ELEVATE
Equity through climate action

Financing Single-Family Electrification and Clean Energy Projects

Can Retrofit Loans Be Delivered with Reasonable Terms and Savings?

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Executive Summary

While the Inflation Reduction Act (IRA) provides unprecedented incentives to fund and finance energy-saving retrofits to low-and moderate-income (LMI) housing, challenges remain in implementing and paying for these projects. Despite historic funding across federal, state, and local incentive programs (especially for LMI projects), funding gaps remain, keeping these important clean energy and cost-saving projects out of reach for many LMI households.

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Technical complexities have also proven to be challenging, especially when combining technologies for decarbonization projects and measuring and ensuring savings for participants. An aspect of this technical complication is also inherent in the financial viability of projects. Combining various measures can have a direct impact on the financial viability of the project and whether there is a funding gap remaining after incentives. Combining these complex technologies also presents challenges with procurement, logistics, stacking incentives, and more – all these have been found to have an impact on the financial viability of projects.

This paper focuses on one segment of the LMI retrofit market and sets out to identify the potential funding gaps, and how these various elements of a retrofit can impact these funding gaps and overall financial viability. The aim is to identify how retrofits can be shaped and targeted to widen the universe of projects that 1) do not have funding gaps or 2) have funding gaps that can be financed in a way that provides reasonable terms and savings for LMI households. While not all projects may hit the mark, understanding how these elements fit together will help program administrators and lenders identify and serve wider segments of LMI households.

While this guide only analyzes single-family homes in Chicago and Minneapolis, it is believed that the approach and findings will provide learning that is relevant for other geographies and building types.

The IRA provides unprecedented funding for energy retrofits to the nation's LMI housing stock, which is needed to advance clean energy, social equity, and climate justice goals, as well as to improve the health, safety, and comfort of LMI households. Even with this funding -- which is subject to change based on the priorities of the incoming administration, the nation's need for energy retrofit funding far outstrips available financial resources, and for many projects, funding gaps remain even after all IRA and other financial incentives are exhausted. Clearly, this depends on the many factors that comprise the energy retrofit, like the existing condition of the home, the retrofit measures included, state regulatory framework, the income and tax status of the property owner or occupants, or other important characteristics. For LMI projects where incentives cannot eliminate the gap in costs, providing financing with reasonable terms and allowing for reasonable customer energy savings will be critical for successful national implementation.

While this paper will be useful to many stakeholders, it targets several primary audiences.

- The first is IRA program implementers, i.e., the Greenhouse Gas Reduction Fund (GGRF), Home Efficiency Rebate (HER), and Home Electrification Appliance Rebate (HEAR) programs.
- The second audience is the lenders that work with and through these programs.
- Lastly, project developers who submit project proposals to these programs will benefit indirectly from this analysis.

As shown through a case study approach, program developers can better understand the financial viability and risk of residential energy retrofit projects with a clearer understanding of housing, energy, project, and financial characteristics and how those characteristics affect costs, savings, payback, and potential loan terms. The case study results show the potential for annual energy cost savings to be used to reasonably fund subsidized loans to homeowners, or, when combined with available incentives, to achieve 100% project financing. The paper discusses the trade-offs and implications of using energy cost savings to fund energy retrofit loans for LMI lenders to consider. The paper recommends that LMI lenders strongly consider using energy cost savings to underwrite retrofit loans, provided appropriate underwriting and structural safeguards are put in place.

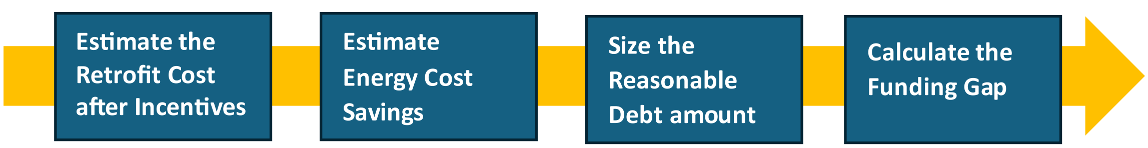
The aim is to identify project scopes and loan terms that ensure energy cost savings with project payback periods that are less than the expected lifetime of the energy equipment being financed. While not every project with a funding gap after incentives are applied will meet these criteria or be a good candidate for financing, it is believed that by understanding how project characteristics impact financing viability, program administrators can design programs around more efficient project scopes and lenders can develop more targeted loan products, increasing the share of electrification and clean energy projects that can be appropriately financed. These developers and lenders can also better understand how requirements for savings and reasonable payback can impact their universe of projects being financed.

> ***By understanding how project characteristics impact financing viability, program administrators and lenders can develop more targeted loan products, increasing the share of electrification and clean energy projects that can be appropriately financed.***

Project developers can use this knowledge to help scope projects in a way that ensures savings and reasonable payback. For example, they can be more confident in their understanding of how combining certain measures in different geographies impacts their ability to gain the best financial terms and best payback.

This report focuses on single-family homes in two cold-climate Midwest markets and looks at both full and partial-electrification project case studies. It is believed that the findings will help program administrators and lenders better shape project deployment and financing for a wide variety of projects, properties, and loan types across the country.

Financial Methodology



The paper includes sensitivity analyses for many project characteristics across four single-family properties and measures the financial impacts of each scenario on viable financing. In total, 168 different sensitivities are presented, with key assumptions and pivot scenarios provided. The sensitivity analyses examine how changes in key financial variables, including loan interest rate and local conditions such as retrofit costs, local incentives, and energy costs, impact financial viability. Some of the key findings are:

Baseline Analysis
After IRA incentives are applied, funding gaps remain: For retrofit projects which ranged in gross costs of $38,000 to $58,000, funding gaps of $6,000 to $26,000 (or 13 to 49%) remain.
Using energy cost savings to fund reasonable debt helps close funding gaps substantially: As all scenarios included the installation of Solar PV, all scenarios produced energy cost savings which could fully (3 cases) or partially finance (13 of 16 cases) the post-IRA funding gap. At 6% interest, loan amounts of $7,000 to $17,000 were reasonably achievable, including a 20% holdback or reserve.

Key Sensitivity Analyses

Lowering the Loan Interest Rate increases the universe of fundable projects: Reducing the subsidized loan interest rate from 6% to 0% was highly impactful, reducing the average funding gap 131% or an average of $5,000.
Eliminating the Energy Savings Holdback lowered funding gaps but increased risk: Reducing the baseline Energy Savings Holdback reserve from 20% of savings to 0% lowered funding gaps somewhat, noting that the increased risk to LMI households would outweigh the benefits.
Eliminating Solar increases the funding gap and lowers savings: All scenarios had substantially increased funding gaps when the benefits of solar PV were removed, showing the energy cost saving potential of solar installations and ability for such installations to create energy cost savings which in turn can fund debt for other, complimentary energy retrofit improvements such as heat pumps.
Elimination of incentives increases funding gaps: The elimination of certain incentives, such as HEAR/HER rebates, state and local incentives, and net metering was highly impactful and made most scenarios financially infeasible for LMI homeowners.

Program managers and lenders should consider the following implications of using energy cost savings to fund loans to homeowners for energy retrofits:

Risk Mitigation

Using estimated Energy Cost savings to underwriting debt to LMI households raises several trade-offs for lenders to consider, including ensuring energy equity, creating a secondary loan market and developing de-risked loan program structures to ensure positive financial results for LMI homeowners and lenders alike.

Savings & Risk

While risks are inherent in using energy savings estimates to fund debt, the mandate to improve the financial standing of LMI residents suffering from high energy burden should require those risks be overcome.

Project Characteristics

various project characteristics and how they are combined will impact savings, including the upgrade measures, project cost, incentives, energy costs, and location.

GGRF Eligibility

Lenders utilizing GGRF funding must meet six requirements for eligibility: 1. Reduction/elimination of GHG; 2. Reduction/elimination of Other Emissions; 3. Deliver community benefits; 4. Deliver "but for" financing; 5. Mobilize private capital; and 6. Support only commercialized technologies. GGRF lenders are currently developing more specific eligibility criteria. The SF energy retrofit packages contained in this report for full electrification broadly qualify with these criteria. Partial electrification retrofits may qualify, depending on the remaining gas-fueled appliances. Program managers and lenders will need to comply with their lender's specific GGRF program eligibility criteria. It is worth noting that for the 16 baseline scenarios included in the report, the estimated energy cost savings were between 30% and 83%, well above a 20% energy cost savings threshold. All baseline projects in this analysis showed measurable CO_2 emissions reductions, estimated between 3.4 to 7.8 $MTCO_2e$.

Location & Income

Local demographics can impact eligibility for programs and incentives. Local regulations, codes, and incentives can help or hinder the project's capital and value stack.

Contents

Introduction

Since the Inflation Reduction Act was announced in August 2022, federal agencies have been providing detailed guidance on its incentives, as well as finalizing the roll-out of the Greenhouse Gas Reduction Fund (GGRF) and working with states to implement the federally funded Home Efficiency Rebate (HER) and Home Electrification Appliance Rebate (HEAR) programs. Now, two years after the enactment, the low- and moderate-income housing community has nearly full visibility into the full menu of IRA incentives and how they work. When combined with existing state, local, and utility incentives, the IRA provides the largest and most comprehensive set of electrification and clean energy incentives available for housing in US history, especially for LMI households.

Clearly, this depends on the many factors that comprise the energy retrofit, like the existing condition of the home, the retrofit measures included, state regulatory framework, the income and tax status of the property owner or occupants, or other important characteristics. For projects where incentives cannot eliminate the gap in costs, providing financing with reasonable terms and allowing for reasonable customer energy savings will be critical for successful national implementation.

The analysis contained in this guide looks at the viability of project financing by analyzing case study projects and measuring how various aspects of the project scope, eligibility, and financial terms can impact net costs and energy cost savings, and whether energy cost savings can reasonably be used to fund debt. The aim is to identify project scopes and loan terms that ensure energy cost savings with project payback periods that are less than the expected lifetime of the energy equipment being financed. While not every project with a funding gap after Incentives are applied will be a good candidate for financing, it is believed that by understanding how project characteristics impact financing viability, program administrators can design programs around more efficient project scopes and lenders can develop more targeted loan products, increasing the share of electrification and clean energy projects that can be appropriately financed.

By understanding how project characteristics impact financing viability, program administrators and lenders can develop more targeted loan products, increasing the share of electrification and clean energy projects that can be appropriately financed.

This report focuses on single-family homes in two cold-climate Midwest markets and looks at both full and partial electrification project case studies. It includes sensitivity analyses for many project characteristics across each of the four properties and measures the financial impacts of each scenario on viable financing. It is believed that the findings will help program administrators and lenders better shape project deployment and financing for a wide variety of projects, properties, and loan types across the country.

This analysis raises important policy and loan program implications, like whether the use of projected energy cost savings should be used to fund subsidized debt to qualifying LMI homeowners. The goal of any LMI housing finance program should be to improve energy equity and not adversely impact the financial position of the homeowner. GGRF and other LMI housing lenders are best positioned to evaluate the inherent tradeoffs of using energy cost savings to fund subsidized homeowner debt and to develop loan programs, terms, structures, and underwriting criteria, which achieve positive financial outcomes for LMI participants and the deployment goals of GGRF program administrators.

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1. Housing and energy characteristics

This research focuses on single-family homes in Chicago and Minneapolis. While there is a diversity of housing stock in each city, single-family homes make up the largest residential property segment and the greatest potential for individual retrofits and loans, with single-family homes comprising 66% of residential buildings in Chicago and 49% in Minneapolis[1]. The predominant heating source in both cities is natural gas. However, electric resistance heating is very common and presents an important and unique energy profile and set of retrofit requirements. As such, this analysis begins with two single-family homes in each city, one currently using natural gas heating and one using electric resistance heating. Chicago homes participated in the Elevate administered Beneficial Electrification Program, where thorough energy audits were conducted, and energy usage data analyzed. Similarly, in Minneapolis, one natural gas and one electric resistance home was identified. While energy data was not available for these properties, NREL's REStock[2] database was used to identify baseline energy usage for each home. Access to energy data is often a barrier for many households and programs. Energy data was not weather normalized.

				
City:	Chicago	Chicago	Minneapolis	Minneapolis
Construction:	Brick	Brick/frame	Frame	Frame
Annual electricity usage:	5,319 kWh	9,850 kWh	7,917 kWh	8,795 kWh
Electricity costs:	$1,118	$1,865	$1,681	$1,841
Gas usage	1,250 therms	307 therms	1,255 therms	310 therms
Gas costs:	$1,490	$547	$1,387	$442
Total energy costs:	$2,608	$2,412	$3,068	$2,283
Heating source:	Natural gas	Electric Resistance	Natural gas	Electric resistance

[1] NREL: Achieving 50% Energy Savings in Chicago Homes: https://www.elevatenp.org/wp-content/uploads/Achieving-50-Energy-Savings-in-Chicago-Homes-1.pdf
[2] https://resstock.nrel.gov/

2. Project and financial characteristics

Project and financial characteristics in this context are aspects of the energy retrofit project that can impact costs, savings, and the ability to finance a project. These can include various characteristics of the property, the property owner, regulatory rules and incentives, or the loan terms. For example, characteristics of the property owner can include their income and whether they qualify for income-eligible incentives, their tax status and whether they can capture tax credits or benefits, their credit score and what loan terms they are eligible for.

The same scope of retrofit can have very different financial outcomes if these characteristics differ. Understanding the impact of these financial characteristics on the cost, savings, or financing requirements can provide guidance on how programs can be designed to maximize effectiveness and financial viability.

The same scope of retrofit can have very different financial outcomes if project and financial characteristics differ.

Two scopes of retrofit were used for each property analyzed, full electrification and partial electrification. By adjusting these characteristics in different ways across the same retrofit projects, how these characteristics impact financial viability can be measured.

Property Owner Characteristics	
Income	Income has direct and indirect impact on the financial viability of a project. Some incentives are specifically targeted to certain income categories, like less than 80% of Area Medium Income (AMI). Homeowner income impacts credit scores and access to financing.
Tax status	Tax status can impact the ability of property owners to capture tax credits and other tax benefits. Investment Tax Credits (ITC) available to property owners require the owner to have taxable income, which may eliminate participation by some low-income homeowners. While outside the scope of this paper, for non-individual taxpayers, new rules for Direct Pay/Elective Pay and Transferability of certain tax credits may allow greater flexibility.
Property Ownership	Property ownership has a direct and indirect impact on financial viability. ITC targeted to individual taxpayers, like Section 25C and 25D credits require that the property be owner-occupied. For non-owner-occupied rental housing, issues around "split incentives" (e.g. where capital costs are borne by the landlord, but utility costs and resulting savings are realized by the renter), mean there is often less incentive for owners to implement energy saving measures when they don't pay the energy bills.
Credit Score	Credit scores and access to banking have a direct impact on the ability to secure a loan, as well as the loan's terms. This directly impacts the financial viability of projects.

Project Characteristics	
Upgrade measures	The upgrades that are part of the retrofit package are a critical aspect of financial viability. Some measures cost significantly more to implement or have greater or lesser savings. Incentives vary for different measures, as well. Therefore, how measures are combined can impact financial viability. One measure alone may not show savings. But paired with other measures, the entire retrofit can show savings.
Construction Type	New construction versus retrofit projects is typically eligible for different incentives.

Property Characteristics	
Building type	Some incentives are targeted at owner-occupied single-family homes, and some at commercially owned, subsidized, or non-subsidized multi-family buildings. Multi-family buildings present additional challenges to realizing savings and payback for energy upgrades. There is often less incentive for owners of multifamily buildings to implement energy upgrades if the savings go to tenants and not to repaying debt.
Metering	Whether a building is master-metered or multi-metered can impact whether the owner or resident realizes savings benefits or has access to energy benefits. With solar photovoltaics, for example, wiring a rooftop array to multiple meters is costly, and the property owner may only see part of the savings but bear all the expenses.
Heating fuel	The source of heating fuel, which differs regionally, can greatly impact the existing energy costs and future savings of a retrofit project. For example, switching to air-source heat pumps will measurably increase electricity usage. While natural gas usage can be eliminated, savings will be dependent on the cost of each fuel. And energy cost increases are possible. While electric resistance, propane or fuel oil heating typically see measurable savings after electrification because the overall cost of fuel is high compared to electricity or the equipment being replaced is inefficient.
Deferred Maintenance	Homes owned by LMI homeowners are more likely to have issues of deferred maintenance. The need for repairs or upgrades to energy equipment, roofing, or the building envelope may present barriers to implementing electrification and clean energy measures. These repairs or upgrades often need to be incorporated into the retrofit package, impacting costs, payback, and overall financial viability, and often available incentives for such deferred maintenance items are low or non-existent. Program administrators and lenders should understand whether mitigations can be included in retrofit packages without jeopardizing the reasonable terms of the loan.

Geography

Regulatory Framework	Regulatory rules can impact the way projects can be deployed and the cost or value of that deployment. For example, some jurisdictions require utilities to provide net metering for solar at the full retail rate. While others only credit at a lesser rate or not at all. Some allow fuel switching and some do not. Some regulatory rules require significant equipment upgrades, whereas others do not.
Local Building Codes	Local codes related to electrification can vary in their stringency. For example, meters may be required to be upgraded or relocated at the customer's expense; solar may have limitations on how or where it can be installed; and inspections and permit approvals can be more time-consuming and unpredictable in one jurisdiction versus another. These factors have a direct impact on cost but are harder to predict accurately.
Incentives	The availability of and eligibility for incentives for different measures has perhaps the greatest impact on financial viability. Many incentives for LMI projects have income and other eligibility criteria, as well as caps and limits, but are often measurably higher than incentives available to the public. Many federal incentives can be applied anywhere in the country, and some are delivered by states or local governments, while utility incentives vary greatly by service area. This means that where the project is located will have a big impact on net retrofit cost after Incentives.
Energy Costs	Energy costs are localized by state or utility and greatly impacted by the regulatory framework. The impact of energy costs directly affects the financial viability of projects. Where upgrade measures reduce energy use, higher energy costs may mean greater savings. Conversely, lower existing energy costs may have a positive impact on energy burden but mean fewer savings.

3. Measures included

Two retrofit packages were considered for each of the four properties. Package one represents **full electrification** and package two represents **partial electrification**, with both including the installation of rooftop Solar PV. Energy audits were conducted for the Chicago properties and defined the standard approaches for which measures to include and their impact on changes in energy use. The measures and equipment included for each of the full and partial electrification packages were identical across properties. Despite identical measures and equipment specifications, however, the project and financial characteristics, as well as the current energy usage for each property, can show different final costs, incentives, savings, and financial viability.

In addition to specific energy measures and based on audit findings from the two Chicago properties, each project includes moderate additional costs for uncategorized construction, such as carpentry, finishing, concrete, etc. Each package also includes the cost of an energy audit, as well as technical assistance for deployment. No deferred maintenance measures have been included.

Measure category	Full Electrification	Partial Electrification

Air-source heat pump • Cold climate air-source heat pumps (ccASHPs) with advanced inverter-driven compressors and refrigerants.	✓	✓
Electric water heater • 50-gallon electric storage with .95 Energy Factor (EF)	✓	X
Electric wiring upgrades • Service upgrades and wiring	✓	✓
Electric panel upgrades • Replace panel and expand circuits	✓	✓
Envelope/weatherization • Air leakage 25% reduction, with mechanical ventilator under 7 ACH50* • Attic insulation R-60† • Drill-and-fill cavity wall insulation to R-13 for frame walls	✓	✓
Electric stove • ENERGY STAR® Integrated Annual Energy Consumption (IAEC): Less than or equal to 195 kWh/year	✓	X
Solar • Designed for maximum rooftop potential or 100% of annual load, whichever is less.	✓	✓
EV charging* • 240 V Level 2 charger	✓	X
Other costs • $1,000 cost representing additional carpentry or finishing expenses.	✓	✓
Audit • ANSI/BPI-1100-T-2023 Home Energy Auditing Standard	✓	✓
Technical assistance • Load analysis, vendor procurement, construction support	✓	✓

**Car charging costs are not included in this analysis.*

4. The Impact of the Inflation Reduction Act

Performing energy retrofits for LMI households has been historically financially challenging, as the scope and scale of the problem outweigh the existing financial resources available to solve it. More practically, the cost for individual property owners to deploy electrification and clean energy upgrades may not produce an acceptable financial payback period or, in some instances, do not produce a payback at all. With the passage of the IRA, this challenge has improved considerably because there are new financial incentives that lower net costs and positively impact financial viability.

Although the incentives of the IRA have an immediate and positive effect on project costs, savings, and financial viability, how they are accessed or combined (stacked) is complicated. Much has been published describing the various incentives of the IRA and how to understand and deploy them. The programs are far-reaching and include three types of financial incentives relevant to our analysis, which are described below and are only now coming into focus as the final IRA rollout progresses. An overview of the broader LMI housing-related provisions of the IRA is contained in the Appendix.

Investment Tax Credits (ITC)	HEAR and HER Rebates	Greenhouse Gas Reduction Fund (GGRF)
Residential and commercial tax credits and deductions. Non-competitive, unlimited and widely available now, as IRS rules and regulations have been announced. This also includes monetization provisions like Direct Pay and Transferability for certain ITCs.	Residential, income eligible with tiers of <80% AMI, 80% to 150% AMI and >150% AMI. Limited and just becoming available as states announce program specifics. How these rebates are accessed will differ by geography.	Debt and equity financing. Limited, by application and just becoming available as GGRF awardees announce financing and grant program details.

5. Limitations of the Inflation Reduction Act

Despite the historic investment in building electrification and clean energy coming from the IRA, there are limitations, and it requires a good deal of due diligence to ensure eligibility and maximize benefits. Many stakeholders involved in the deployment of electrification and clean energy projects need to understand the complexities and limitations to ensure projects can maximize benefits, meet the requirements of various programs, and mitigate risks during deployment. Some of these considerations require consultation by tax advisors or legal counsel. However, many of these complexities can be understood by program administrators and even property owners in a way that can positively affect deployment.

Program administrators and loan providers need a clear understanding of eligibility, stacking, and compliance to ensure project assumptions are accurate and predictable. They must also work with property owners and their vendors to ensure construction risks are understood and accounted for. There is always a degree of uncertainty in any electrification or clean energy project scope prior to construction because of local jurisdiction and utility compliance requirements, deployment milestones and timing, as well as potential deferred maintenance issues that are often identified only when construction begins. These risks cannot always be fully mitigated before construction starts. These issues become more important to understand when serving LMI households.

Program administrators and loan providers will need a clear understanding of eligibility, stacking, and compliance to ensure project assumptions are accurate and predictable.

Market-driven programs, where contractors do their own customer acquisition and project origination, often find that contractors avoid LMI segments because of these complexities and instead focus on higher profits or less risky customer segments. For program administrators and loan providers, it is important to understand these limitations and incorporate solutions to ensure that LMI customers are directly included in program design so those who need it most can realize the benefits of this historic investment.

Complexity of Stacking Incentives

When scoping an electrification or clean energy project, homeowners and contractors must consider market conditions, supply chain, and other complex issues, to estimate realistic and bankable project costs. With the creation of the IRA, new rules for eligibility and combining incentives create a need for sometimes complex considerations of how to combine incentives. For example:

- Using grants for solar can sometimes mean deducting the grant amount from the eligible cost basis, resulting in a reduced tax credit.
- For owner-occupied single-family retrofits, under the Residential Clean Energy Credit (IRS Section 25D) and the Energy Efficient Home Improvement Credit (IRS Section 25C), utility rebates and incentives and HEAR/HER rebates are deducted from the eligible project costs before calculating the ITC, whereas in most cases State incentives and Renewable Energy Credits (RECs) are not.
- Under the HEAR and HER rebate programs, rebates cannot be stacked by measure but can be stacked with non-federal funds and loans.

Program administrators, project developers, and/or property owners need to understand which incentive program or combination of programs has the best value. Since the enactment of the IRA, federal agencies have published helpful explainers and examples of how to stack and braid incentives, and many housing industry service providers have augmented these guides with helpful advice, models, and other aides. For example, the household electrification incentives calculator from Rewiring America does this stacking calculation for single-family retrofits. The resources page in the Appendix provides links to this and other helpful resources. Combining incentives can be complex. Program managers and homeowners must weigh risk and uncertainty and understand when to contact their tax professionals for project-specific advice.

Eligibility Limitations

Determining incentive eligibility is a critical first step in measuring the financial viability of a project. Some eligibility requirements are not obvious or changing information has been published during the IRA rollout period. For example, under Section 25D and 25C, individual taxpayers must occupy the residence, have taxable income, and cannot carry forward the Section 25C credit, but may carry forward the Section 25D credit. This limits the use of these provisions for low-income homeowners without taxable income. When determining Area Median Income (AMI) for HEAR and HER rebates, different rules for specific federal agencies, such as the Dept. of Energy (DOE) or the Environmental Protection Agency (EPA) may apply, despite a concerted effort by federal and state agencies to drive to universal eligibility between IRA and other programs where practical. For example, the Weatherization Assistance Program (WAP) and Low-Income Home Energy Assistance Program (LIHEAP) programs measure income eligibility based on 150% of Federal Poverty Level (FPL), while the IRA bases eligibility on AMI. Local utility incentive and assistance programs can vary in their income eligibility requirements.

Unclear or Inconsistent Compliance Rules

There are some inconsistencies or uncertainties across IRA programs when it comes to compliance with eligibility or verification requirements. For example, an important requirement for many incentives is meeting prevailing wage and apprenticeship requirements. The verification of prevailing wage may not be the same as the existing and similar Davis-Bacon requirement. Where Davis-Bacon is a labor law, prevailing wage and apprenticeship is a tax law. A similar inconsistency is with Domestic Content for the ITC, which has a similar requirement to Build America Buy America (BABA). Each is distinct and both have unclear verification requirements at the time of writing. These, like many issues that are not yet fully clear, will likely be clarified over time. However, program administrators and loan providers should consider these risks and support projects in finding solutions and identifying consistent compliance processes.

Energy Cost Savings are Not Ensured

Achieving energy savings is typically a goal of energy retrofits and is critical for projects serving LMI households. Many incentive programs focus on reducing retrofit costs and only indirectly target annual savings or leave savings as an implicit objective. Any increase in expenses, whether from energy cost increases or debt, can have outsized consequences for LMI households compared to other households. Finding project scopes and loan terms that are cost-neutral or better for LMI property owners is an ideal that should govern the approach to program and loan product development, with the aim of improving energy equity. Cost-neutral projects can provide energy cost savings to the homeowner, which can potentially be used to underwrite market rate, subsidized, or even forgivable debt to fill the post-IRA funding gap. This analysis aims to understand how ensuring this cost neutrality or ensured customer savings impacts the financial viability of retrofit projects.

Funding Gaps Remain

IRA tax credits and rebates are focused on reducing capital costs. Yet, for many electrification and clean energy projects, financial gaps of 20% to 60% of project costs after tax credit and rebate incentives are common. Primary drivers of wider financial gaps are measurable inflation and lingering supply chain issues post-pandemic. Another driver is deferred maintenance, which is more common in LMI homes and mostly ignored by incentive programs. Incentive caps within the IRA program limit the ability to fill these gaps, like incentive caps for HER/HEAR rebate programs, AMI thresholds, or taxable income requirements for some ITC provisions. GGRF funding is intended to help fill these gaps for LMI homeowners, combining financing and grants where possible.

6. Solving for Financial Viability

In the analysis for this guide, four single-family homes are analyzed, two in Chicago and two in Minneapolis. Two homes switched from natural gas heating to air-source heat pumps and two from electric resistance to air-source heat pumps. Information captured through energy audits in the Chicago homes allowed us to identify a common set of measures and metrics used to define full and partial electrification for this analysis. Detailed construction costs were determined using market averages, and energy loads were modeled based on the recommended scopes. With this data, it was possible to estimate incentives and loan amounts, using a portion of energy savings to fund subsidized loans. The results show that there may be more desirable candidates for financing based on the characteristics of each project.

The analysis then measures sensitivities on how financial viability is impacted when project and financial characteristics are changed. While many characteristics are inherent in the project's location, like regulatory framework, energy costs, or incentives, the impact of combining different measures has an impact on financial viability. The sensitivity analyses assessed the effect of changing characteristics to simulate the impact of financial viability when the housing type, geography, eligibility, or other changing aspects of the project.

By understanding these interactions, program administrators and loan providers can better understand how property and market characteristics affect project scopes and their financial viability and design and administer programs to serve the greatest number of households without creating adverse financial implications for property owners. However, homes and communities that are not candidates for loan programs or for electrification should not be ignored. Instead, administrators can work to engage those property owners and their contractors to encourage other efficiency upgrades and weatherization. This can allow a more nuanced approach to program design and loan product development based on geography, housing type, income, and project scope. By understanding how to maximize incentives and optimize energy cost savings, more households can be served through energy retrofit lending products with reasonable terms that ensure customer savings, as opposed to relying solely on competitive grants to fill the gaps. To illustrate the premise, it is helpful to categorize energy retrofit measures and combinations of measures into four levels of annual energy savings from worst to best, as represented by simple payback periods:

Negative Energy Cost Savings / Negative Payback

Retrofits where energy costs increase, such as some gas to electric heat pump conversions in markets with low gas prices and high electricity prices. Such retrofits are uneconomic despite achieving important non-financial objectives.

Low Energy Cost Savings / Long Payback

Retrofits where energy costs decrease somewhat, yielding long payback periods which exceed the life of the retrofit equipment, such as some partial electrification retrofits without solar installations. These retrofits are suboptimal financially.

Acceptable Energy Cost Savings / Acceptable Paybacks

Retrofits where energy costs decrease proportionate with the life of the retrofit equipment, such as many heat pump installations with 15-year expected equipment lives, and where energy cost savings help fund the cost of the retrofit.

High Energy Cost Savings / Accelerated Paybacks

Retrofits where energy cost savings result in payback periods significantly less than the life of the equipment, i.e., solar in high tariff markets and high incentives, and where such high energy savings can help fund other measures.

7. Single Family Retrofit Financial Model

Data and Calculations

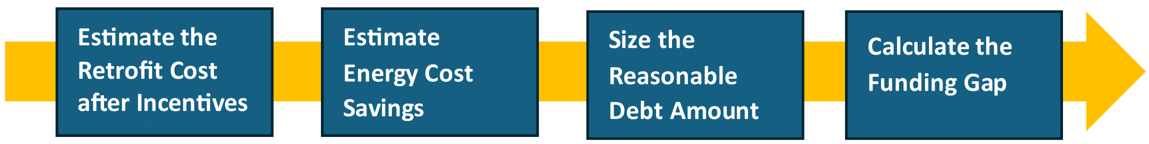
An Excel-based model was developed, beginning with key property data for each of the four properties being analyzed. This data includes the property location, heating fuel, as baseline energy data (as described in Section 2), as well as energy rates and costs. Energy audits were conducted on the homes in Chicago to determine the appropriate measures and equipment for full and partial electrification retrofit packages, which were used identically for each property. Nameplate data for each energy measure in the retrofit packages were used to model future changes in energy usage based on this data for multiple scenarios (for each property, for both full and partial electrification packages). Non-equipment measures were modeled separately (air sealing, insulation) using OpenStudio. This approach provides data that measures the change in electricity and gas usage for each measure, each retrofit package, and each specific home. A summary of this data is available in the appendix and the full Excel-based financial model is available for download.

Per measure costs and construction budgets were developed using data from energy efficiency, electrification, and solar programs administered by Elevate across theMidwest. Solar was designed using Helioscope software to meet 100% of the projected load or as much as could fit on the roof if less than 100%. The solar electricity generation estimates were incorporated into energy change calculations. Finally, incentive data was gathered, including all qualified, non-competitive IRA tax credits and rebates, as well as state, local, and utility incentives relevant to each measure and location. The Excel model estimates incentives based on known stacking rules and eligibility requirements.

In this paper, the possibility is raised of using a portion of savings in loan underwriting for LMI targeted loans.

With this data, estimated gross retrofit costs for each retrofit package were developed, followed by an estimate of the total incentives available based on eligibility assumptions, which yields the retrofit cost after incentives. Our engineering analysis then calculated energy savings available for debt, which represents estimated annual energy cost reductions based on all measures of the retrofit package for each property. Our premise is that a portion of these energy savings could be reasonably used to fund retrofit financing, further leveraging IRA incentives, through subsidized GGRF lending programs or other programs. Many lenders administering loans outside of the clean energy sector would not consider energy savings in underwriting a loan to the homeowner to fully or partially fund the cost of the energy retrofit. However, there are programs administered by green banks, for example, that use energy savings in their underwriting. This paper raises the possibility of using a portion of such savings in loan underwriting for LMI-targeted loans, provided such loans are reasonably underwritten and subsidized. Doing so increases the number of LMI energy retrofits that can be completed and are currently offered in some markets with “on-bill” utility finance programs. This approach also ensures property owners are cost-neutral or realize savings. The implications of using a portion of energy savings to fund consumer energy retrofit debt are discussed later in this paper.

In determining the amount of energy savings that could be used to fund the reasonable debt amount, 20% of the available energy cost reduction is reserved and labeled savings holdback for homeowners, with the balance available to service debt payments. The baseline analysis assumes an interest rate of 6% and, assumes zero closing costs. The 20% savings holdback for homeowners' amount was selected based on competitive practices in the solar leasing/PPA space, where it is accepted practice that homeowners require at least 20% energy savings net of lease/PPA payments to entice homeowners to act. Other amounts may be appropriate for different circumstances or markets. Different interest rates and closing costs can easily be estimated using this model. In one sensitivity analysis, the interest rate was reduced to 0% to measure the impact on financial viability. Finally, if energy savings do not provide enough debt funding based on reasonable terms, the funding gap is calculated and serves as the primary metric for financial viability in this analysis. This is the gap in funding that needs to be filled by grants or other capital to achieve 100% retrofit project funding.



Baseline Data and Assumptions

Each of the four properties was modeled with two retrofit packages (full and partial electrification), making eight scenarios or data sets. Each property was then analyzed with two income tiers, less than 80% AMI and 80% to 150% AMI, making four datasets or scenarios for each property or 16 total scenarios, as shown below:

Chicago: Natural Gas Heating	Chicago	Minneapolis	Partial Electrification	Full Electrification	<80% AMI	80%-150% AMI	Resistance Heat	Gas Heat	Solar Included	Gross Retrofit Cost	Total Value of Incentives	Net Retrofit Cost (after incentives)	% Gross	Minimum Equipment Lifetime	Value of Energy Savings	GHG Reduction MTCO2E	Savings Holdback for Homeonwers	Net Retrofit Payback	Energy Savings Available for Debt	Funding Gap (Net Cost after Debt)
Scenario 1a	✓		✓		✓			✓	✓	$51,500	$45,062	$6,438	13%	16	$941	-4.8	$188	7	$7,435	-$997
Scenario 1b	✓			✓	✓			✓	✓	$57,700	$48,687	$9,013	16%	16	$1,005	-4.2	$201	9	$7,942	$1,071
Scenario 1c	✓		✓			✓		✓	✓	$51,500	$28,440	$23,060	45%	16	$941	-4.8	$188	25	$7,435	$15,626
Scenario 1d	✓			✓		✓		✓	✓	$57,700	$31,165	$26,535	46%	16	$1,005	-4.2	$201	26	$7,942	$18,594
													29.7%							
Chicago: Electric Resistance Heating																				
Scenario 2a	✓		✓		✓		✓		✓	$38,000	$31,657	$6,344	17%	16	$1,311	-5.7	$262	5	$10,357	-$4,014
Scenario 2b	✓			✓	✓		✓		✓	$44,200	$35,332	$8,869	20%	16	$1,375	-5.0	$275	6	$10,864	-$1,995
Scenario 2c	✓		✓			✓	✓		✓	$38,000	$19,912	$18,088	48%	16	$1,311	-5.7	$262	14	$10,357	$7,731
Scenario 2d	✓			✓		✓	✓		✓	$44,200	$22,637	$21,563	49%	16	$1,375	-5.0	$275	16	$10,864	$10,699
													33.3%							
Minneapolis: Natural Gas Heating																				
Scenario 3a		✓	✓		✓			✓	✓	$48,500	$29,630	$18,870	39%	16	$878	-4.0	$176	22	$6,934	$11,936
Scenario 3b		✓		✓	✓			✓	✓	$54,700	$33,720	$20,980	38%	16	$839	-3.4	$168	25	$6,627	$14,353
Scenario 3c		✓	✓			✓		✓	✓	$48,500	$27,355	$21,145	44%	16	$878	-4.0	$176	24	$6,934	$14,211
Scenario 3d		✓		✓		✓		✓	✓	$54,700	$30,455	$24,245	44%	16	$839	-3.4	$168	29	$6,627	$17,618
													41.3%							
Minneapolis: Electric Resistance Heating																				
Scenario 4a		✓	✓		✓		✓		✓	$45,500	$28,490	$17,010	37%	16	$1,788	-7.8	$358	10	$14,123	$2,887
Scenario 4b		✓		✓	✓		✓		✓	$51,700	$32,580	$19,120	37%	16	$1,901	-7.1	$380	10	$15,022	$4,098
Scenario 4c		✓	✓			✓	✓		✓	$45,500	$26,215	$19,285	42%	16	$1,788	-7.8	$358	11	$14,123	$5,162
Scenario 4d		✓		✓		✓	✓		✓	$51,700	$29,315	$22,385	43%	16	$1,901	-7.1	$380	12	$15,022	$7,363
													40.0%							

Determining Financial Viability

Scenario 1a is a retrofit for a Chicago single-family home currently heated with natural gas. It includes partial electrification, where the homeowner has an income of less than 80% AMI. The gross retrofit cost is estimated to be $51,500, with total incentives (including WAP) of $45,062, leaving a net retrofit cost after incentives of $6,438. Energy savings are estimated to be $941 annually. From this amount, a 20% savings holdback for homeowners is deducted in the amount of $188 annually, leaving the energy savings available for debt at $753 annually or $7,435 over the life of the equipment and loan. Only 80% of the energy savings is used to fund debt service payments for the baseline analysis, calculated based on a 15-year, fully amortizing loan at a subsidized interest rate of 6%, which yields an annual loan constant of 10.13%. The annual loan constant comprises both principal and interest payments on the loan, based on the above terms. In this scenario (1a), the energy savings available for debt of $7,435 over the lifetime of the project/loan, exceeds the net retrofit costs (after Incentives), meaning that the scenario can be fully funded with incentives and debt with no funding gap, while still ensuring a 20% savings for the property owner. This scenario becomes financially viable in our analysis. In an actual project, the funded debt would be sized to cover only the net retrofit cost after Incentives and would not exceed 100% of the gross retrofit cost.

Two primary metrics are used to determine financial viability. The first is the funding gap which equates to the net cost after debt**.** This is calculated by subtracting the loan amount from the net retrofit cost, after incentives. If this value is negative, it means that the amount of energy savings available for debt is high enough to repay a loan that exceeds the net retrofit cost, after incentives; that is, no grants or additional capital are needed to fund the retrofit. The second primary metric is net retrofit payback. The project and loan are viable if the net retrofit payback period in years is equal to or less than the shortest retrofit equipment lifetime, ensuring the loan for the retrofit is fully repaid before the expected end of the life of the equipment being financed. In summary, this analysis looks to identify reasonable lending scenarios for LMI households that ensure some savings and a loan payback before the end of retrofit equipment life.

8. Findings

Baseline Findings

The financial viability of projects and lending is better for low-income households.

The output of the 16 scenarios in the baseline data follows a logical path for calculating financial viability for each scenario, going from gross retrofit costs on the left to a funding gap on the right. The key finding is that substantial funding gaps remain for many scenarios, as illustrated in the retrofit cost after incentives column. This shortfall ranges from as low as $6,344 to as high as $26,535, or 13% of costs to as high as 49%. The low-income category (80% or less AMI) has a retrofit cost after an incentives gap of 27%, while moderate-income (80%-150% AMI) has a retrofit cost after an incentives gap of 45%. This is because of higher incentives for low- compared to moderate-income segments through the IRA and other state and local incentive programs. Even though low-income households have lower retrofit costs after incentives gaps, these homeowners generally have lower personal financial resources to fill this gap than moderate-income households.

In the baseline analysis, only three of the 16 projects, representing 19% of the projects in the dataset, have energy savings available for debt higher than the net retrofit cost. The remaining 81% of scenarios have a greater funding gap–a value in the dataset greater than zero.

The differences in the funding gap across scenarios are more pronounced by geography, where Chicago has an average gap of $5,839, while Minneapolis has an average gap of $9,704 for the same project scopes. This is largely because Illinois has higher solar and energy efficiency incentives than Minnesota. Similarly, the funding differences are based on the type of heating fuel being replaced. The average funding gap across both cities for natural gas to air-source heat pumps (ASHP) conversion projects is $11,552. While the funding gap across both cities for electric resistance to ASHP is $3,991. This is because electric resistance is less efficient and more expensive than natural gas heating. So, converting to ASHP from electric resistance drives greater energy savings compared to natural gas conversions, which allows more of the energy cost reduction to ultimately go toward narrowing the funding gap.

The average funding gap for full electrification projects is $8,975, while partial electrification is $6,568. Air-source heat pumps are included in both full and partial retrofit scopes. The gaps are wider for full electrification scopes because there is less energy reduction value from the appliances added to the full electrification scope to offset the increased electricity usage from electrification.

Importantly, all scenarios show positive energy savings, which in turn can be used to underwrite reasonable debt amounts. Much of these savings are driven by rooftop solar as part of the retrofit package in all scenarios, where the combination of incentives, energy savings, and net metering bill credits yields high returns and shorter payback periods in the markets being analyzed. This may not be true in other markets. In this analysis, strong local incentives combined with IRA tax credits 25C (residential clean energy) or 48E (commercial clean energy, and as available to single-family, owner-occupied housing through solar leases or ITC Transfer) reduced solar installation costs by 40% to 60%. However, in states without a Renewable Portfolio Standard, net metering, or other local incentives, this may not be the case. This is why Sensitivity Analysis 3 looks at the impact of removing solar from all retrofits and Sensitivity Analysis 4 looks at reducing net metering from retail rate to avoided cost and supply rate.

Sensitivity Analysis on Key Retrofit Characteristics

The primary goal of these analyses is to identify and measure the interaction of retrofit projects and financial characteristics on financial viability. By measuring the funding gap of our baseline scenarios, we find clear winners and losers in terms of those projects that are good candidates for reasonable debt amounts. The analysis seeks to understand how financial viability changes when project and financial characteristics change, by adjusting or toggling off certain characteristics and measuring the changes in the funding gap. It is recommended that administrators and lenders use a similar scenario analysis at both the project and portfolio levels to understand how best to include the greatest number of projects in their loan programs. Where funding gaps remain, having a solid understanding of the size of the gap and where they come from may help more easily fill those funding gaps with grants and other capital to further increase the percentage of LMI households served by programs.

The following sensitivities were analyzed:

Sensitivities
1.The impact of reducing the debt interest rate from 6% to 0%
2. Eliminating minimum required Energy Savings Holdback reserve
3. Eliminating solar as part of electrification projects
4. The impact of weakened net metering
5. Supply chain and market cost variances
6. The impact of energy cost increases
7. Eliminating all state, local and utility incentives
8.Eliminating HEAR and HER rebates

Summaries of the findings for these analyses are described below, with detailed data tables showing changes to key metrics for each scenario in Appendix 4. Further data and calculations for each sensitivity analysis can be found in the Excel-based model.

Sensitivity 1: The Impact of Reducing Interest Rate from 6% to 0%

Change from Baseline: Loan interest rates decrease from 6% to 0%, for 15-year self-amortizing loans.

Change in viable financing: All scenarios see a narrowed funding gap by an average of 131% or $5,031, with a range between $3,363 and $7,624.

This sensitivity analysis looks at the impact of reducing the cost of capital by reducing the interest rate on loans from 6% to 0%, without changes to the 20% savings held back for property owners. All scenarios see a reduction in their funding gaps on average of 131%. If the debt becomes interest-free, energy savings available for debt increase by 51% and result in 50% of scenarios being fully funded compared to 19% in the baseline, i.e. the combination of incentives plus debt will fully finance the energy retrofit without the need for additional grants.

Interest-free debt can be a powerful tool to create more financially viable projects without compromising customer savings, especially for LMI households. If reasonably underwritten and where energy savings are reasonably assured -- and potentially backstopped by credit enhancement structures or flexible loan terms-- such debt allows the homeowner to upgrade their home, potentially increasing its value, comfort, and occupant health, while contributing to decarbonization efforts. Key questions to be answered by GGRF and other LMI lenders include how to structure and underwrite such loans to ensure the homeowner is better off financially and not put at financial risk. This entails looking at underwriting criteria and considering energy equity objectives and trade-offs.

Sensitivity 2: Eliminating the Customer Energy Savings Holdback

Change from baseline: The minimum savings holdback for homeowners was eliminated, reducing customer savings from 20% to 0% (breakeven).

Change in viable financing: Funding gaps narrow, but at an increase in loan underwriting risk and elimination of cash flow benefits to homeowners.

A savings holdback for homeowners can provide a cushion to the homeowner in case energy cost savings are less than estimated or to more efficiently manage cash flow when energy costs fluctuate month to month. This is critical for low-income households, where energy burden or the percent of income spent on energy costs is on average three times more than households nationwide[3]. This is why the premise of this analysis advocates ensuring a minimum savings holdback for homeowners of at least 20% to lower the energy burden, provide a cushion for energy reduction fluctuations, and mitigate the risk of loan defaults.

When the 20% savings holdback for homeowners is reduced to zero or the customer sees a breakeven in energy costs rather than a 20% savings, the funding gap narrows for all scenarios by an average of 65%. In this scenario, 31% of scenarios have no funding gap (increased from 19% in the baseline). This means five of the 16 scenarios do not need additional grants or capital to make them financially viable for reasonable financing terms.

The gaps narrowed more significantly for low-income households (<80% AMI) versus moderate-income households (80% to 150% AMI) when the savings holdback for homeowners was removed. This is because the net cost for low-income households is less due to richer incentives, i.e., there is less of a funding gap to start. Therefore, the 20% savings holdback for homeowners is greater and affects the funding gap more positively. Similarly, categories where incentives are higher show the funding gap narrowed more significantly as well. For example, Chicago scenarios reduce the funding gap by 39% versus 28% for Minneapolis scenarios because incentives are higher in Chicago.

In general, the risks associated with eliminating savings for LMI households outweigh the benefits to the financial viability. GGRF and other LMI lenders should consider this when weighing financial and non-financial program objectives and benefits.

Sensitivity 3: Elimination of Solar from the Retrofit Package

Change from Baseline: Solar was removed from all scenarios.

Change in viable financing: Funding gaps nearly double on average, and all scenarios have funding gaps when solar is removed.

This analysis removes solar for all scenarios to measure the impact on financial viability. It illustrates how solar drives the energy savings available for both debt and customer holdback. While project costs and incentives are lowered mostly proportionally and are reduced by removing solar (Gross Costs by 38% and Net Costs by 33%), energy savings are reduced far more significantly, by 79% on

[3] *U.S. Dept. of Energy: Low-Income Energy Affordability Data (LEAD) Tool and Community Energy Solutions*

average. This reduces the amount of capital available for debt and for customer savings. The net result is that the funding gap increases on average by 97%.

While there is a narrowing of the funding gap for some scenarios, every project scenario has a funding gap when removing solar, where only 19% had funding gaps with solar included. Importantly, energy savings are reduced significantly. When removing solar, half of the scenarios (all the natural gas conversion scenarios) see an increase in an average energy cost increase of $114 per year. Therefore, there are no savings to hold back. While the electric resistance scenarios still see savings, it is reduced on average from $319 to $128 per year.

In Minneapolis, where the retrofit cost after incentives is significantly reduced after removing solar, the loss of energy from solar meant far longer payback times and less energy savings available for debt. In short, solar improves financial viability and savings for electrification projects and should be pursued whenever possible. In this sensitivity analysis, solar was valued based on full retail rate net metering in Chicago and Value of Solar tariff (VOS) in Minneapolis, which is approximately equivalent to retail rate net metering currently.

Solar improves financial viability and savings for electrification projects and should be pursued whenever possible.

Sensitivity 4: Changing Retail Net Metering to Supply/Avoided Cost

Change from Baseline: Bill credit value was reduced by 50% to approximate Net Metering changing from retail value to avoided cost or supply value.

Change in viable financing: Only 6% of projects -- one of 19 scenarios -- are financially viable. Sixty-six percent reduction from baseline.

Net Metering rules determine the value of rooftop solar, specifically, how solar is valued when some of the generated power is sent to the grid and credited back to customers per kilowatt hour. The baseline scenario for Chicago and Minneapolis uses a retail rate or Value of Solar (nearly identical to the retail rate in Minnesota) assumption as mandated in each market. Both effectively credit the full retail rate (16 and 18 cents respectively). In markets where net metering only credits for the Supply Rate or Avoided Cost Rate and not the full retail rate, the bill credit is around half the value -- 8 cents or 9 cents respectively. Some markets only require an Avoided Cost rate, which could be less than the Supply rate. The analysis below assumes a bill credit of half the value compared to the baseline to approximate the change to Supply-only or Avoided Cost net metering.

With the value of net metering reduced, all projects except one have a funding gap, with an average 172% increase in these gaps across projects. Similarly, with significantly less value from solar, retrofit paybacks take almost four times as long, and homeowner savings are reduced on average from $251 to $131 annually. In short, net metering rules impact the financial viability of projects such as removing solar altogether. Including solar, especially in markets with strict net metering rules, is essential for the financial viability of electrification retrofits.

Sensitivity 5: Supply Chain Variances; Construction Costs Increase by 10%

Change from Baseline: Construction costs increase by 10%.

Change in viable financing: Only 6% of projects -- one of 16 scenarios-- are financially viable. A 66% reduction from baseline (from three scenarios to one scenario).

Post-pandemic inflation and supply chain volatility are still creating cost unpredictability for trades generally and for electrification and clean energy projects specifically. Costs may increase between the project design and deployment stages. Some less developed markets for electrification and clean energy work may be less competitive even before supply chain constraints. These market conditions can directly impact the cost and financial viability of projects. This analysis looked at a 10% retrofit construction cost increase to approximate that impact.

Not surprisingly, every project and scenario were affected negatively, with an average increase in the funding gap of 85%. The average net retrofit payback went up from 16 years to 18 years. Some incentives increased, dollar for dollar (subject to caps) as costs went up. For example, for a low-income homeowner, if the cost of a heat pump installation increases from $7,000 to $10,000, only $1,000 of the increase would be covered by a HEAR rebate due to the $8,000 heat pump cap. This is proportionately true for tax credits like the ITC, as well. The impacts differed by market, with Chicago seeing an average funding gap increase of $3,312 and Minneapolis $2,400. Low-income households also see a disproportionate increase, with an 84% increase in funding gap versus 24% for moderate-income households.

Escalating costs have an outsized impact on all projects, but more so for low-income households. In this way, cost unpredictability is a significant risk. Projects with longer procurement and development timelines have a higher risk of cost increases. Depending on the program design, an administrator or lender may be protected from cost increases because homeowners contract directly with contractors, but care should be taken to limit or mitigate such risks. Mitigating cost increases through managed procurement, program requirements, or negotiated costs can help all stakeholders.

Sensitivity 6: Energy Costs Increase by 10%

Change from Baseline: Electricity rates increase by 10%.

Change in viable financing: Mixed outcome based on heating fuel type.

While the analysis does not factor in long-term energy cost inflation, it was important to understand the immediate impacts of energy cost increases, or fuel cost differentials, on the financial viability of a project at initiation. In this analysis, the electricity and gas costs were increased by 10% in separate analyses. The key takeaway is that for electric resistance to ASHP conversions, where electricity makes up most of the energy costs and ASHPs are inherently more efficient, the increase in electricity rates boosts the value of energy savings and reduces the funding gap by an average of 23%. Gas-to-electric conversions are the opposite, and the funding gap grew by 8% as the gas-to-electricity fuel cost differential widened.

When gas rates are increased by 10%, all scenarios show a narrowing of the funding gap by an average of 16%. This is because all scenarios benefit from reducing or eliminating high-cost natural gas usage. The scenarios with Chicago homeowners of 80% or less AMI are anomalous because of the solar incentives from the Illinois LMI solar program, which, when combined with the ITC cover almost all the solar costs. These high incentives, together with the reduction of high natural gas costs, provided a reduced funding gap of 91% for these scenarios while the other scenarios averaged about 5%. In all cases, though, switching from higher initial gas costs to electricity yields higher energy savings.

Sensitivity 7: Eliminate All State, Local, and Utility Incentives

Change from Baseline: All state, local, and utility incentives are eliminated.

Change in viable financing: No scenarios are financially viable without additional grant funding. All scenarios have a funding gap, compared to three of 16 having funding gaps in the baseline data.

The IRA must have state, local, and utility incentives to work.

This scenario illustrates the impact of local incentives, especially in Chicago, where Illinois incentives for solar combined with ITCs can yield 60% to 70% cost reductions for most projects, and almost 100% for low-income projects. Eliminating these incentives has a significant impact on financial viability. The funding gap for Chicago projects increased more than fivefold when state, local, and utility incentives were eliminated. In Minneapolis, where Minnesota has fewer solar incentives, the impact is less but still significant, with an average 94% increase in the funding gap. In essence, the IRA must have state, local, and utility incentives to work.

Sensitivity 8: Eliminate HEAR and HER Rebates

Change from Baseline: HEAR and HER rebate amounts are eliminated.

Change in viable financing: No scenarios are financially viable without additional grant funding.

The IRA is crucial for realizing electrification and clean energy projects that serve LMI housing.

This analysis clearly shows the importance of IRA rebate programs. Across all scenarios, the funding gap increases more than threefold. Households of 80% or less AMI are impacted even more, with nearly a fivefold increase in the funding gap. While this sensitivity analysis, in some ways, seems academic, it is relevant because some states may not participate in these programs, and some may have rules that limit their access. This, suggests that the geographic location of the program may be very relevant to the financial viability of projects and some states may require significantly more outside funding to fill the gaps before the project can become viable for financing. If these rebate programs are eliminated or exhausted, under no scenarios are these single-family retrofit projects financially viable under the assumptions of this analysis, and the need for additional grants or capital amounts increases substantially. The IRA is crucial for realizing electrification and clean energy projects that serve LMI housing.

9. Implications for Program Design

Energy Savings Estimates

Actual energy savings may be different than pro forma estimates, whether developed by a contractor or objective technical advisor. This is an inherent risk given the number of variables involved in developing estimates, as well as year-to-year changes in weather, fuel prices, customer usage patterns, etc. Energy software tools, databases, and standards have improved significantly, but risks remain in accurately projecting future energy costs and savings. To counter this risk, program administrators should consider the following:

- Use actual historical utility data for the property provided by the local utility whenever possible.
- Use the lower range of potential savings.
- Understand that defined measures have a higher degree of certainty than others regarding changes in energy usage and, therefore, savings, such as many PV solar installations.
- Select well-trained contractors and technical advisors who have deep experience in the local market and utilize recognized engineering tools, standards, and databases.
- Develop energy cost savings guidelines over time using local empirical data. Consider both monthly and annual energy costs and savings for the property. The monthly cash flow may be more volatile and can create hardships, even when savings are realized annually.

It's particularly important to understand how monthly usage and cost may be very different than annual usage and cost. For example, where an analyzed retrofit may project $1,000 in savings annually, some months may see $200 in savings, and other months may see $100 or more in increases due to increased electrical usage. This can impact the ability of an LMI household to keep up with month-to-month expenses, even if there are savings at the end of the year. Where annual budget plans are available through utilities this can be mitigated, but it may take time to establish the energy cost pattern to bring the budget amount in line with new savings.

Selecting Markets

The implications of geography are clear: location matters. The local regulatory framework can create rules that accelerate electrification and clean energy deployment or create barriers. The legislative and regulatory framework can create incentives that can be layered over IRA incentives to reduce net costs and funding gaps. Chicago and Minneapolis both have excellent regulatory frameworks to support this work. The funding gap for full electrification projects for low-income households is just 15% in Chicago and 42% in Minneapolis. For moderate-income households, this gap is 45% in Chicago and 47% in Minneapolis. After factoring in the value of energy savings, the funding gap is slightly smaller, and the payback is shorter.

These funding gaps will be higher in states with no solar or energy efficiency incentives or where there is no or poor net metering. Understanding how to balance grants and loans and knowing the thresholds of the grants required is key to entering a market. Providing loans in markets where there is no chance for payback or customer savings is risky for both homeowners and lenders unless clear mechanisms for filling funding gaps are in place.

Income Segments Being Served

Clearly, serving low-income households provides the ability to access higher incentives both federally and locally. Low-income, defined as 80% or less AMI, has a retrofit cost after an incentive gap of 27%, while moderate-income, defined as 80%-150% AMI, has a 45% gap. Program administrators and funders can take advantage of these incentives so that projects will need much smaller grants or alternative capital to make them financially viable. These are ideal projects for GGRF programs that can combine grants and financing, if the risks are understood and mitigated as much as possible.

Serving low-income households has added challenges because they include a higher percentage of unbanked households, households with weaker credit histories, or households with higher energy burdens and less tolerance for increased costs of any kind. Ensuring energy savings are part of these retrofits is the primary way to mitigate many of these risks. Mechanisms for guaranteeing loans and otherwise reducing or eliminating the cost of capital are another. LMI homeowners and/or projects that are not good candidates for debt need to be served by other financial assistance programs and grants so they are not left behind. Moderate-income households will have lesser incentives and larger gaps but will often have more means for incurring debt and potentially filling gaps on their own. Because of these reasons, moderate-income households are often left behind during energy program design and should also be considered for other financial assistance programs whenever possible.

Understanding the Impact of Measures Included

The funding gaps for individual measures or combinations of measures vary widely because of the cost of installation as well as the incentives available. Some measures reduce energy, adding to the long-term value and increasing the energy savings available to fund debt, thereby narrowing the funding gap, while other measures increase energy costs and have the converse effect. How these factors balance is important. As illustrated in the baseline analysis, there are differences in the funding gaps and financial viability of full versus partial electrification projects. The average retrofit cost after incentives for full electrification projects is $8,975, while partial electrification is $6,568. This is logical because full electrification projects have more measures and costs. But it is also true that some measures have a greater impact on savings and debt tolerance. Some are more expensive, and some have a greater share covered by incentives.

It’s also important to consider how measures are combined. For full electrification, it is assumed that all natural gas appliances are replaced and included in the retrofit package. Other measures may be required to facilitate the base electrification, like electrical wiring and panel upgrades, or minor carpentry and finishing. Measures like EV charger installations consistently have high funding gaps and are not required for electrification. So, EV charging can be considered on an individual basis rather than built into program assumptions.

Solar can be an important measure, especially when combined with heat pumps. While solar as a measure will significantly increase retrofit costs, it provides high incentive and energy savings value, directly impacting the loan amounts needed and the funding gaps. As indicated in the sensitivity analysis, removing solar from the projects analyzed turned savings into a $114 loss for natural gas conversion projects and, on average, reduced $319 in annual savings to $128.

Because of higher incentives for heat pumps, especially for low-income households, the net costs of heat pumps evaluated individually are reasonable, not exceeding 25% in our analysis. The funding gap is also reasonable, not exceeding 34%. However, the potential to reduce energy savings and impacts on potential debt funding is high, depending on the heating fuel being replaced. When heat pumps and solar are analyzed in combination, the net costs and funding gaps are significantly reduced where local solar incentives are good. Energy savings and potential debt are increased in all scenarios.

SOLAR FUNDING GAPS AND VALUE

	Cost	Incentives	Energy Value	Net Cost Gap	Funding Gap
80% or less AMI					
Chicago Natural Gas	$24,000	$23,832	$1,584	1%	-6%
Chicago Electric Resistance	$10,500	$10,427	$693	1%	-6%
Minneapolis Natural Gas	$21,000	$7,980	$1,529	62%	55%
Minneapolis Electric Resistance	$18,000	$6,840	$1,310	62%	55%
80% to 150% AMI					
Chicago Natural Gas	$24,000	$15,160	$1,584	37%	30%
Chicago Electric Resistance	$10,500	$6,632	$693	37%	30%
Minneapolis Natural Gas	$21,000	$7,980	$1,529	62%	55%
Minneapolis Electric Resistance	$18,000	$6,840	$1,310	62%	55%

AIR-SOURCE HEAT PUMP FUNDING GAPS AND VALUE

	Cost	Incentives	Energy Value	Net Cost Gap	Funding Gap
80% or less AMI					
Chicago Natural Gas	$10,000	$9,580	-$872	4%	13%
Chicago Electric Resistance	$10,000	$9,580	$389	4%	0%
Minneapolis Natural Gas	$10,000	$10,000	-$1,059	0%	11%
Minneapolis Electric Resistance	$10,000	$10,000	$429	0%	-4%
80% to 150% AMI					
Chicago Natural Gas	$10,000	$7,480	-$872	25%	34%
Chicago Electric Resistance	$10,000	$7,480	$389	25%	21%
Minneapolis Natural Gas	$10,000	$10,000	-$1,059	0%	11%
Minneapolis Electric Resistance	$10,000	$10,000	$429	0%	-4%

HEAT PUMPS and SOLAR FUNDING GAPS AND VALUE

	Cost	Incentives	Energy Value	Net Cost Gap	Funding Gap
80% or less AMI					
Chicago Natural Gas	$34,000	$33,412	$712	2%	0%
Chicago Electric Resistance	$20,500	$20,007	$1,082	2%	-3%
Minneapolis Natural Gas	$31,000	$17,980	$470	42%	40%
Minneapolis Electric Resistance	$28,000	$16,840	$1,739	40%	34%
80% to 150% AMI					
Chicago Natural Gas	$34,000	$22,640	$712	33%	31%
Chicago Electric Resistance	$20,500	$14,112	$1,082	31%	26%
Minneapolis Natural Gas	$31,000	$17,980	$470	42%	40%
Minneapolis Electric Resistance	$28,000	$16,840	$1,739	40%	34%

The cost of energy audits and load modeling were included in all project costs. Energy audits should be included in retrofit packages to ensure proper project scoping and ensure energy usage and savings can be projected accurately. This should include load modeling as this is essential to ensure retrofit projects are not increasing the energy burden for low- and moderate-income households.

Technical assistance costs were included in all scenarios and should be considered as part of retrofit packages. Whether programs are designed as market-driven, where contractors do customer acquisition and scoping, or administrator-driven, providing an objective owner's representative may be critical to ensuring energy and savings assumptions are realistic, project scopes and costs are within market norms, and installation is completed as planned. The investment in technical assistance is small when weighed against the risks to the project without it.

> ***The investment in technical assistance is small when weighed against the risks to the project without***

Lending Implications

Commercial consumer lenders underwrite loans based on individual credit scores, proprietary credit models, debt-to-income ratios, and other financial metrics that indicate the borrower's ability to repay the loan. They typically do not factor into the loan underwriting criteria, such as future wage increases, the potential for property value increases, or in this case, energy savings. Community lenders, such as GGRF awardees and sub-awardees, however, should strongly consider the use of energy savings in loan underwriting, balancing the objective to increase LMI energy retrofits with the risk of increased loan delinquency and/or adverse financial impacts to the homeowner. The use of energy savings in loan underwriting requires hard trade-offs and LMI lenders can prioritize the financial health and wealth building of LMI communities by taking these active steps:

Equity and Wealth	The principal goal of always improving the financial health of LMI homeowners should inform the development of a clear policy that weighs and balances the trade-offs between improving energy equity, scaling GGRF funding, and achieving the highest number of retrofits possible.
By the Numbers	Ensure the energy retrofit project is appropriately designed for the home, local weather, and market conditions. Ensure that costs and energy savings projections are clear and verifiable.
Ensure Savings	To mitigate the risks to the homeowner and lender, apply a guaranteed minimum savings requirement for all projects. A common starting point for savings is 20%.
Secondary Markets Standards	Work to develop secondary market standards so that LMI energy retrofit loans can trade on the secondary market, thereby enhancing their liquidity and providing access to broader capital markets. This includes developing standards for the use of Energy Cost Savings in loan underwriting based on empirical performance data and experience. This is important to provide the level of investor confidence to achieve GGRF's stated private investment leverage targets.
De-risk	Design and implement loan program structures and terms which reduce the risk of potential increases in loan delinquency and default, such as 1) Subsidized loan terms, including partial and full loan forgiveness or earn-out which provide better loan terms to LMI borrowers; 2) "Soft" loan terms which provide loan repayment flexibility; 3) Credit enhancement structures, which aim to transfer risk to subsidized or catalytic capital providers and risk takers; 4) De-risking estimates of Energy Cost Savings, through improved modeling techniques, empirical data analysis of past retrofits, etc.

Filling Funding Gaps

The final funding gap represents the dollar amount greater than the Annual Value of Energy Savings amortized over the life of the loan. In other words, the amount of shortfall to breakeven after making all payments over the lifetime of the loan and maintaining terms that meet the minimum equipment lifetime, and account for loan terms and the Savings Holdback for Homeowners requirement -- 20% in this analysis. The Final funding gap shortfall must be filled for the loan to provide a reasonable financing solution for the retrofit project. Gaps of this nature are typically filled by capital provided by the property owner or by grants. Below are several categories of grants typically available for residential electrification and clean energy projects. See the Resources Section of the Appendix for links and information about specific grant programs.

State Grant Programs

States can create energy grant programs, typically through legislation, that send grant dollars to homeowners. These programs are often administered by State Energy Offices. More often, states leverage federal dollars that provide grants to homeowners. Homeowners, administrators, and contractors can check State Energy or Commerce offices for available grant and incentive programs that align with the criteria of the project and recipient.

Federal Grant Programs

Federal grant dollars often flow through states and then are programmatically delivered to homeowners. Municipalities, tribal governments, and nonprofits can also be the recipients of federal dollars that get distributed as grants to homeowners. Federally funded energy grant programs may have high-level parameters on what measures can be funded, grant amounts, and eligibility. But often, local entities have some flexibility to design programs locally.

Federal grant programs often have rules that limit the amount of grant dollars that can be combined with other federal incentives, like the IRA. For example, most federal grants must be deducted from the cost basis of tax credits and other incentive programs, reducing the overall value of the incentives when combined.

Some entities, like the United States Department of Agriculture (USDA), offer grant programs to farmers and rural communities. The Department Of Environment (DOE) offers grant programs to state and local governments, tribes, and nonprofits, to fund energy grants to homeowners. Contact your local municipality, state energy office, tribal government, or local nonprofits. Some federal agencies fund home repair and improvement assistance programs for target audiences, like American Indians and Alaska Natives, veterans, or rural residents. Check agencies like the USDA, Bureau of Indian Affairs, or the Veteran's Administration for specific grant programs. HUD offers grant programs, like The Green and Resilient Retrofit Program (GRRP), which fund residential energy efficiency projects.

Philanthropic Grant Programs

Foundations and nonprofit organizations work locally, regionally, and nationally to provide resources, including grants, for various target audiences and areas of focus. Every grant program within a foundation or nonprofit program portfolio will have its own eligibility parameters and guidance on how the grant dollars can be spent.

APPENDIX

Appendix 1: Definition of Terms in the Financial Model

Terms Used in the New Sensitivity Values table

Column in Data Model	Label	Definition
Col. B	*Scenario Label*	Grouped by City and Heating Fuel Type
Col. C	*Chicago*	Green arrow indicates Yes to this category label
Col. D	*Minneapolis*	Green arrow indicates Yes to this category label

Col. E	*Partial Electrification*	Green arrow indicates Yes to this category label
Col. F	*Full Electrification*	Green arrow indicates Yes to this category label
Col. G	*<80% AMI*	Green arrow indicates Yes to this category label
Col. H	*80% to 150% AMI*	Green arrow indicates Yes to this category label
Col. I	*Electric Resistance Heat*	Green arrow indicates Yes to this category label
Col. J	*Natural Gas Heat*	Green arrow indicates Yes to this category label
Col. K	*Solar Included*	Green arrow indicates Yes to this category label
Col. L	*Gross Retrofit Cost*	Estimated cost of a combination of retrofit measures before incentives.
Col. M	*Total Value of Incentives*	Estimated total of Federal, State, local, and utility incentives for all measures represented in the retrofit scenario, assuming certain eligibility criteria, such as AMI. Details of this are found in the Project Details tab of the model.
Col. N	*Net Retrofit Cost (after Incentives)*	Gross Retrofit Cost is less than the Total Value of Incentives. Net cost of retrofit after incentives are applied, noting cash flow timing differences may occur
Col. 0	*% Gross*	Net Retrofit Cost (after incentives) divided by the Gross Retrofit Costs.
Col. P	*Minimum Equipment Lifetime*	Shortest estimated functional life of all the equipment included in the retrofit package.
Col. Q	*Annual Value of Energy Savings*	Estimated annual energy savings as a result of all measures included in the retrofit. Historical energy costs less estimated energy costs after completion of the retrofit.
Col. R	*Savings Holdback for Homeowners*	Value of Energy Savings times the Energy Savings Holdback percentage. The proportion of energy savings that are not included in potential debt calculations, providing a cushion for the variability of estimates versus post-retrofit actuals and providing net annual cash flow benefits to the homeowner
Col. S	*Net Retrofit Payback*	Net Retrofit Cost (after Incentives) divided by the Annual Value of Energy Savings. This represents the number of years it will take to pay off this debt before the cost of capital is added.
Col. T	*Energy Cost Savings Available for Debt*	The Value of Energy Savings less the Savings Holdback for Homeowners. The portion of savings that can be used to payback debt.
Col. U	*Funding Gap (Net Cost After Debt)*	Net Retrofit Cost (after incentives) less the Energy Cost Savings Available for Debt. How much of a financial gap there is over the lifetime of the loan after incentives, ensuring minimum savings, and paying the loan.
N/A	*Loan Constant*	Principal and interest payments for a fully amortizing loan given a certain term and interest rate (not shown in the model).
N/A	*Reasonable Debt Amount*	The amount of debt that can be funded using Energy Savings Available for Debt capitalized using the assumed loan terms per the Loan Constant.

Terms Used in the Change from Baseline Table

Column in Data Model	**Label**	**Definition**
Col. W	*Scenario Label*	Grouped by City and Heating Fuel Type
Col. X	*Baseline savings available for debt (after holdback)*	Pulled directly from the Energy Savings Available for Debt. In Col. T of the Baseline Data Set.
Col. Y	*New savings available for debt (after holdback)*	The newly calculated value of the Energy Savings Available for Debt. based on changes indicated in this sensitivity analysis.
Col. Z	*Change*	The dollar value difference between Col. Y and Col. X
Col. AA		The percentage difference between Col. Y and Col. X
Col. AB	*Baseline Final Funding Gap*	Pulled directly from the Funding Gap (Net Cost After Debt) In Col. U of the Baseline Data Set.

Col. AC	*New Final Funding Gap*	The newly calculated value of the Funding Gap (Net Cost After Debt) is based on changes indicated in this sensitivity analysis.
Col. AD	*Change*	The dollar value difference between Col. AC and Col. AB
Col. AE		The percentage difference between Col. AC and Col. AB

Terms Used in the Change from Baseline by Category Table

Column in Data Model	Label	Definition
Col. AG	*Category Label*	Indicates the category of scenario being compared from Baseline Data to the data in this sensitivity analysis.
Col. AH	*Net Cost Change*	The percentage change comparing the Net Retrofit Cost (after Incentives) from the Baseline Data to the data from this sensitivity analysis for this category.
Col. AI	*Value of Savings Change*	The percentage change comparing the Annual Value of Energy Savings from the Baseline Data to the data from this sensitivity analysis for this category.
Col. AJ	*Net Payback Change*	The percentage change comparing the Net Retrofit Payback from the Baseline Data to the data from this sensitivity analysis for this category
Col. AK	*Savings Available for Debt Change*	The percentage change comparing the Energy Cost Savings Available for Debt from the Baseline Data to the data from this sensitivity analysis for this category.
Col. AL	*Funding Gap change*	The percentage change comparing the Funding Gap (Net Cost After Debt) from the Baseline Data to the data from this sensitivity analysis for this category.

Appendix 2: Inflation Reduction Act Programs and Incentives

Within the IRA, there are 12 noncompetitive financial incentives available for electrification, clean energy, and energy efficiency projects. There are five clean energy programs and two additional clean energy monetary provisions (Direct Pay and Transferability). There are five energy efficiency and electrification programs. All the programs listed here are non-competitive; meaning, they are not based on applications competing for approval. However, certain programs, like the ITC Adders Programs, have limited budgets and are allocated on a first-come, first-served basis.

Each program may have a specific target audience indicated by their eligibility requirements. Like those that are only for commercial property owners, residential property owners, or nonprofit and tribal property owners. Similarly, each will have specific requirements for the measures allowed for the specific incentive being offered.

While this report focuses on single-family owner-occupied housing, the list below applies to all ownership and building types for a broader context. Below is a summary of each IRA incentive, categorized by clean energy and energy efficiency incentives, as well as the two monetization provisions as described above. Lastly, this section provides an overview of the recently awarded Greenhouse Gas Reduction Fund programs.

IRA Clean Energy Incentives

The IRA offers several tax credits and tax deductions designed to support the development of clean energy resources by consumers, commercial owners, nonprofits, governmental bodies, and Tribes. Below is a synopsis of the most common incentives for use with solar PV and storage applications.

Section 48 and Section 48E (Commercial)

ITC BASE CREDIT:

The Section 48 and 48E tax credits are available to commercial owners, nonprofits, government entities, and Tribal communities. It provides for a base tax credit of 6% of the upfront cost or eligible cost basis for a solar, battery, geothermal heat pump, or other clean energy installation. This increases to 30% of the cost basis if the project is under 1 MW or Prevailing Wage and Apprenticeship requirements are met. There are several bonus adders that increase this percentage if the project meets qualifications. It is applied for using Form 5695 when filing federal tax documents. There is an Elective Pay option available to non-profits, governments, and tribes, where the building owner can receive a tax refund for the credit or participate in a Tax Equity financing structure. Taxable owners can realize the ITC directly, pursue a Transfer of the ITC for Cash, or participate in a Tax Equity financing structure.

ITC BONUS ADDERS:

A total of 70% bonus credits are available if a project were to meet all the criteria below and be awarded competitively awarded credits.

Small Project/Prevailing Wage Bonus Adder

This adder increases the ITC base rate from 6% of the project cost to 30% if the project size is under 1 MW. If the project is above 1 MW, it can still qualify for the 30% ITC if installers are paid at or above the prevailing wages. The IRS has published Prevailing Wage and Apprenticeship requirements, which are governed by published prevailing wages by County.

Domestic Content Bonus Adder (10%, fact-based)

This adder increases the ITC percentage by an additional 10% for systems that meet Domestic Content standards for steel and manufactured components made in the United States. Between 2023 to 2025, the qualifying level of Domestic Content is 40%, increasing to 55% in 2026. Domestic Content rules are complex and require certification.

Energy Communities Bonus Adder (10%, location-based)

This adder increases the ITC percentage by an additional 10% if the project is in an Energy Community and meets certain prevailing wage and apprenticeship requirements. Projects must be in one of the three following categories to qualify as an Energy Community: 1) Brownfield site category. 2) Statistical area category, defined as a Municipal Statistical Area (MSA) or non-MSA, that has either at minimum a .17% direct unemployment rate or receives at least 25% of local tax revenue from fossil fuel (coal, natural gas, or oil) extraction or transportation. Or 3) Coal closure category, defined as a census tract in which a coal mine has been closed after 1999, or a coal-fired electric plant has been closed after 2009. Census tracts that share a border with these qualifying tracts may also qualify. The Department of Energy's National Renewable Energy Lab (NREL) has released a map to help property owners determine if they are in a qualified energy community that can be found here.

Low-income Communities Bonus Adders (10 or 20%, based on competitive award)

This adder increases the ITC percentage by an additional 10 or 20% if the project is under 5 MW AC and located in a low-income community as defined by the Treasury/IRS. There are four categories for competitive bonus adder awards:

Category 1 – Located in a Low-Income census tract (<80 AMI) – 10%

Category 2 – Located on Tribal Land – 10%

Category 3 – Federal Housing Program – 20%

Category 4 – Meets 50% economic benefit test – 20%

A project is eligible for a 10% bonus if it meets one of the following criteria: Category 1 - The project is in a low-income community which is defined as a census tract where the poverty rate is at least 20%, and/or if in a metropolitan area, the median family income is 80% or less than the median family income of the state or metro area. Non-metro areas where the poverty rate is less than 20% are qualified if the median family income does not exceed 80% of the statewide median income. Or Category 2 - The project is located on Tribal land, defined as property within a reservation, pueblo, or rancheria, or a census tract where most people are Native American or enrolled members of a federally recognized Tribal community.

Projects can receive the 20% adder if the installation is: Category 3 - Located on a qualified low-income residential building, which is a residential rental building that participates in a qualifying Federal affordable housing program, and the produced electricity is allocated to tenants, or Category 4 - Is part of a "qualified low-income economic project" where at least 50% of the financial benefits are allocated among tenants of households with income of less than 200% of poverty line, or less than 80% of the area median income (AMI).

The LI bonus adders is a competitive application process with 1.8 GW available annually, with two significant additional criteria available for specific sub-allocations (in addition to usual readiness, sponsorship and other qualifying criteria) provided by the DOE: 1) Project Ownership: Nonprofit, electric coop, etc.; 2) Location in either a Persistent Poverty County (PPC) or as identified in an area as provided in the Climate Equity and Economic Justice Tool (CEEJT).

Section 25D - Residential Clean Energy Credit

This credit is for individual taxpayers and/or residential owners who occupy the building where the Solar PV and storage facility is installed. This includes single family as well as multifamily housing if at least one unit is owner-occupied. It is worth 30% of the qualified installation cost, with any public utility incentives or rebates deducted from the basis. This credit is claimed on personal tax returns, is not refundable but can be carried forward if the taxpayer does not have adequate taxable income. It can be used for both primary and secondary homes. The credit is applied for on Form 5695.

Section 45 - Production Tax Credit

This credit is a technology-neutral Production Tax Credit that provides $0.0055 (or 0.55/cent) per kilowatt, per year for ten years, adjusted for inflation. The credit is increased to $0.00275/kW (or 5x) for projects meeting prevailing wage and apprenticeship requirements. The credit is increased by 10% for meeting Domestic Content requirements, and/or 10% if located in an Energy Community (see Domestic Content and Energy Communities Bonus Adders*)*. Note that Low Income Communities Bonus Adder credits are ineligible for Section 45 Production Tax Credits. The use of the PTC vs the ITC is advantageous for larger, utility-scale solar arrays.

Section 30L – Alternative Fuels, including EV chargers

Section 30L allows a tax credit equal to 30% of the cost, subject to caps and limits for the installation of EV chargers. The credit is available to individual and commercial taxpayers, nonprofits, and governmental agencies. It is Transferable and eligible for Elective Pay. For consumers, the credit has a cap of $1,000. For all other taxpayers, the credit is capped at $100,000 and is eligible only in certain areas designated as rural or low-income.

Accelerated Depreciation

While not specific to the IRA, accelerated depreciation can reduce a commercial taxpayer's taxable income, and thus taxes, and it is a valuable incentive. In the Solar PV installation context, there are two types of depreciation that can be used by commercial owners: Bonus Depreciation and Accelerated Modified Accelerated Cost Recovery System (MACRS) depreciation. Nonprofit and other tax-exempt entities cannot gain the benefit of such incentives, except via a tax equity partnership structure.

BONUS DEPRECIATION

For tangible assets with depreciable service lives of less than 20 years, such as solar installations, one-time Bonus Depreciation is available as placed in service as follows:

- 2023 - 80%
- 2024 - 60%
- 2025 - 40%
- 2026 - 20%
- 2027+ - 0%

MACRS

Depreciation of eligible solar energy equipment can be claimed by for-profit entities using the Modified Accelerated Cost Recovery System (MACRS). Solar energy equipment is eligible for an accelerated cost recovery period of five years, during which taxpaying entities can take annual tax deductions. If the ITC is also claimed, the project's depreciable basis is reduced by one half of the ITC amount unless a CE asset is part of a LIHTC project.

Bonus Depreciation and MACRS depreciation can be combined in a depreciation waterfall or declining balance schedule.

Tax depreciation rules are complex and require fact-specific calculations, and various carryforward and other rules apply. The value of a tax depreciation deduction is determined by the taxpaying entity's tax rate and NPV of taxes saved. Nonprofit, governmental, and other tax-exempt entities can use tax equity partnership structures to monetize the NPV benefits of depreciation deductions provided such benefits are substantial enough to offset the cost of establishing such structures.

IRA Energy Efficiency Incentives

Home Energy Performance-Based, Whole-House Rebates (HOMES)

HOMES is a program that provides rebates for whole house, energy efficiency improvements above threshold levels. It is available to all homeowners and multifamily building owners, with increased rebates available to households at or below 80% or MF buildings where at least 50% of the tenants are at or below 80% AMI. The rebate amount is based on whether savings are measured or modeled, LMI or non-LMI status, and the percentage of energy reduction due to the improvements. This and the HEERHA program below are funded by the DOE via grants to States. State-by-state programs are expected to be rolled out in mid-2024. This program is being rolled out by individual State Energy Offices.

	Single Family:			Multi-family (per unit):		
		20-35% Savings	**35%+ Savings**		**20-35% Savings**	**35%+ Savings**
Calculating Value and Limits – MODELED SAVINGS	**LMI** (<80% AMI)	80% of cost, up to $4,000	80% of cost, up to $8,000	**LMI** (50% units are <80% AMI)	80% of cost, up to $4,000	80% of cost, up to $8,000
	Non-LMI	50% of cost, up to $2,000	50% of cost, up to $4,000	**Non-LMI**	$2,000 per unit $200,000 per building	$4,000 per unit $400,000 per building
Calculating Value and Limits – MEASURED SAVINGS	LMI (<=80% AMI): 80% of cost **or** $200 per 1% energy reduction versus state average. Non-LMI: $100 per 1% energy reduction versus state average; no cap.					

High Efficiency Electric Home Rebate Program (HEERHA or HEAR)

This is a rebate program for households that are below 150% AMI, including multifamily buildings (including tribal communities, nonprofit, and public housing) that have at least 50% of residents below 150% AMI. This is a state and Tribal administered program that provides point of sale rebates for electrification projects such as electric panels and stoves, heat pumps, and insulation. Like HOMES, this program is being rolled out by individual State Energy Offices.

Households under 80% AMI are eligible for a rebate of 100% of the costs up to $14,000. Households between 80% and 150% AMI are eligible for a rebate of 50% of the costs up to $14,000.

Multi-family buildings with over 50% of residents below 80% AMI are eligible for a rebate of 100% of the costs of up to $14,000 per unit. Multi-family buildings with over 50% of residents below 150% AMI are eligible for a rebate of 50% of the costs of up to $14,000 per unit.

Calculating Value	50% or 100% of cost based on income level, with a max per measure and an annual overall max.	
	• Electric Circuit Panels: $4,000 • Electric Stoves: $840 • Electric Wiring: $2,500	• Heat Pump Clothes Dryer: $840 • Heat Pump Water Heaters: $1,750 • Heat Pumps: $8,000 • Insulation: $1,600
Limits	Maximum per Household/Unit: • <=80% AMI: 100% of cost up to $14,000 max per household or per unit for multifamily • 80-150% AMI): 50% of cost up to $14,000 max per household or per unit for multifamily • >150% AMI: Not eligible	

Section 25C - Energy Efficient Home Improvement Credit

This is a tax credit for homeowners/ individual taxpayers who make qualified energy-efficiency improvements to their homes. Qualified improvements include heat pumps, HVAC, electric appliances, envelope measures, and energy audits. The credit is worth 30% of the associated costs, with limits based on the type of improvement, with per year caps.

- Heat pumps can receive a credit of 30% of the cost up to $2,000 per year.
- High-efficiency HVAC can receive a credit of 30% of the cost up to $600.
- Window and skylight replacements can receive a credit of 30% of the cost up to $600.
- Door replacements can receive a credit of 30% of the cost up to $250 per door, with a $500 maximum credit.
- Energy audits can receive a credit of 30% of the cost up to $150.

An annual cap for Heat Pumps is $2,000 and $1,200 for all other Section 25C credits or combined $3,200. Utilization of 25C credits requires taxable income as the credits are not refundable and cannot be carried forward.

Section 45L - New Energy Efficient Homes Credit

This is a federal tax credit for the builders/developers of new homes (single and multi-family), or homes/ MF properties undergoing substantial rehab. Single family builders can receive a credit of $2,500 or $5,000 for energy certifications through ENERGY STAR's Residential New Construction Program or Manufactured New Homes Program, as well as meeting the Department of Energy's Energy Star or Zero Energy Ready Home (ZERH) program requirements. Multi-family builders can receive $500 or $1,000 per unit for buildings certified through ENERGY STAR's Multi-family New Construction Program and meet either Energy Star or ZERH requirements. If the Multi-family project meets prevailing wage requirements, the credit increases to $2,500 (ENERGY STAR) or $5,000 (ZERH) per unit (5x). ZERH program requirements are dependent on the type of building and are subject to change from year to year. Current certification requirements can be viewed at the DOE's Office of Energy Efficiency and Renewable Energy ZERH webpage. ENERGY STAR certification requirements and instructions on how to apply can be found on the ENERGY STAR website.

Section 179D – Tax Deductions for certain energy-saving improvements to commercial and Multi-family buildings.

Section 179D provides a tax deduction for three types of energy efficiency improvements to commercial buildings and multi-family buildings at or above four stories high which exceed a minimum 25% energy saving above a referenced ASHRAE building standard (not existing conditions). The three eligible measures are: 1. Lighting upgrades; 2. Building envelope upgrades; and 3) HVAC upgrades. The deduction is calculated as a $/SF deduction above 25%, including a PWA adder. It can be used by the building owner, or if the building owner is tax-exempt, the deduction can be transferred to the project architect, engineer or contractor and realized by the tax-exempt entity via the bidding process and tax benefit sharing agreement. Note a separate engineering study is required to document energy savings above the ASHRAE standard, which from a practical matter, limits the use of this incentive to buildings greater than ~ 15,000 square feet.

Direct Pay (Section 6417)

Direct Pay was introduced through the IRA for tax-exempt entities to directly monetize certain ITCs. Direct Pay, or Elective Pay, allows the direct payment or refund by the IRS of certain Clean Energy ITCs to qualifying nonprofits, governmental entities, Tribal communities, and other qualifying entities. Direct Pay (and Transferability below) is eligible for 12 types of Clean Energy ITCs, and, in the context of this paper, applies to Sections 48/48E, 30C, and 45 PTC only. Direct Pay allows a tax-exempt organization to file for a "refund" in the amount of the ITC, subject to certain rules, pre-registration, and tax filing requirements. For entities that normally do not file a tax return, certain rules are provided to claim Direct Pay. Direct Pay is a powerful funding source, noting the cash flow timing gap between project completion, pre-registration, tax return filing and refund can be 12- 18 months. Note tax exempt entities cannot combine Direct Pay with depreciation. Direct Pay is not transferable.

Transferability (Section 6418)

Commercial taxpaying entities qualify for Transferability (Section 6418), which allows for certain ITCs to be sold for cash to eligible taxpaying entities. There is a similar pre-registration process as above. Transferability has enjoyed quick adoption, particularly with hybrid Tax Equity structures.

IRA Greenhouse Gas Reduction Fund (GGRF)

The DOE has announced awardees under the IRA's $27B Greenhouse Gas Reduction Fund (GGRF), with an intent for awardees to roll out financing programs funded by the Fund in Fall, 2024. The objectives of the GGRF are to 1. Reduce GHG emissions; 2. Deliver benefits to communities, particularly low-income and disadvantaged communities; 3. Mobilize financing and private capital to stimulate additional deployment.

Three programs are funded through GGRF: the National Clean Investment Fund (NCIF), the Clean Communities Investment Accelerator (CCIA), and the Solar For All program. The Solar For All program is being administrated through states, regions, and local governments, in which programs rolled out in 2024. Solar For All is being administered in a similar way to previous solar programs, which NCIF and CCIA represent an entirely new effort to create a permanent source of green financing. The remaining discussion in this section applies to the NCIF and CCIA programs.

While NCIF and CCIA project eligibility criteria are beginning to emerge, loan and equity product specifics are not known currently. Much of the funding is expected to be targeted at the LMI residential building sector. From review of awardee proposals, the amount of funding going to building projects is likely to be in the $10 billion to $12 billion range; this will be a mixture of retrofits and new construction and apply to a variety of building types. The amount devoted to projects that serve LMI residents is not known, though it is expected to be significant.

GGRF funding will primarily be deployed by awardees as direct financial assistance to qualified projects structured as debt or equity. Awardees may also fund predevelopment and market-building activities, but most expenditures will be for project financing.

Qualified projects are required to have six characteristics: reduce Green House Gas (GHG) emissions; reduce other pollutants; deliver additional community benefits; would not have happened without GGRF investment; leverage additional financing; and use commercially available technologies.

The three NCIF awardees will offer financing themselves and are meant to function as permanent green banks. The five CCIA awardees are passing through equity to community-level lending institutions – CDFIs, credit unions, and others – to allow them to initiate green lending programs.

Weatherization Assistance Program (WAP)

Weatherization Assistance Program (WAP): The financial results shown herein include WAP program amounts up to $8,250 per retrofit for low-income homeowner scenarios for weatherization costs, noting that WAP is a by application program managed by states and different state rules apply.

Appendix 3: Resources

IRA Program and Policy Overviews

Section 25C ITC (Energy Efficiency upgrades)

- Internal Revenue Service: Energy Efficient Home Improvement Credit

Section 25D ITC (Clean Energy – Solar)

- Internal Revenue Service, Q&A on Tax Credits for Sections 25C and 25D
- Solar Energy Industry Association: The 25D Solar Tax Credit: What Homeowners Need to Know

Section 30C ITC (EV chargers)

- U.S. Dept of Energy: Tax Credits for Electric Vehicles and Charging Infrastructure

HEAR and HER Rebates

- Congressional Research Service: Inflation Reduction Act
- Energy.Gov: Home Energy Rebates Overview

Other Federal Guides and Tools

- White House: IRA Overview
- CAP: How States Can Equitably Deliver Home Electrification Rebates
- Rewiring America IRA Calculator
- EnergyStar Tax Credit Guide
- Weatherization Assistance Program (WAP)

Stacking and Braiding Incentives

- Ann Dyl Policy Group: The Residential Capital Stack
- EnergyStar Tax Credit Guide
- RMI: Gaps and Barriers to Stacking Federal, State, and Local Incentives

State, Local, and Utility Programs

Illinois Programs

- Illinois Solar for All: Income-eligible Solar Programs
- Illinois Shines: General Market Solar Program
- ComEd: General Energy Incentives and Rebates
- ComEd: Income-eligible Energy Incentives and Rebates

Chicago Programs:

- Chicago Solar Express: Expedited Solar Permitting and Zoning
- Retrofit Chicago Multi-Family Residential Partnership

Minnesota Programs:

- Xcel Energy: General Energy Incentives and Rebates
- Xcel Energy: Income-eligible Energy Incentives and Rebates
- Minnesota Commerce Dept. Energy Incentives and Rebates

Other Tools and Information:

- DSIRE database of state, local and utility incentives

Clean Energy Financing
Illinois Programs • EPA: Clean Energy Financing Toolkit for Decisionmakers • U.S. Dept. of Energy: Better Buildings Financing Navigator • EPA: Clearinghouse for Environmental Finance • NASEO: Key Financing Resources and Publications • Lawrence Berkeley National Lab: Financing Energy Efficiency
Solar Tools: • U.S. Energy Information Agency: Renewable Energy Explained • PVWatts Calculator • EPA: Renewable Energy Certificates (RECs)

Appendix 4: State, Local, and Utility Programs

Incentives and rebates are available in Chicago and Minneapolis from two state-administered solar programs (general market and income eligible), as well as from electric utilities that serve each city. Additional incentives are available from gas utilities. However, those are not relevant to this analysis. Below are descriptions of each program used in this analysis, along with links to current programs and incentive websites. Specific incentive values may change seasonally or regularly. Specific incentive values used in this analysis can be found in the published Excel-base data model.

Illinois

ILLINOIS SHINES

Illinois Shines is the state-administered Renewable Energy Credit (REC) program that most Illinois residential or commercial solar installations are eligible for. Incentives are issued via RECs to registered Approved Vendors. The value is determined by the amount of solar energy produced in the first 15 years of the system. The price per REC varies by utility. To receive REC payments, system owners must register with an Approved Vendor (AV), who will sell the credits received from the state to a contracted utility. For systems under 25 kW the utility must pay the AV in a lump sum. Payments from the AV to the system owner are scheduled as previously agreed upon between the two parties. REC contracts from Illinois Shines are estimated to return around 30% of the total system cost. Available funds are limited and allocated by block. Blocks are determined by the electric utility. Within each block, funds are distributed into categories based on size and type of project (distributed generation or community solar). The remaining funds for each block can be viewed on the Illinois Power Agency's Block Capacity Dashboard. Note that available funds change yearly.

ILLINOIS SOLAR FOR ALL

Illinois Solar for All (ILSFA) is the State of Illinois' solar program that provides incentives for solar installations that serve low- and moderate-income households. The program is structured similarly to the Illinois Shines program, with RECs issued to registered Approved Vendors (AV) based on energy produced by the qualified solar array. The incentive value for ILSFA is nearly twice that of Illinois Shines. To qualify, the energy produced by qualified systems must be used by homeowners below 80% AMI. For multi-family buildings, at least half of the units must be below the 80% AMI threshold. Note that the value of these incentives can change every two years. Project funding is not guaranteed and is based on budget availability. ILSFA incentives are awarded via Renewable Energy Credits to registered AV. The REC values may change every two years.

COMED INCENTIVES AND REBATES

ComEd is the electric utility provider for the City of Chicago. ComEd offers several energy efficiency and electrification incentives and rebates for HVAC, appliances, lighting, and other clean energy and water efficiency measures. ComEd also offers specific income-eligible incentives and rebates, providing greater discounts and savings for this category. These incentives and rebates change seasonally. So, links are provided below with current program details.

Minnesota

XCEL ENERGY INCENTIVES AND REBATES

Xcel Energy Minnesota is the electric utility provider for the City of Minneapolis. Xcel offers several energy efficiency and electrification incentives and rebates for HVAC, appliances, lighting, and other clean energy and water efficiency measures. ComEd also offers specific income-eligible incentives and rebates, providing greater discounts and savings for this category. These incentives and rebates change seasonally. Links are provided below with current program details.

MINNESOTA COMMERCE DEPT. ENERGY INCENTIVES AND REBATES

The Minnesota Commerce Department has a number of energy incentives and rebate programs that serve multiple audiences, including homeowners, businesses, and schools. The Dept. also provides incentives and rebates for multiple measures, including electrification, energy efficiency, solar, battery storage, community solar, and more. These incentives and rebates change seasonally. Links are provided below with current program details.

Appendix 5: Sensitivity Analysis Data; changes from baseline

Sensitivity 1: The impact of reducing debt interest rate from 6% to 0%

Chicago: Natural Gas Heating	GHG Reduction MTCO2E	GHG Reduction Change from Baseline	Baseline savings available for debt (after holdback)	New savings available for debt (after holdback)	Change		Baseline Final Funding Gap	New Final Funding Gap	Change	
Scenario 1a	-4.8	0.0	$7,435	$11,208	$3,773	50.8%	-$997	-$4,770	-$3,773	-378.6%
Scenario 1b	-4.2	0.0	$7,942	$11,972	$4,031	50.8%	$1,071	-$2,959	-$4,031	-376.2%
Scenario 1c	-4.8	0.0	$7,435	$11,208	$3,773	50.8%	$15,626	$11,852	-$3,773	-24.1%
Scenario 1d	-4.2	0.0	$7,942	$11,972	$4,031	50.8%	$18,594	$14,563	-$4,031	-21.7%
Chicago: Electric Resistance Heating										
Scenario 2a	-5.7	0.0	$10,357	$15,614	$5,257	50.8%	-$4,014	-$9,270	-$5,257	-131.0%
Scenario 2b	-5.0	0.0	$10,864	$16,378	$5,514	50.8%	-$1,995	-$7,509	-$5,514	-276.3%
Scenario 2c	-5.7	0.0	$10,357	$15,614	$5,257	50.8%	$7,731	$2,474	-$5,257	-68.0%
Scenario 2d	-5.0	0.0	$10,864	$16,378	$5,514	50.8%	$10,699	$5,185	-$5,514	-51.5%
Minneapolis: Natural Gas Heating										
Scenario 3a	-4.0	0.0	$6,934	$10,453	$3,519	50.8%	$11,936	$8,417	-$3,519	-29.5%
Scenario 3b	-3.4	0.0	$6,627	$9,990	$3,363	50.8%	$14,353	$10,990	-$3,363	-23.4%
Scenario 3c	-4.0	0.0	$6,934	$10,453	$3,519	50.8%	$14,211	$10,692	-$3,519	-24.8%
Scenario 3d	-3.4	0.0	$6,627	$9,990	$3,363	50.8%	$17,618	$14,255	-$3,363	-19.1%
Minneapolis: Electric Resistance Heating										
Scenario 4a	-7.8	0.0	$14,123	$21,291	$7,168	50.8%	$2,887	-$4,281	-$7,168	-248.3%
Scenario 4b	-7.1	0.0	$15,022	$22,646	$7,624	50.8%	$4,098	-$3,526	-$7,624	-186.0%
Scenario 4c	-7.8	0.0	$14,123	$21,291	$7,168	50.8%	$5,162	-$2,006	-$7,168	-138.9%
Scenario 4d	-7.1	0.0	$15,022	$22,646	$7,624	50.8%	$7,363	-$261	-$7,624	-103.5%

Sensitivity 2: The impact of reducing savings from 20% to 0%

Chicago: Natural Gas Heating	GHG Reduction MTCO2E	GHG Reduction Change from Baseline	Baseline savings available for debt (after holdback)	New savings available for debt (after holdback)	Change		Baseline Final Funding Gap	New Final Funding Gap	Change	
Scenario 1a	-4.8	0.0	$7,435	$9,293	$1,859	25.0%	-$997	-$2,855	-$1,859	-186.5%
Scenario 1b	-4.2	0.0	$7,942	$9,927	$1,985	25.0%	$1,071	-$914	-$1,985	-185.3%
Scenario 1c	-4.8	0.0	$7,435	$9,293	$1,859	25.0%	$15,626	$13,767	-$1,859	-11.9%
Scenario 1d	-4.2	0.0	$7,942	$9,927	$1,985	25.0%	$18,594	$16,608	-$1,985	-10.7%
Chicago: Electric Resistance Heating										
Scenario 2a	-5.7	0.0	$10,357	$12,946	$2,589	25.0%	-$4,014	-$6,603	-$2,589	-64.5%
Scenario 2b	-5.0	0.0	$10,864	$13,580	$2,716	25.0%	-$1,995	-$4,711	-$2,716	-136.1%
Scenario 2c	-5.7	0.0	$10,357	$12,946	$2,589	25.0%	$7,731	$5,141	-$2,589	-33.5%
Scenario 2d	-5.0	0.0	$10,864	$13,580	$2,716	25.0%	$10,699	$7,983	-$2,716	-25.4%
Minneapolis: Natural Gas Heating										
Scenario 3a	-4.0	0.0	$6,934	$8,667	$1,733	25.0%	$11,936	$10,203	-$1,733	-14.5%
Scenario 3b	-3.4	0.0	$6,627	$8,284	$1,657	25.0%	$14,353	$12,696	-$1,657	-11.5%
Scenario 3c	-4.0	0.0	$6,934	$8,667	$1,733	25.0%	$14,211	$12,478	-$1,733	-12.2%
Scenario 3d	-3.4	0.0	$6,627	$8,284	$1,657	25.0%	$17,618	$15,961	-$1,657	-9.4%
Minneapolis: Electric Resistance Heating										
Scenario 4a	-7.8	0.0	$14,123	$17,654	$3,531	25.0%	$2,887	-$644	-$3,531	-122.3%
Scenario 4b	-7.1	0.0	$15,022	$18,777	$3,755	25.0%	$4,098	$343	-$3,755	-91.6%
Scenario 4c	-7.8	0.0	$14,123	$17,654	$3,531	25.0%	$5,162	$1,631	-$3,531	-68.4%
Scenario 4d	-7.1	0.0	$15,022	$18,777	$3,755	25.0%	$7,363	$3,608	-$3,755	-51.0%

Sensitivity 3: Eliminate Solar

Chicago: Natural Gas Heating	GHG Reduction MTCO2E	GHG Reduction Change from Baseline	Baseline savings available for debt (after holdback)	New savings available for debt (after holdback)	Change		Baseline Final Funding Gap	New Final Funding Gap	Change	
Scenario 1a	1.9	6.7	$7,435	$0	-$7,435	-100.0%	-$997	$6,270	$7,267	729.1%
Scenario 1b	2.5	6.7	$7,942	$0	-$7,942	-100.0%	$1,071	$8,845	$7,774	725.5%
Scenario 1c	1.9	6.7	$7,435	$0	-$7,435	-100.0%	$15,626	$14,220	-$1,406	-9.0%
Scenario 1d	2.5	6.7	$7,942	$0	-$7,942	-100.0%	$18,594	$17,695	-$899	-4.8%
Chicago: Electric Resistance Heating										
Scenario 2a	-2.8	2.9	$10,357	$4,882	-$5,475	-52.9%	-$4,014	$1,388	$5,401	134.6%
Scenario 2b	-2.1	2.9	$10,864	$5,389	-$5,475	-50.4%	-$1,995	$3,406	$5,401	270.7%
Scenario 2c	-2.8	2.9	$10,357	$4,882	-$5,475	-52.9%	$7,731	$9,338	$1,607	20.8%
Scenario 2d	-2.1	2.9	$10,864	$5,389	-$5,475	-50.4%	$10,699	$12,306	$1,607	15.0%
Minneapolis: Natural Gas Heating										
Scenario 3a	1.9	5.9	$6,934	$0	-$6,934	-100.0%	$11,936	$5,850	-$6,086	-51.0%
Scenario 3b	2.5	5.9	$6,627	$0	-$6,627	-100.0%	$14,353	$7,960	-$6,393	-44.5%
Scenario 3c	1.9	5.9	$6,934	$0	-$6,934	-100.0%	$14,211	$8,125	-$6,086	-42.8%
Scenario 3d	2.5	5.9	$6,627	$0	-$6,627	-100.0%	$17,618	$11,225	-$6,393	-36.3%
Minneapolis: Electric Resistance Heating										
Scenario 4a	-2.8	5.0	$14,123	$5,233	-$8,890	-62.9%	$2,887	$617	-$2,270	-78.6%
Scenario 4b	-2.1	5.0	$15,022	$4,669	-$10,352	-68.9%	$4,098	$3,291	-$808	-19.7%
Scenario 4c	-2.8	5.0	$14,123	$5,233	-$8,890	-62.9%	$5,162	$2,892	-$2,270	-44.0%
Scenario 4d	-2.1	5.0	$15,022	$4,669	-$10,352	-68.9%	$7,363	$6,556	-$808	-11.0%

Sensitivity 4: Reduce Retail Net Metering to Supply/Avoided Cost (Bill Credits reduced from 100% to 50% of kWh value)

Chicago: Natural Gas Heating	GHG Reduction MTCO2E	GHG Reduction Change from Baseline	Baseline savings available for debt (after holdback)	New savings available for debt (after holdback)	Change		Baseline Final Funding Gap	New Final Funding Gap	Change	
Scenario 1a	-4.8	0.0	$7,435	$1,178	-$6,257	-84.2%	-$997	$5,260	$6,257	627.8%
Scenario 1b	-4.2	0.0	$7,942	$1,685	-$6,257	-78.8%	$1,071	$7,328	$6,257	584.0%
Scenario 1c	-4.8	0.0	$7,435	$1,178	-$6,257	-84.2%	$15,626	$21,883	$6,257	40.0%
Scenario 1d	-4.2	0.0	$7,942	$1,685	-$6,257	-78.8%	$18,594	$24,851	$6,257	33.7%
Chicago: Electric Resistance Heating										
Scenario 2a	-5.7	0.0	$10,357	$7,620	-$2,737	-26.4%	-$4,014	-$1,276	$2,737	68.2%
Scenario 2b	-5.0	0.0	$10,864	$8,126	-$2,737	-25.2%	-$1,995	$742	$2,737	137.2%
Scenario 2c	-5.7	0.0	$10,357	$7,620	-$2,737	-26.4%	$7,731	$10,468	$2,737	35.4%
Scenario 2d	-5.0	0.0	$10,864	$8,126	-$2,737	-25.2%	$10,699	$13,436	$2,737	25.6%
Minneapolis: Natural Gas Heating										
Scenario 3a	-4.0	0.0	$6,934	$1,459	-$5,475	-79.0%	$11,936	$17,411	$5,475	45.9%
Scenario 3b	-3.4	0.0	$6,627	$1,152	-$5,475	-82.6%	$14,353	$19,828	$5,475	38.1%
Scenario 3c	-4.0	0.0	$6,934	$1,459	-$5,475	-79.0%	$14,211	$19,686	$5,475	38.5%
Scenario 3d	-3.4	0.0	$6,627	$1,152	-$5,475	-82.6%	$17,618	$23,093	$5,475	31.1%
Minneapolis: Electric Resistance Heating										
Scenario 4a	-7.8	0.0	$14,123	$10,409	-$3,714	-26.3%	$2,887	$6,601	$3,714	128.7%
Scenario 4b	-7.1	0.0	$15,022	$9,846	-$5,176	-34.5%	$4,098	$9,274	$5,176	126.3%
Scenario 4c	-7.8	0.0	$14,123	$10,409	-$3,714	-26.3%	$5,162	$8,876	$3,714	72.0%
Scenario 4d	-7.1	0.0	$15,022	$9,846	-$5,176	-34.5%	$7,363	$12,539	$5,176	70.3%

Sensitivity 5: Supply Chain Variance; Construction Costs Increase by 10%

:hicago: Natural Gas Heating	GHG Reduction MTCO2E	GHG Reduction Change from Baseline	Baseline savings available for debt (after holdback)	New savings available for debt (after holdback)	Change		Baseline Final Funding Gap	New Final Funding Gap	Change	
Scenario 1a	-4.8	0.0	$7,435	$7,435	$0	0.0%	-$997	$2,208	$3,205	321.6%
Scenario 1b	-4.2	0.0	$7,942	$7,942	$0	0.0%	$1,071	$5,496	$4,425	413.0%
Scenario 1c	-4.8	0.0	$7,435	$7,435	$0	0.0%	$15,626	$19,156	$3,530	22.6%
Scenario 1d	-4.2	0.0	$7,942	$7,942	$0	0.0%	$18,594	$22,484	$3,890	20.9%
Chicago: Electric Resistance Heating										
Scenario 2a	-5.7	0.0	$10,357	$10,357	$0	0.0%	-$4,014	-$1,754	$2,260	56.3%
Scenario 2b	-5.0	0.0	$10,864	$10,864	$0	0.0%	-$1,995	$1,660	$3,655	183.2%
Scenario 2c	-5.7	0.0	$10,357	$10,357	$0	0.0%	$7,731	$10,316	$2,585	33.4%
Scenario 2d	-5.0	0.0	$10,864	$10,864	$0	0.0%	$10,699	$13,644	$2,945	27.5%
Minneapolis: Natural Gas Heating										
Scenario 3a	-4.0	0.0	$6,934	$6,934	$0	0.0%	$11,936	$14,231	$2,295	19.2%
Scenario 3b	-3.4	0.0	$6,627	$6,627	$0	0.0%	$14,353	$16,943	$2,590	18.0%
Scenario 3c	-4.0	0.0	$6,934	$6,934	$0	0.0%	$14,211	$16,419	$2,208	15.5%
Scenario 3d	-3.4	0.0	$6,627	$6,627	$0	0.0%	$17,618	$20,186	$2,568	14.6%
Minneapolis: Electric Resistance Heating										
Scenario 4a	-7.8	0.0	$14,123	$14,123	$0	0.0%	$2,887	$4,972	$2,085	72.2%
Scenario 4b	-7.1	0.0	$15,022	$15,022	$0	0.0%	$4,098	$6,478	$2,380	58.1%
Scenario 4c	-7.8	0.0	$14,123	$14,123	$0	0.0%	$5,162	$7,519	$2,358	45.7%
Scenario 4d	-7.1	0.0	$15,022	$15,022	$0	0.0%	$7,363	$10,081	$2,718	36.9%

Sensitivity 6a: Electricity rates increase by 10%

go: Natural Gas Heating	GHG Reduction MTCO2E	GHG Reduction Change from Baseline	Baseline savings available for debt (after holdback)	New savings available for debt (after holdback)	Change		Baseline Final Funding Gap	New Final Funding Gap	Change	
Scenario 1a	-4.8	0.0	$7,435	$7,285	-$149	-2.0%	-$997	-$847	$149	15.0%
Scenario 1b	-4.2	0.0	$7,942	$7,559	-$383	-4.8%	$1,071	$1,454	$383	35.7%
Scenario 1c	-4.8	0.0	$7,435	$7,285	-$149	-2.0%	$15,626	$15,775	$149	1.0%
Scenario 1d	-4.2	0.0	$7,942	$7,559	-$383	-4.8%	$18,594	$18,977	$383	2.1%
Chicago: Electric Resistance Heating										
Scenario 2a	-5.7	0.0	$10,357	$11,245	$888	8.6%	-$4,014	-$4,902	-$888	-22.1%
Scenario 2b	-5.0	0.0	$10,864	$11,518	$654	6.0%	-$1,995	-$2,650	-$654	-32.8%
Scenario 2c	-5.7	0.0	$10,357	$11,245	$888	8.6%	$7,731	$6,843	-$888	-11.5%
Scenario 2d	-5.0	0.0	$10,864	$11,518	$654	6.0%	$10,699	$10,045	-$654	-6.1%
Minneapolis: Natural Gas Heating										
Scenario 3a	-4.0	0.0	$6,934	$6,734	-$199	-2.9%	$11,936	$12,136	$199	1.7%
Scenario 3b	-3.4	0.0	$6,627	$6,194	-$433	-6.5%	$14,353	$14,786	$433	3.0%
Scenario 3c	-4.0	0.0	$6,934	$6,734	-$199	-2.9%	$14,211	$14,411	$199	1.4%
Scenario 3d	-3.4	0.0	$6,627	$6,194	-$433	-6.5%	$17,618	$18,051	$433	2.5%
Minneapolis: Electric Resistance Heating										
Scenario 4a	-7.8	0.0	$14,123	$15,388	$1,265	9.0%	$2,887	$1,622	-$1,265	-43.8%
Scenario 4b	-7.1	0.0	$15,022	$16,175	$1,153	7.7%	$4,098	$2,945	-$1,153	-28.1%
Scenario 4c	-7.8	0.0	$14,123	$15,388	$1,265	9.0%	$5,162	$3,897	-$1,265	-24.5%
Scenario 4d	-7.1	0.0	$15,022	$16,175	$1,153	7.7%	$7,363	$6,210	-$1,153	-15.7%

Sensitivity 6b: Gas rates increase by 10%

cago: Natural Gas Heating	GHG Reduction MTCO2E	GHG Reduction Change from Baseline	Baseline savings available for debt (after holdback)	New savings available for debt (after holdback)	Change		Baseline Final Funding Gap	New Final Funding Gap	Change	
Scenario 1a	-4.8	0.0	$7,435	$8,327	$893	12.0%	-$997	-$1,889	-$893	-89.6%
Scenario 1b	-4.2	0.0	$7,942	$8,929	$988	12.4%	$1,071	$84	-$988	-92.2%
Scenario 1c	-4.8	0.0	$7,435	$8,327	$893	12.0%	$15,626	$14,733	-$893	-5.7%
Scenario 1d	-4.2	0.0	$7,942	$8,929	$988	12.4%	$18,594	$17,606	-$988	-5.3%
Chicago: Electric Resistance Heating										
Scenario 2a	-5.7	0.0	$10,357	$10,505	$148	1.4%	-$4,014	-$4,161	-$148	-3.7%
Scenario 2b	-5.0	0.0	$10,864	$11,106	$243	2.2%	-$1,995	-$2,238	-$243	-12.2%
Scenario 2c	-5.7	0.0	$10,357	$10,505	$148	1.4%	$7,731	$7,583	-$148	-1.9%
Scenario 2d	-5.0	0.0	$10,864	$11,106	$243	2.2%	$10,699	$10,456	-$243	-2.3%
Minneapolis: Natural Gas Heating										
Scenario 3a	-4.0	0.0	$6,934	$7,826	$893	12.9%	$11,936	$11,044	-$893	-7.5%
Scenario 3b	-3.4	0.0	$6,627	$7,618	$991	15.0%	$14,353	$13,362	-$991	-6.9%
Scenario 3c	-4.0	0.0	$6,934	$7,826	$893	12.9%	$14,211	$13,319	-$893	-6.3%
Scenario 3d	-3.4	0.0	$6,627	$7,618	$991	15.0%	$17,618	$16,627	-$991	-5.6%
Minneapolis: Electric Resistance Heating										
Scenario 4a	-7.8	0.0	$14,123	$14,271	$148	1.0%	$2,887	$2,739	-$148	-5.1%
Scenario 4b	-7.1	0.0	$15,022	$15,267	$245	1.6%	$4,098	$3,853	-$245	-6.0%
Scenario 4c	-7.8	0.0	$14,123	$14,271	$148	1.0%	$5,162	$5,014	-$148	-2.9%
Scenario 4d	-7.1	0.0	$15,022	$15,267	$245	1.6%	$7,363	$7,118	-$245	-3.3%

Sensitivity 7: Eliminating all state, local and utility incentives

cago: Natural Gas Heating	GHG Reduction MTCO2E	GHG Reduction Change from Baseline	Baseline savings available for debt (after holdback)	New savings available for debt (after holdback)	Change		Baseline Final Funding Gap	New Final Funding Gap	Change	
Scenario 1a	-4.8	0.0	$7,435	$7,435	$0	0.0%	-$997	$17,035	$18,032	1809.1%
Scenario 1b	-4.2	0.0	$7,942	$7,942	$0	0.0%	$1,071	$19,228	$18,157	1694.6%
Scenario 1c	-4.8	0.0	$7,435	$7,435	$0	0.0%	$15,626	$24,985	$9,360	59.9%
Scenario 1d	-4.2	0.0	$7,942	$7,942	$0	0.0%	$18,594	$28,078	$9,485	51.0%
Chicago: Electric Resistance Heating										
Scenario 2a	-5.7	0.0	$10,357	$10,357	$0	0.0%	-$4,014	$4,663	$8,677	216.2%
Scenario 2b	-5.0	0.0	$10,864	$10,864	$0	0.0%	-$1,995	$6,856	$8,852	443.6%
Scenario 2c	-5.7	0.0	$10,357	$10,357	$0	0.0%	$7,731	$12,613	$4,882	63.2%
Scenario 2d	-5.0	0.0	$10,864	$10,864	$0	0.0%	$10,699	$15,706	$5,007	46.8%
Minneapolis: Natural Gas Heating										
Scenario 3a	-4.0	0.0	$6,934	$6,934	$0	0.0%	$11,936	$15,616	$3,680	30.8%
Scenario 3b	-3.4	0.0	$6,627	$6,627	$0	0.0%	$14,353	$18,623	$4,270	29.7%
Scenario 3c	-4.0	0.0	$6,934	$6,934	$0	0.0%	$14,211	$24,541	$10,330	72.7%
Scenario 3d	-3.4	0.0	$6,627	$6,627	$0	0.0%	$17,618	$28,448	$10,830	61.5%
Minneapolis: Electric Resistance Heating										
Scenario 4a	-7.8	0.0	$14,123	$14,123	$0	0.0%	$2,887	$6,327	$3,440	119.2%
Scenario 4b	-7.1	0.0	$15,022	$15,022	$0	0.0%	$4,098	$8,128	$4,030	98.3%
Scenario 4c	-7.8	0.0	$14,123	$14,123	$0	0.0%	$5,162	$15,252	$10,090	195.5%
Scenario 4d	-7.1	0.0	$15,022	$15,022	$0	0.0%	$7,363	$17,953	$10,590	143.8%

Sensitivity 8: The impact of eliminating HEAR and HER rebates

cago: Natural Gas Heating	GHG Reduction MTCO2E	GHG Reduction Change from Baseline	Baseline savings available for debt (after holdback)	New savings available for debt (after holdback)	Change		Baseline Final Funding Gap	New Final Funding Gap	Change	
Scenario 1a	-4.8	0.0	$7,435	$7,435	$0	0.0%	-$997	$12,503	$13,500	1354.5%
Scenario 1b	-4.2	0.0	$7,942	$7,942	$0	0.0%	$1,071	$15,071	$14,000	1306.6%
Scenario 1c	-4.8	0.0	$7,435	$7,435	$0	0.0%	$15,626	$25,226	$9,600	61.4%
Scenario 1d	-4.2	0.0	$7,942	$7,942	$0	0.0%	$18,594	$30,044	$11,450	61.6%
Chicago: Electric Resistance Heating										
Scenario 2a	-5.7	0.0	$10,357	$10,357	$0	0.0%	-$4,014	$9,486	$13,500	336.4%
Scenario 2b	-5.0	0.0	$10,864	$10,864	$0	0.0%	-$1,995	$12,005	$14,000	701.6%
Scenario 2c	-5.7	0.0	$10,357	$10,357	$0	0.0%	$7,731	$17,331	$9,600	124.2%
Scenario 2d	-5.0	0.0	$10,864	$10,864	$0	0.0%	$10,699	$22,149	$11,450	107.0%
Minneapolis: Natural Gas Heating										
Scenario 3a	-4.0	0.0	$6,934	$6,934	$0	0.0%	$11,936	$23,336	$11,400	95.5%
Scenario 3b	-3.4	0.0	$6,627	$6,627	$0	0.0%	$14,353	$26,693	$12,340	86.0%
Scenario 3c	-4.0	0.0	$6,934	$6,934	$0	0.0%	$14,211	$22,711	$8,500	59.8%
Scenario 3d	-3.4	0.0	$6,627	$6,627	$0	0.0%	$17,618	$28,468	$10,850	61.6%
Minneapolis: Electric Resistance Heating										
Scenario 4a	-7.8	0.0	$14,123	$14,123	$0	0.0%	$2,887	$14,287	$11,400	394.9%
Scenario 4b	-7.1	0.0	$15,022	$15,022	$0	0.0%	$4,098	$16,588	$12,490	304.8%
Scenario 4c	-7.8	0.0	$14,123	$14,123	$0	0.0%	$5,162	$13,662	$8,500	164.7%
Scenario 4d	-7.1	0.0	$15,022	$15,022	$0	0.0%	$7,363	$18,213	$10,850	147.4%