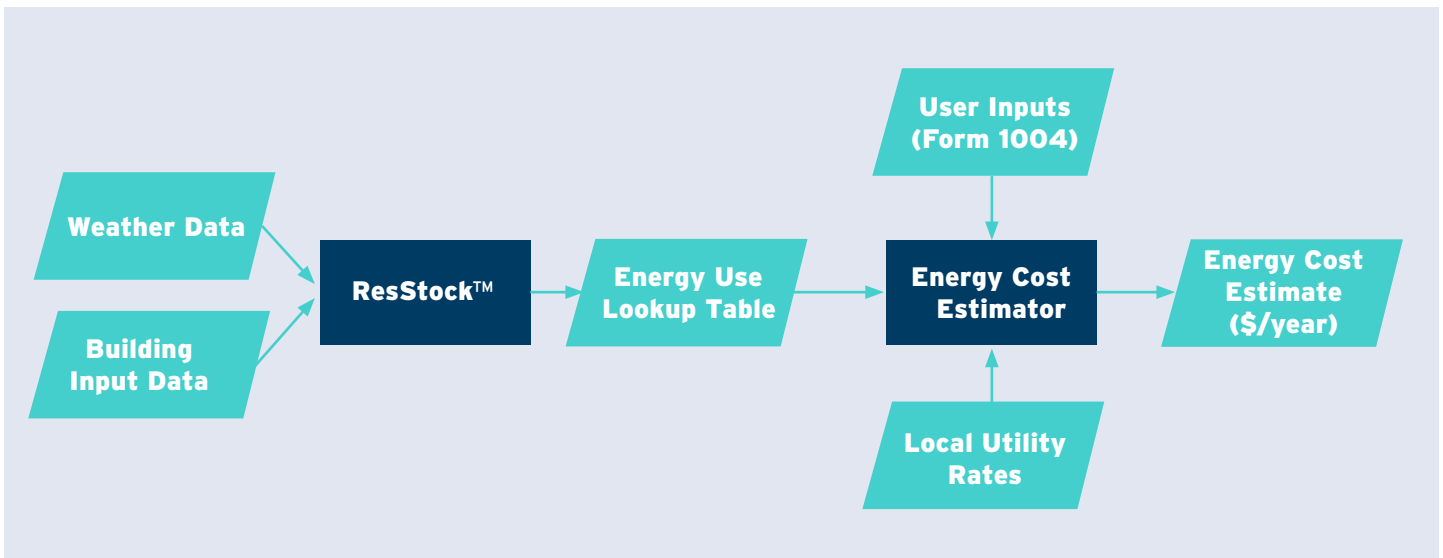
This appendix summarizes a draft unpublished methodology white paper by the National Renewable Energy Laboratory (NREL) for calculating energy cost estimates (ECEs) of single-family detached homes based on a handful of attributes commonly found in residential appraisals. The objective of this tool is to demonstrate accurate cost estimations for single-family detached homes using readily available inputs that, in turn, can be leveraged for a range of potential use cases in the market, including standard home appraisal processes.

Because a home's overall energy performance is the product of many complex (and often hidden) home energy features and characteristics, stakeholders across the residential industry who stand to benefit

from this information have long been challenged in factoring it into decision-making. As a result, DOE and NREL set out to develop a tool capable of generating conservative energy cost estimates for single-family homes in the United States, based on nationally standardized data. These conservative ECEs are intended to mitigate risk for both borrowers and lenders by enabling more complete homeownership costs to be considered, and serve as a baseline upon which energy costs of upgraded homes can be compared.

The following diagram shows the general steps in determining a home ECE (note that Form 1004 is the GSEs' Uniform Residential Appraisal Report):

**Exhibit D1** Workflow diagram for estimating annual home energy costs



**Notes:** ResStock is used for energy modeling and the Home Energy Cost Estimator represents post-processing of the data.



To select inputs for building models, the tool considers responses on typical appraisal forms that are most relevant to a home’s energy loads. The table below shows the six common appraisal fields chosen to inform the energy cost estimator, alongside the corresponding ResStock parameters, and the number of possible options for each parameter. These inputs are chosen because they closely impact the

energy demand of a home and can be pulled from the appraisal form, while limiting the computational resources needed for larger sets of inputs. To ensure that each combination of these options is represented with a unique building model, NREL evenly distributes the frequency of each option in the ResStock sampling routine and generates 362,880 models.

**Exhibit D2** Appraisal form inputs mapped to ResStock parameters and the number of ResStock options for each

Form 1004 Input	ResStock Parameter	# of Options	Option Values
Zip Code	Weather File Location	216	Atlanta, Denver, etc.
Age	Vintage	7	<1950s-2000s
Floor Area	Floor Area	4	1,000-4,000 ft <sup>2</sup>
Cooling	Cooling Type	3	Central, Room, None
Utilities	Heating Fuel	5	Natural Gas, Electric, etc.
Foundation	Foundation Type	4	Slab, heated basement, etc.

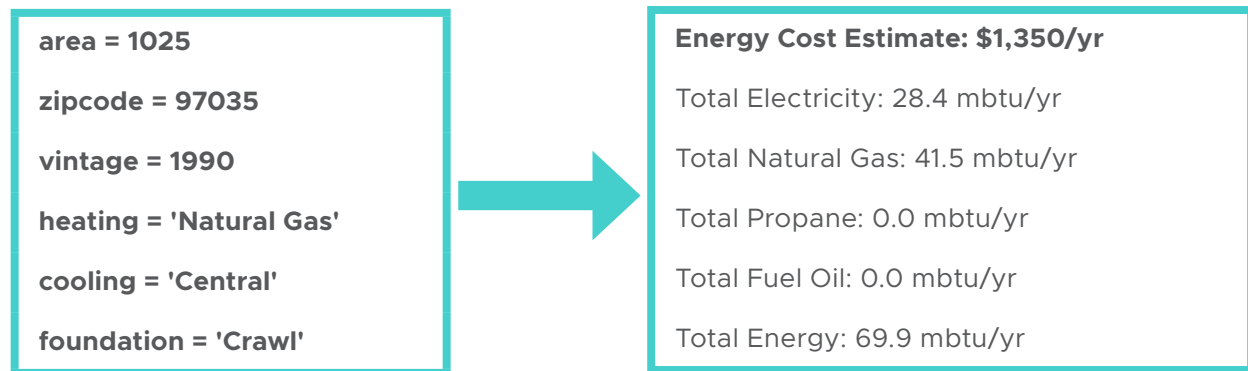
The ResStock sampling routine decides the likeliness of selecting options using a unique distribution within each parameter, often dependent on other parameters such as location, home size, or vintage. However, to maintain consistency among the ECE building models, and prevent outlying options from skewing results, NREL fixes distributions of options for the remaining parameters based on their categorization. The remaining inputs not relayed from the Uniform Residential Appraisal Report (Form 1004) are categorized and assigned in three ways:

1. Energy-related parameters, such as HVAC systems or insulation R-values, are fixed at the 20th percentile of efficiency for a given set of dependencies. The 20th percentile is determined by sorting options from least to most efficient and provides a conservative estimate of energy demand.

2. Design parameters, such as garage size or number of stories, have a less direct impact on energy demand, and cannot be sorted by efficiency. These are fixed at the most common option for each parameter.
3. Operational parameters, such as hot water draw schedules, are set to a single schedule.

Upon fixing input options for the building models, ResStock utilizes high-performance computing to simulate models and generate annual energy use data for the unique combinations of appraisal form inputs. This energy data includes electricity, natural gas, propane, and fuel oil loads, and is the basis for determining final cost estimates. The methodology for ECEs involves post-processing steps to expand the potential input options and translate energy data to consumer costs. The figure below shows example inputs and their outputs:

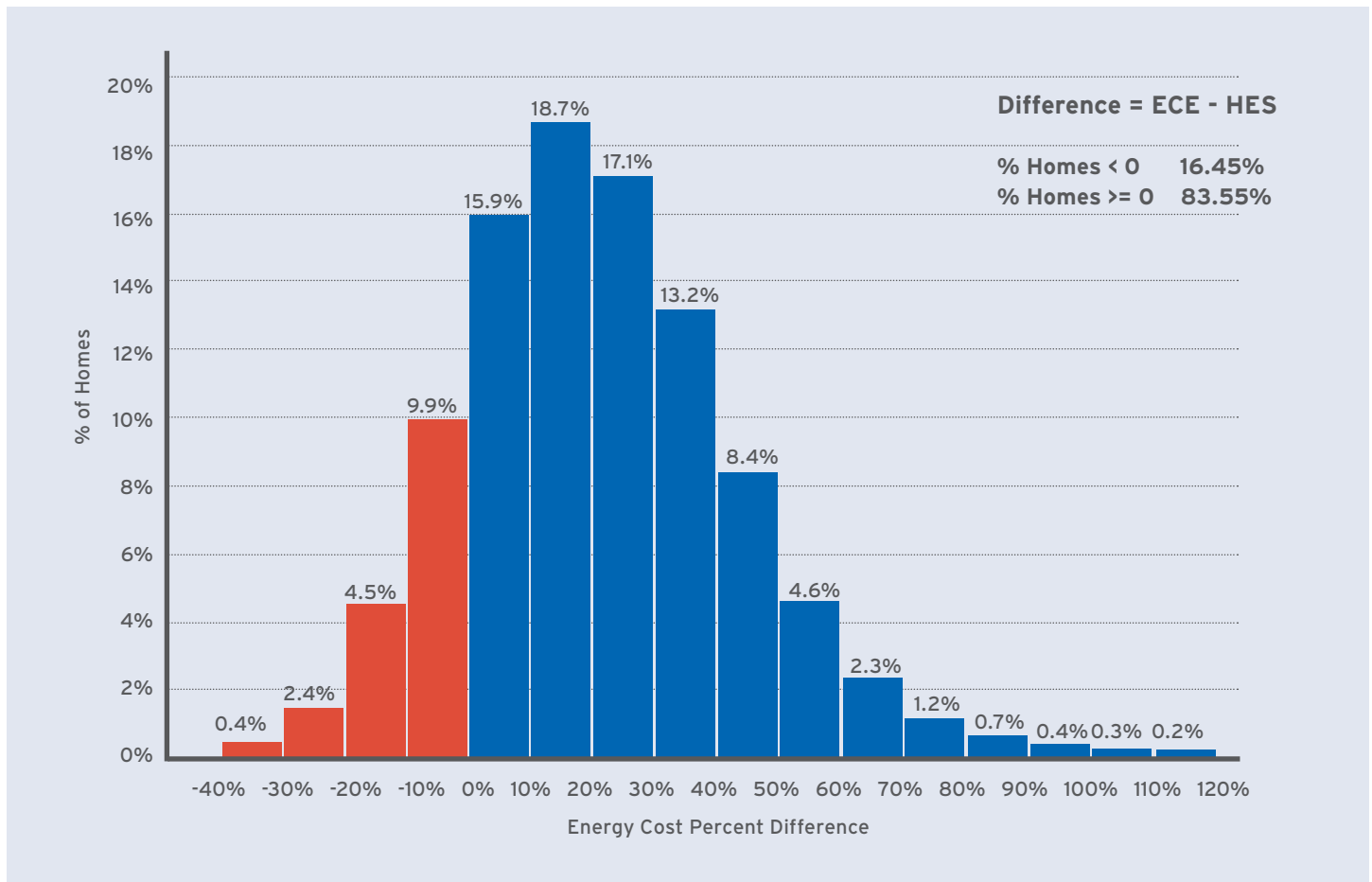
### Exhibit D3 Example inputs and outputs of the ECE lookup tool



To test and analyze ECE data, NREL retrieved a sampling of homes from the Home Energy Score database and calculated what the energy estimates would be using the ECE tool for those houses. In this way NREL could use the HES data as a “truth standard” for comparison. The figures below compare the cost data. In general, the ECE estimates costs to be higher than the HES, because all energy-related parameters are assumed to be the 20th percentile in

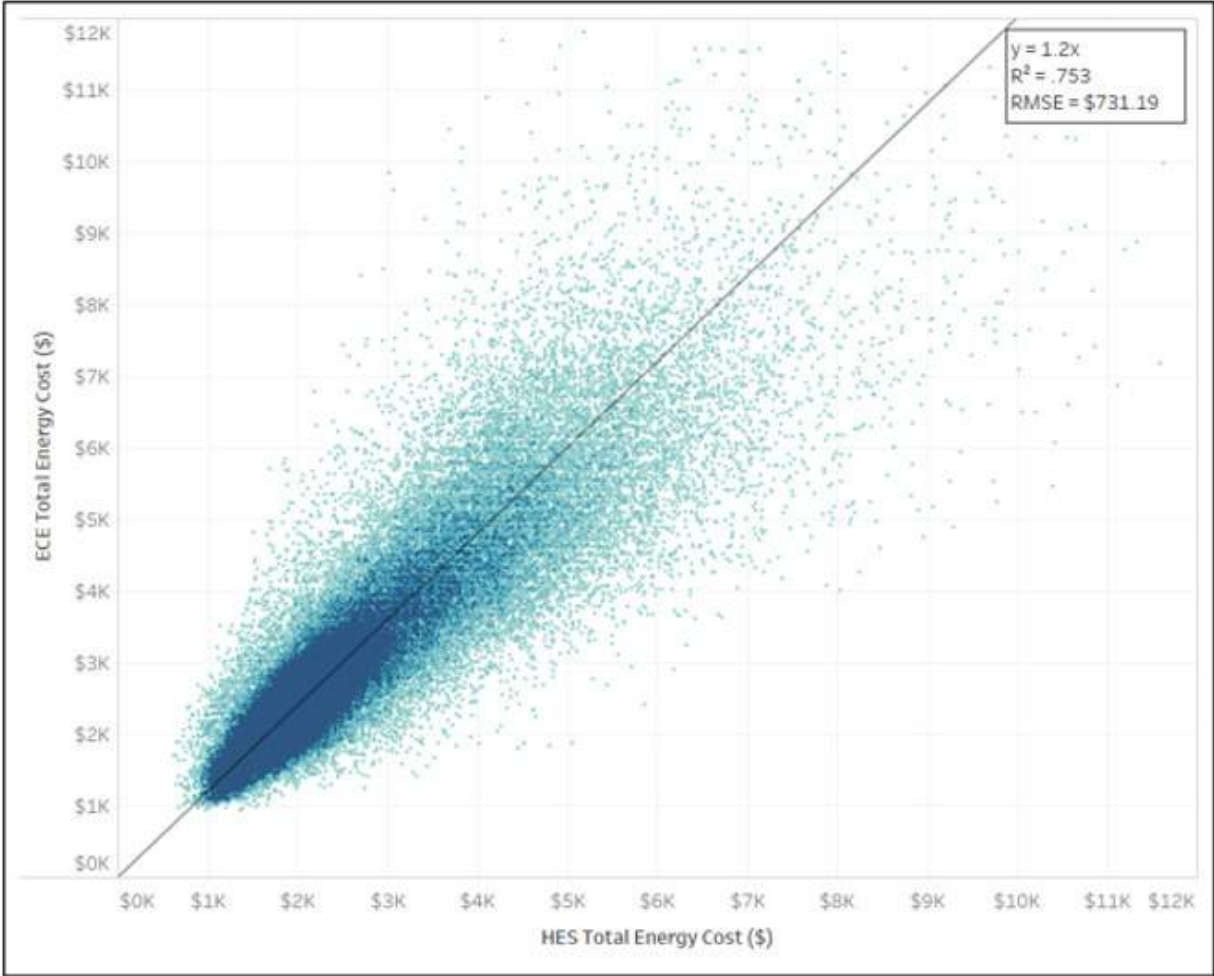
efficiency. This results in a majority of ECE costs being 0%–30% higher than HES, underscoring the tool’s conservatism. Additionally, ECE costs have a direct correlation with HES costs. Data points that diverge from this correlation have ECE parameters that do not align with the HES because 1) they are not available in the appraisal form, and 2) the assumptions used in ResStock do not match that home.

## Exhibit D4 Distribution of percent differences between the ECE and HES



**Notes:**  $(ECE\ Cost - HES\ Cost) / (HES\ Cost)$ ; positive percent differences indicate the ECE overpredicts compared to HES, while negative percent differences indicate an underprediction.

**Exhibit D5** Scatter plot of yearly energy costs as calculated by HES and by the ECE



**Notes:** The fit line,  $y=1.2x$ , is the expected relationship given the assumption of lower efficiency in the ECE. The  $R^2$  and RMSE values are calculated from this line.



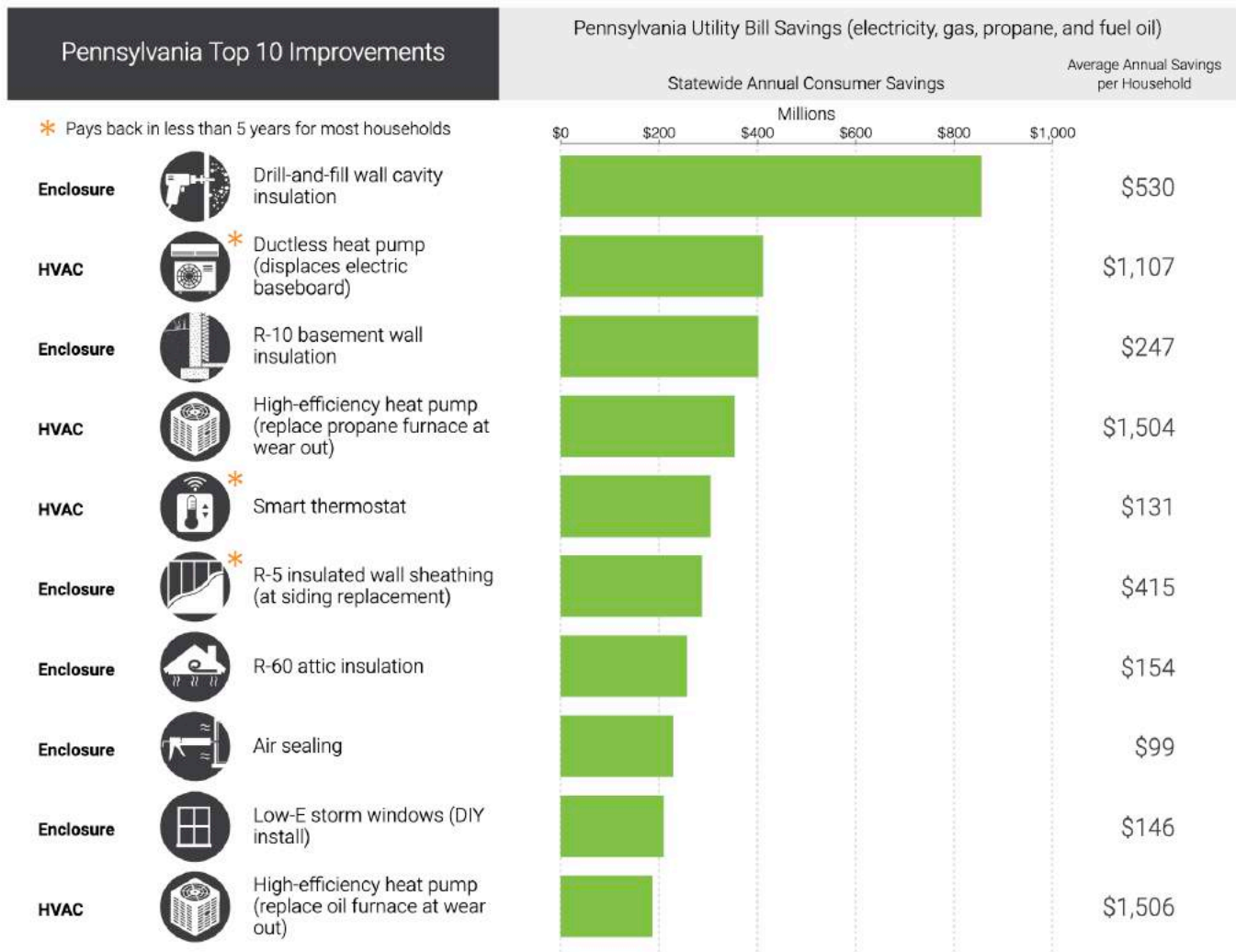
# Appendix E

## ResStock Representative State-Level Information

ResStock’s State Fact Sheets provide a summary of the cost-effective residential savings potential and top priority energy efficiency improvements in that state. This same data can be customized, simplified, and reconfigured to serve the needs of lenders and loan officers in their interactions with borrowers. ResStock accounts for the vast diversity in age,

size, construction practices, installed equipment, appliances, and resident behavior of the single-family and multifamily residential housing stock nationally, in addition to the diverse range of climates. As an example, Pennsylvania’s top 10 improvements are shown below.

### Exhibit E1 Pennsylvania top 10 improvements



Source: ResStock State Fact Sheets <https://resstock.nrel.gov/factsheets/>

# Appendix F

## Additional Green Mortgage Product/Process Recommendations

Below are additional recommendations for the GSEs from a home performance perspective. These recommendations are intended to improve their single-family green mortgage products and/or processes to streamline adoption and scale impact:

- **Adjust guidelines for allowances for small projects:** Energy reports are currently not required by the GSEs for basic energy and water efficiency upgrades with costs below \$3,500 for Fannie Mae or \$6,500 for Freddie Mac. We recommend that Fannie Mae increase its threshold to at least \$5,000, and ideally higher to align with Freddie Mac's and reduce market confusion. Currently as-completed appraisals are required for all improvements, regardless of size, including for smaller measures like programmable thermostats. Green mortgages could be streamlined significantly if basic improvements below these thresholds only require evaluations (i.e., automated AVM-based value adjustments confirmed manually by appraisers). As-completed appraisals would remain necessary for larger retrofit projects above these thresholds.
- **Extend timeline for previous energy reports:** Per GSE seller guidelines, a property may use an energy report that is less than 120 days old for green mortgage financing. Extending this window to at least two years will limit barriers to borrowers seeking financing for single-family properties. On the multifamily side, green building certifications dated within five years are recognized.
- **Improve data integration and facilitate systems updates:** Fannie Mae requires that lenders' loan origination systems (LOS) be able to submit certain energy data fields to Desktop Underwriter, Fannie Mae's automated underwriting system. Most lenders have not made system updates for these fields. Both GSEs require lenders to submit Uniform Loan Delivery Dataset (ULDD) data upon loan

delivery. Lender systems must be able to populate these fields specific to green mortgages and many have not yet been updated to do so, adding complication that limits adoption. The GSEs can work with the industry to determine if incentives or other mechanisms can spur LOS updates to better streamline data transfers. At the same time, the GSEs should ensure that their Uniform Appraisal Dataset redesign initiative incorporates a few critical foundational data fields (e.g., home energy cost estimate for all homes) to support these goals.

- **Expand underwriting:** Through data-driven analyses, the GSEs can evaluate the impact of utility expenses on borrowers and incorporate this information into standard underwriting practices. This would allow GSEs to beneficially account for reduced housing costs through green home improvement measures. Both Fannie Mae and Freddie Mac already have guidance in place to allow for higher expense ratios when improvements meet a certain efficiency threshold, but only for manually underwritten loans. By conducting pilots with access to much more information about home energy costs, expanded criteria can be considered and built into automated underwriting.
- **Expand Duty to Serve credit:** We recommend that, after the 2022-2024 plan cycle, FHFA reopen the DTS rulemaking. When the regulation is revised, we recommend amending Section 1282.34(d)(3) of the regulation to include any and all types of upgrades financed by green mortgages (including increasingly important resilience improvements) as qualifying for Duty to Serve credit. This would align with the GSEs' existing green mortgage requirements and would ease FHFA's added qualifying and reporting requirements. This approach is reasonable given the multiple benefits green improvements can provide to LMI households and the reduced risks for the GSEs.

# Appendix G

## Model Language for the GSEs' 2022–2024 Duty to Serve Plans

### Duty to Serve Overview

Under the Housing and Economic Recovery Act of 2008, the “Duty to Serve” provisions established by their regulator, the Federal Housing Finance Agency (FHFA), require Fannie Mae and Freddie Mac to facilitate a secondary market for mortgages on housing for very low-, low-, and moderate-income (LMI) families in three underserved markets: manufactured housing, affordable housing preservation, and rural housing. To fulfill this mandate, the FHFA’s Duty to Serve Regulation, published in December 2016, requires each GSE to adopt three-year Underserved Markets Plans with specific activities. The Affordable Housing Preservation market includes activities related to purchasing energy and water efficiency improvement loans on multifamily and single-family

properties with Fannie Mae or Freddie Mac first mortgage liens. Both GSEs can incorporate this report’s recommendations into their new plans due to FHFA in May 2021 for the 2022–2024 period. More information can be found on FHFA’s website.<sup>60</sup>

### Model Language for 2022–2024 Plans

The following proposed objectives and actions illustrate how the GSEs can take the recommendations in this report and build them into their upcoming Duty to Serve plans. These high-level actions will need further details, narrative, and impact discussion in the submission of the plans in order to meet FHFA’s requirements.

### Exhibit G1 Proposed objectives and actions for 2022–2024

Objective: Increase annual purchases of green mortgage loans from less than 200 in number to 5% of all loans for low- and moderate-income families by 2024.	
Proposed Actions for 2022–2024	
<b>Year 1—Loan Product</b>	<ul style="list-style-type: none"><li>To enable borrower and lender identification of green home improvement potential and to address burdensome project evaluations for lenders:<ul style="list-style-type: none"><li>Evaluate tools like NREL’s Home Energy Cost Estimator that can auto-generate a home’s energy cost estimate (ECE).</li><li>Develop and execute a pilot to assess one or more tools’ impact on consumer decision-making in pursuing green mortgage products.</li><li>Develop a plan to allow lenders to use prequalified eligible measure lists in order to streamline cost-effectiveness and eligibility determinations.</li></ul></li><li>Initiate discussions with the Uniform Appraisal Dataset (UAD) redesign initiative project team to share evaluation findings and consider necessary UAD data fields to support this objective.</li></ul>
<b>Year 2—Loan Product</b>	<ul style="list-style-type: none"><li>Based on findings in year 1, finalize the terms and publish guidance on how to incorporate such information into the appraisal standards and underwriting process to identify green mortgage candidates.</li><li>Collaborate with UAD redesign project managers to ensure key new data fields are added for home ECEs and other green home data in alignment with Duty to Serve and broader GSE goals.</li><li>Establish a lender outreach plan to promote use of new tool(s) and prequalified eligible measure lists so they can increase their ability to effectively market green mortgage products.</li></ul>
<b>Year 3—Loan Purchase</b>	<ul style="list-style-type: none"><li>Purchase a number of green mortgage loans representing 5% of all loans for low- and moderate-income families.</li></ul>

**Objective: Increase the percentage of Duty to Serve eligible green mortgage loans for basic retrofits (saving >15%) purchased annually that are underwritten with automated valuation models from zero to 50% by 2024.**

**Proposed Actions for 2022–2024**

**Year 1—Loan Product**

- Evaluate how to recognize the value added by basic green improvements below stated energy report size thresholds using automated methods, in collaboration with home performance experts.
- Develop a methodology for fulfilling the completion certification without the use of a full as-completed appraisal.
  - Identify third parties (e.g., qualified HERS or Home Energy Score raters) who can inspect, verify, and document green improvements after completion.
  - Develop a plan to pass findings from the inspection to automated valuation models (AVMs).

**Year 2—Loan Product**

- Work with industry stakeholders to ensure project completion data is integrated and accessible to AVMs and to lenders via a green database.
- Develop and publish guidelines for when automated valuation is permitted, a full as-completed appraisal is required, and a combination of automation and verification is acceptable.
- Work with key stakeholders in the appraisal industry to develop training and educational materials for appraisers and evaluators about changes to the valuation approach for this purpose.

**Year 3—Loan Purchase**

- Purchase a number of green mortgage loans underwritten with AVMs that represent 50% of Duty to Serve eligible green mortgage loans.

**Objective: In 5 of the top 10 energy-burdened areas of the United States, annually purchase a number of green mortgage loans that represent 10% of all loans for low- and moderate-income families by 2024.**

**Proposed Actions for 2022–2024**

**Year 1—Outreach**

- Identify five underserved communities with disproportionate concentrations of low-performing homes that make it more expensive to maintain safe and comfortable conditions (e.g., leveraging [ACEEE energy burden data](#)).
- Develop a plan to test new approaches to reach populations in these areas that are currently not well-served by access to comfortable, safe, and healthy green housing.
- Execute a pilot in at least two of these markets to more effectively offer the benefits of green mortgages.

**Year 2—Outreach**

- Develop and execute an incentive program for first-time home buyers, in collaboration with community programs and partnerships, to combine down payment assistance and affordable lending products with green mortgage financing in the five selected areas.

**Year 3—Loan Purchase**

- In the five selected energy-burdened areas, purchase a number of green mortgage loans representing 10% of all loans for low- and moderate-income families.



**Objective: Increase liquidity for green improvements and meet investor demand for green MBS by issuing 5% of all single-family MBS backed by green mortgages that finance existing home improvements by 2024.**

**Proposed Actions for 2022–2024**

**Year 1—Loan Product**

- Outline a calibration framework with tiers based on levels of energy efficiency for planned green improvements to existing homes (in addition to new construction):
  - Engage investors of ESG securities and reporting organizations to understand demand, drivers, and required disclosures for green bond securities and to allow them to review the framework.
  - Assess how required disclosure data on proposed and completed improvements will be consolidated from third parties and green databases.
  - Assess the feasibility to identify improvements financed outside the mortgage process that can be used to categorize a home's green tier within the framework.
- Develop and execute a pilot that evaluates expected savings on planned improvements with actual savings on completed improvements.
- Outline required changes to the ULDD and impacted systems to support required disclosures for the framework; engage industry stakeholders to begin the update process.

**Year 2—Loan Product**

- Update MBS disclosure documents to incorporate the calibration framework.
- Continue to lead efforts to update the ULDD; develop a plan to support internal and external impacted systems.

**Year 3—Loan Purchase**

- Issue a number of single-family MBS backed by green mortgages that finance existing home improvements that represents 5% of all single-family MBS and that includes a proportionate number of mortgages for low- and moderate-income homeowners.

# Appendix H

## Residential Green and Energy-Related Data Sources

Multiple databases and related data services have been developed by nonprofits and government entities to provide access to records of energy performance for homes. Four example products that could act as beneficial resources as discussed in this report include:

- RESNET National Registry
- HELIX from Northeast Energy Efficiency Partnerships
- Green Building Registry from Earth Advantage
- ResStock Analysis Tool and Home Energy Cost Estimator API service from National Renewable Energy Laboratory

The **RESNET National Registry** allows a public user to enter a street address at <https://www.hersindex.com/hers-rated-home-search/> to determine if that home has a HERS rating. If the home does have a HERS rating, then the following information is provided: rating company that rated the home, date that rating was completed, and the HERS Index Score of the home. RESNET also offers an API service that can be used to retrieve HERS records for a given address.

The **Home Energy Labeling Information eXchange (HELIX)** is a multi-state project that aims to automate the transfer of home energy data to Multiple Listing Services (MLSs) across the Northeast region. HELIX will make home energy information accessible to local MLSs and other market interests (e.g., assessors, appraisers, energy efficiency programs and service providers, lenders, and energy code officials), ultimately making the energy efficiency of homes visible and better understood at the time of sale or rental. Although HELIX focuses on the Northeast region, it aims to provide a replicable, open-source

model that can be used throughout the country. The project will include training delivered to real estate professionals as well as continuous engagement with stakeholders in the real estate market to ensure a useful and effective product. For more information on HELIX, visit <https://neep.org/home-energy-labeling-information-exchange-helix>.

The **Green Building Registry (GBR)**, developed by Earth Advantage, is a software-as-a-service system that aggregates green building data and makes it available through a public search website and an API to which listing services can directly connect. The system went live in late 2017 in conjunction with the City of Portland Home Energy Score program. It directly auto-populates listings in the state's largest MLS and transforms Home Energy Score data into a locally branded, two-page label format that provides local energy prices, local carbon information, and actionable linkage to contractors, financing products, and incentives. In 2018 the GBR deployed state-level reports based on Home Energy Score and HERS data that align with the NASEO-endorsed EMPRESS recommendations for home energy labels.

GBR contains all of the HERS Index ratings in the RESNET National Registry; the green certification data from LEED, NGBS, and the major regional green certifications; solar data from select localities; and Home Energy Score reports from select HES Partners. GBR contains over 1.7 million third-party verified home performance records. GBR has also integrated the Home Energy Cost Estimator tool from NREL to provide a reference value against which verified energy cost estimates from ratings can be compared. The GBR API is available to the MLS systems nationwide. For more information on the Green Building Registry, visit <https://www.greenbuildingregistry.com>.

The ResStock™ analysis tool is helping states, municipalities, utilities, and manufacturers identify which home improvements save the most energy and money. Across the country, there's a vast diversity in the age, size, construction practices, installed equipment, appliances, and resident behavior of the housing stock, not to mention the range of climates. These variations have hindered the accuracy of predicting savings for existing homes. With support from the US Department of Energy (DOE), researchers at NREL developed ResStock. It is a versatile tool that takes a new approach to large-scale residential energy analysis by combining:

- Large public and private data sources
- Statistical sampling
- Detailed subhourly building simulations
- High-performance computing

This combination achieves unprecedented granularity and, most importantly, accuracy in modeling the diversity of the single-family housing stock. With NREL supercomputing, the ResStock team has run more than 20 million simulations using a statistical model of housing stock characteristics. With this data, researchers have uncovered \$49 billion in potential annual utility bill savings through cost-effective energy efficiency improvements.

Detailed information on the technical and economic potential of residential energy efficiency improvements and packages is available for 48 states domestically. Policymakers, program designers, and manufacturers can use these results to identify improvements with the highest potential for cost-effective savings in a particular state or region, as well as to help identify customer segments for targeted marketing and deployment.

In 2020, NREL researchers used the ResStock database to create the Home Energy Cost Estimator tool described in *Appendix D* to produce a relatively conservative estimate of energy consumption and cost for any home in the United States.

For an example of how this data can be utilized, this home record (<https://us.greenbuildingregistry.com/green-homes/OR10009268>) shows that a home built

in 1912 has a poor Home Energy Score of 1. However, the verified energy cost estimate (ECE) of \$2,261/year is substantially lower than the reference ECE provided by NREL, which is \$2,900/year. Reviewing the home's HES report (<https://rpt.greenbuildingregistry.com/hes/OR10009268.pdf>) shows the home already has an efficient furnace and some insulation installed, but it could save another \$681/year if straightforward cost-effective improvements are made that have paybacks of 10 years or less.

Another example would be this new home built in 2020 (<https://us.greenbuildingregistry.com/green-homes/OR10188324>) that has a verified ECE of \$970/year from an HES report. This is compared with a reference ECE from NREL of \$1,450/year that might be expected from a code-built new home of the same size in this location.

## Why Asset Ratings versus Utility Bills?

Home energy costs can be derived from either asset data (via ratings like HERS and Home Energy Score and tools like NREL's Home Energy Cost Estimator) or operational data such as from utility bills. Asset ratings provide modeled information using data about a home's design and physical characteristics to reveal intrinsic energy performance with standardized assumptions about how it is operated. Utility bills provide operational data based on actual energy use, occupancy, and behavior, which can change significantly when a home's occupants change (e.g., an elderly couple selling their home to a family of six). This makes asset data and ratings more useful in the context of real estate transactions and transfers of ownership. For more on this distinction, visit <https://empress.naseo.org/home-energy-labeling-tools>.

In addition, analysis by the EMPRESS project team found that there are several laws that ban the sharing of utility data, but there are no laws banning the public sharing of asset ratings as of this writing. Please see "Considerations and Best Practices for Publicly Disclosing Energy Information" in the EMPRESS final report for more detail: [https://empress.naseo.org/Data/Sites/21/media/documents/empress-project-final-report\\_v1\[1\].pdf](https://empress.naseo.org/Data/Sites/21/media/documents/empress-project-final-report_v1[1].pdf).

# Endnotes

1. Sarah LaMonaca, Tyeler Matsuo, Brian O'Hanlon, and Lucy Kessler, *Charting the Course to Climate-Aligned Finance: Five Barriers to Alignment and How a Sectoral Approach Can Help*, RMI, 2020, <https://rmi.org/navigating-five-barriers-to-climate-aligned-finance/>.
2. "Record \$269.5bn Green Issuance for 2020: Late Surge Sees Pandemic Year Pip 2019 Total by \$3bn," Climate Bonds Initiative, January 24, 2021, <https://www.climatebonds.net/2021/01/record-2695bn-green-issuance-2020-late-surge-sees-pandemic-year-pip-2019-total-3bn>.
3. DM Anderson, DB Belzer, OV Livingston, and MJ Scott, *Assessing National Employment Impacts of Investment in Residential and Commercial Sector Energy Efficiency: Review and Example Analysis*, Pacific Northwest National Laboratory, 2014, [https://www.pnnl.gov/main/publications/external/technical\\_reports/PNNL-23402.pdf](https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23402.pdf).
4. Lyubov Pronina and Tom Freke, "Why Bonds Good for the Earth Now Carry a 'Greenium'," *Bloomberg Green*, October 29, 2020, <https://www.bloomberg.com/news/articles/2020-10-30/why-bonds-good-for-the-earth-now-carry-a-greenium-quicktake>; and S. MacAskill, E. Roca, B. Liu, R.A. Stewart, and O. Sahin, "Is There a Green Premium in the Green Bond Market? Systemic Literature Review Revealing Premium Determinants," *Journal of Cleaner Production*, Volume 280, Part 2, January 20, 2021, <https://www.sciencedirect.com/science/article/abs/pii/S0959652620345352>.
5. "Fannie Mae Issues More Than \$100 Million of Single-Family Green MBS Since April 2020," January 28, 2021, <https://www.fanniemae.com/newsroom/fannie-mae-news/fannie-mae-issues-more-100-million-single-family-green-mbs-april-2020>.
6. "Center for Climate-Aligned Finance," accessed February 1, 2021, <https://climatealignment.org/>.
7. "Uniform Appraisal Dataset: Improving the Quality and Consistency of Appraisal Data," accessed February 5, 2021, <https://singlefamily.fanniemae.com/delivering/uniform-mortgage-data-program/uniform-appraisal-dataset>.
8. "The Biden Plan to Build a Modern, Sustainable Infrastructure and an Equitable Clean Energy Future," accessed February 14, 2021, <https://joebiden.com/clean-energy/>.
9. "Consumer Expenditure Surveys," US Bureau of Labor Statistics data, 2019, <https://www.bls.gov/cex/tables.htm#annual>.
10. "Selected Housing Characteristics - American Community Survey," United States Census data, 2019, <https://data.census.gov/cedsci/table?q=us%20housing&tid=ACSDP1Y2019.DPO4&hidePreview=false>.
11. "Housing Affordability in the U.S.," Esri Demographics, accessed January 22, 2021, <https://www.arcgis.com/apps/Cascade/index.html?appid=1419fe7ee70c4267a7258eb59a9a824c>; and *The State of the Nation's Housing 2019*, Joint Center for Housing Studies of Harvard University, 2019, [https://www.jchs.harvard.edu/sites/default/files/reports/files/Harvard\\_JCHS\\_State\\_of\\_the\\_Nations\\_Housing\\_2019%20%281%29.pdf](https://www.jchs.harvard.edu/sites/default/files/reports/files/Harvard_JCHS_State_of_the_Nations_Housing_2019%20%281%29.pdf).
12. "HUD's New Rental Affordability Index," *PD&R Edge*, accessed January 25, 2021, <https://www.huduser.gov/portal/pdredge/pdr-edge-trending-110716.html>.



13. David Stiff, "Land Values Drive Home Price Volatility," *CoreLogic Insights Blog*, September 20, 2016, <https://www.corelogic.com/blog/2016/09/land-values-drive-home-price-volatility.aspx>; and Brad Hunter, "Skyrocketing Land Costs Have Driven the Runup in Home Prices," *Forbes*, June 28, 2019, <https://www.forbes.com/sites/bradhunter/2019/06/28/skyrocketing-land-costs-have-driven-the-runup-in-home-prices/?sh=6e9429063631>.
14. "U.S. Billion-Dollar Weather and Climate Disasters: Overview," NOAA National Centers for Environmental Information (NCEI), 2021, <https://www.ncdc.noaa.gov/billions/>.
15. Christopher Flavelle, "U.S. Disaster Costs Doubled in 2020, Reflecting Costs of Climate Change," *New York Times*, January 7, 2021, <https://www.nytimes.com/2021/01/07/climate/2020-disaster-costs.html>.
16. "How Climate Change Is Changing Your Insurance," *PBS News Hour*, November 27, 2018, <https://www.pbs.org/newshour/economy/making-sense/how-climate-change-is-changing-your-insurance>.
17. Coral Davenport and Jeanna Smialek, "Federal Report Warns of Financial Havoc from Climate Change," *New York Times*, September 8, 2020, <https://www.nytimes.com/2020/09/08/climate/climate-change-financial-markets.html>.
18. *Mitigation Saves: Mitigation Saves up to \$13 per \$1 Investment*, National Institute of Building Sciences, 2020, [https://cdn.ymaws.com/www.nibs.org/resource/resmgr/reports/mitigation\\_saves\\_2019/mitigationsaves2019\\_complete.pdf](https://cdn.ymaws.com/www.nibs.org/resource/resmgr/reports/mitigation_saves_2019/mitigationsaves2019_complete.pdf).
19. Ariel Dreihobl, Lauren Ross, and Roxana Ayala, *How High Are Household Energy Burdens? An Assessment of National and Metropolitan Energy Burden across the United States*, American Council for an Energy-Efficient Economy (ACEEE), September 2020, <https://www.aceee.org/sites/default/files/pdfs/u2006.pdf>.
20. "One in Three U.S. Households Faces a Challenge in Meeting Energy Needs," US Energy Information Administration, September 19, 2018, <https://www.eia.gov/todayinenergy/detail.php?id=37072>.
21. Dreihobl et al., *How High Are Household Energy Burdens?*, ACEEE, 2020.
22. "'The Color of Law' Details How U.S. Housing Policies Created Segregation," NPR's *All Things Considered*, May 17, 2017, <https://www.npr.org/2017/05/17/528822128/the-color-of-law-details-how-u-s-housing-policies-created-segregation>.
23. Brian Thompson, "The Racial Wealth Gap: Addressing America's Most Pressing Epidemic," *Forbes*, February 18, 2018, <https://www.forbes.com/sites/brianthompson1/2018/02/18/the-racial-wealth-gap-addressing-americas-most-pressing-epidemic/#5e0fa3a07a48>.
24. Danyelle Solomon, Connor Maxwell, and Abril Castro, "Systemic Inequality: Displacement, Exclusion, and Segregation," Center for American Progress, August 7, 2019, <https://www.americanprogress.org/issues/race/reports/2019/08/07/472617/systemic-inequality-displacement-exclusion-segregation/>.
25. Dreihobl et al., *How High Are Household Energy Burdens?*, ACEEE, 2020.
26. Brady Seals and Andee Krasner, *Health Effects from Gas Stove Pollution*, RMI, Physicians for Social Responsibility, Mothers Out Front, and Sierra Club, 2020, <https://rmi.org/insight/gas-stoves-pollution-health/>.
27. "Special Report: Global Warming of 1.5°C: Summary for Policymakers," The Intergovernmental Panel on Climate Change (IPCC), 2018, <https://www.ipcc.ch/sr15/chapter/spm/>.

28. Benjamin Goldstein, Dimitrios Gounaridis, and Joshua P. Newell, "The Carbon Footprint of Household Energy Use in the United States," *Proceedings of the National Academy of Sciences*, August 2020, <https://www.pnas.org/content/117/32/19122>.
29. "Housing Finance at a Glance: A Monthly Chartbook (December 2020)," Urban Institute Housing Finance Policy Center, December 2020, [https://www.urban.org/sites/default/files/publication/103430/housing-finance-at-a-glance-a-monthly-chartbook-december-2020\\_0\\_0.pdf](https://www.urban.org/sites/default/files/publication/103430/housing-finance-at-a-glance-a-monthly-chartbook-december-2020_0_0.pdf).
30. "Mortgage Statistics: Historical & Current United States Residential Mortgage Origination & Loan Servicing Statistics for 2021," Mortgage Calculator, accessed February 4, 2021, <https://www.mortgagecalculator.org/helpful-advice/mortgage-statistics.php>; and Mortgage Bankers Association (MBA).
31. Ibid.
32. *Improving America's Housing 2019*, Joint Center for Housing Studies of Harvard University, 2019, [https://www.jchs.harvard.edu/sites/default/files/reports/files/Harvard\\_JCHS\\_Improving\\_Americas\\_Housing\\_2019.pdf](https://www.jchs.harvard.edu/sites/default/files/reports/files/Harvard_JCHS_Improving_Americas_Housing_2019.pdf).
33. "The Housing Satisfaction Gap: What People Want, but Don't Have," Demand Institute, 2014, <https://climateaccess.org/system/files/top-10-housing-desires.pdf>.
34. "2020 REALTORS® Sustainability Report," National Association of REALTORS, April 30, 2020, <https://www.nar.realtor/sites/default/files/documents/2020-sustainability-04-30-2020.pdf>.
35. "Why Energy Efficiency Upgrades," US Department of Energy Office of Energy Efficiency & Renewable Energy, accessed January 16, 2021, <https://www.energy.gov/eere/why-energy-efficiency-upgrades>.
36. *Home Energy Efficiency and Mortgage Risks*, Institute for Market Transformation and UNC Center for Community Capital, March 2013, [https://www.imt.org/wp-content/uploads/2018/02/IMT\\_UNC\\_HomeEEMortgageRisksfinal.pdf](https://www.imt.org/wp-content/uploads/2018/02/IMT_UNC_HomeEEMortgageRisksfinal.pdf).
37. Robert Argento, Xian Fang Bak, and Lariece M. Brown, *Energy Efficiency: Value Added to Properties & Loan Performance*, Freddie Mac Single-Family, 2019, [https://sf.freddiemac.com/content/\\_assets/resources/pdf/fact-sheet/energy\\_efficiency\\_white\\_paper.pdf](https://sf.freddiemac.com/content/_assets/resources/pdf/fact-sheet/energy_efficiency_white_paper.pdf).
38. Martin J. Brown and Taylor Watkins, *The "Green Premium" for Environmentally Certified Homes: A Meta-Analysis and Exploration*, 2016, <http://martinjohnbrown.net/wp-content/uploads/2016/02/green-premium-metaanalysis-2015-10-24-for-researchgate.pdf>.
39. S. MacAskill et al., "Is There a Green Premium in the Green Bond Market?" 2021.
40. "Basics of Fannie Mae Single-Family MBS," Fannie Mae, February 2021, <https://www.fanniemae.com/media/17751/display>.
41. "Multifamily Green MBS," Fannie Mae, accessed February 10, 2021, <https://capitalmarkets.fanniemae.com/sustainable-bonds/green-bonds/multifamily-green-mbs>.

42. Aleksandrs Rozens, "Fannie Mae Multifamily Closes 2017 with Record Volume of More than \$67 Billion," Fannie Mae, January 25, 2018, <https://www.fanniemae.com/newsroom/fannie-mae-news/fannie-mae-multifamily-closes-2017-record-volume-more-67-billion>; Aleksandrs Rozens, "Fannie Mae Multifamily Closes 2018 with Volume of More than \$65 Billion," Fannie Mae, January 24, 2019, <https://www.fanniemae.com/newsroom/fannie-mae-news/fannie-mae-multifamily-closes-2018-volume-more-65-billion>; Aleksandrs Rozens, "Fannie Mae Multifamily Closes 2019 with Record Volume of More than \$70 Billion," Fannie Mae, January 16, 2020, <https://www.fanniemae.com/newsroom/fannie-mae-news/fannie-mae-multifamily-closes-2019-record-volume-more-70-billion>; and "Fannie Mae Multifamily Closes 2020 with Record Volume of More than \$76 Billion," Fannie Mae, January 14, 2021, <https://www.fanniemae.com/newsroom/fannie-mae-news/fannie-mae-multifamily-closes-2020-record-volume-76-billion>.
43. "Weatherization Works!", US Department of Energy Office of Energy Efficiency & Renewable Energy, 2019, <https://www.energy.gov/sites/prod/files/2019/07/f64/WAP-Fact-Sheet-2019.pdf>.
44. "Uniform Loan Delivery Dataset: Improving Loan Delivery Consistency," Fannie Mae, Accessed February 2, 2021, <https://singlefamily.fanniemae.com/delivering/uniform-mortgage-data-program/uniform-loan-delivery-dataset>.
45. 12 CFR Part 1282, "Enterprise Duty to Serve Underserved Markets," Federal Housing Finance Agency, Section 1282.34(d)(3), December 29, 2016, <https://www.govinfo.gov/content/pkg/FR-2016-12-29/pdf/2016-30284.pdf>.
46. "ResStock: State Fact Sheets," National Renewable Energy Laboratory, accessed January 17, 2021, <https://resstock.nrel.gov/factsheets/>.
47. Seals and Krasner, *Health Effects from Gas Stove Pollution*, 2020.
48. *The Impact of Fossil Fuels in Buildings: A Fact Base*, RMI, 2019, <https://rmi.org/insight/the-impact-of-fossil-fuels-in-buildings/>.
49. Michael Neal, Sarah Stochak, Linna Zhu, and Caitlin Young, "How Automated Valuation Models Can Disproportionately Affect Majority-Black Neighborhoods," Urban Institute, December 29, 2020, <https://www.urban.org/research/publication/how-automated-valuation-models-can-disproportionately-affect-majority-black-neighborhoods>.
50. "The Biden Plan to Build a Modern, Sustainable Infrastructure and an Equitable Clean Energy Future," accessed February 14, 2021, <https://joebiden.com/clean-energy/>.
51. "Home Energy Labeling: Residential Energy Disclosure Policies in States and Cities," National Association of State Energy Officials (NASEO), accessed January 11, 2021, <https://www.naseo.org/issues/buildings/home-energy-labeling>.
52. "Center for Climate-Aligned Finance," accessed February 1, 2021, <https://climatealignment.org/>.
53. Dr. Lindsay Owens, *Soaked: A Policy Agenda to Prepare for a Climate-Triggered Housing Crash*, The Great Democracy Initiative, July 2020, <https://greatdemocracyinitiative.org/wp-content/uploads/2020/07/Climate-and-Housing-Report-Final-Copy.pdf>.
54. Lowell Ungar, "Three Steps Federal Agencies Can Take toward a Better Climate," American Council for an Energy-Efficient Economy (ACEEE), July 29, 2020, <https://www.aceee.org/blog-post/2020/07/three-steps-federal-agencies-can-take-toward-better-climate>.
55. Brown and Watkins, *The "Green Premium" for Environmentally Certified Homes*, 2016.

56. "Green Building Certifications (Multifamily)," Fannie Mae, accessed February 12, 2021, <https://multifamily.fanniemae.com/sites/g/files/koqyhd161/files/2019-12/4250.pdf>.
57. Rachel Cluett, Marshall Duer-Balkind, James Perakis, James Tosh, and Molly Simpson, *Driving Market Transformation: Ranking and Rewarding Certifications for Energy-Efficient and Healthy Multifamily Buildings*, Fannie Mae, September 2020, <https://multifamily.fanniemae.com/media/14001/display>.
58. Danny Parker, Evan Mills, Leo Rainer, Norm Bourassa, and Greg Homan, *Accuracy of the Home Energy Saver Energy Calculation Methodology*, Lawrence Berkeley National Laboratory, 2012, <http://hes-documentation.lbl.gov/accuracy>; and Emelie Cuppernell, *Existing Home Energy Rating and Disclosure Laws, Programs and Best Practices*, New York State Energy Research and Development Authority (NYSERDA), September 2015, <http://www.ulysses.ny.us/pdf/Attachment-2.-Report-on-Existing-Home-Energy-Rating-and-Disclosure-Programs.pdf>.
59. *Selling Guide*, Fannie Mae Single Family, February 3, 2021, <https://singlefamily.fanniemae.com/media/25071/display>; and *Seller/Service Guide*, Freddie Mac Single-Family, February 10, 2021, [https://guide.freddiemac.com/ci/okcsFattach/get/1002095\\_2](https://guide.freddiemac.com/ci/okcsFattach/get/1002095_2).
60. "Duty to Serve Program," Federal Housing Finance Agency, accessed January 9, 2021, <https://www.fhfa.gov/PolicyProgramsResearch/Programs/Pages/Duty-to-Serve.aspx>.



Rita Ballesteros, David Heslam, and Greg Hopkins, *Build Back Better Homes: How to Unlock America's Single-Family Green Mortgage Market*, RMI, 2021,  
<http://www.rmi.org/insight/build-back-better-homes>.

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