Building the Foundation for a Residential Utility Affordability Program in Detroit and Highland Park

2020 DOW SUSTAINABILITY FELLOWS PROJECT

FINAL REPORT

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CLIENT

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DOW SUSTAINABILITY FELLOWS
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EXECUTIVE SUMMARY

EcoWorks is a Detroit-based nonprofit, founded in 1981, focused on building inclusive solutions to climate change and other community sustainability challenges. In order to address the rising utility burdens faced by low-income homeowners in Detroit not adequately served by existing programs, EcoWorks is leading the charge to create a new program, Turnkey Home Retrofits (THR), to lower utility bills by implementing comprehensive energy and water efficiency measures and home repairs at no cost to the homeowner. This Dow Sustainability Fellows project was focused on building a solid foundation on which to develop and implement THR, specifically through (1) a financial model to evaluate the fiscal viability of the THR program and (2) a metrics and evaluation framework and implementation strategy.

The financial model is a tool for demonstrating the financial viability of achieving THR objectives and can be used interactively to evaluate varying cohort sizes, heating fuel choices, and investment level mixes. To inform the inputs and approach, the team engaged in a thorough literature review and a series of expert interviews, and underwent several iterations of client and stakeholder feedback and validation. Ultimately, the model demonstrates that collectively, the measures do not pay for themselves within 10 years and thus the program will require additional funding. Without a financial return, impact investments and other forms of returns-based financing will not be feasible in the short term. Even so, the model projects meaningful utility bill savings and energy burden reductions for homeowners.

The financial model relies in part on grant and investment opportunities, requiring the demonstration of THR impact and desired outcomes through a metrics and evaluation framework. To develop a household survey for THR clients and a survey guide, the team conducted a literature review of previous metrics and evaluation plans for health and energy efficiency programs. Given the innovative nature of THR's model, the team developed a hybrid approach to evaluate the programs impacts and outcomes by combining a series of demographic, health, energy efficiency, financial, community education and outreach, and client satisfaction questions. These questions target both quantitative and qualitative data points and address methods in which to claim that the changes in the participants' lives, whether positive or negative, are a result of the program.

Given these findings, the team shares recommendations in streamlining and improving data and information, accessing additional program cost savings, seeking additional funding opportunities, and developing strategic partnerships to advance the program. Once implemented, THR will enable up to $2,191 in annual bill savings per THR client and up to 7,151,401 lbs of annual CO_2e emissions reductions for a cohort of 100 homes. Moreover, the efficiency, weatherization, and home repairs to be implemented will demonstrate real health benefits, measured in the evaluation framework. The program seeks to alleviate high energy burdens among low income homeowners in Detroit, who are primarily Black and Latinx, representing an important form of distributive or corrective justice for communities that have historically been discriminated against and marginalized. As individual households become healthier and home values increase, neighborhoods will be transformed into more stable, resilient, and vibrant communities.

ACKNOWLEDGMENTS

This report was developed by a team of interdisciplinary Masters candidates from the University of Michigan's School for Environment and Sustainability (SEAS), Stephen M. Ross School of Business, School of Public Health, and Gerald R. Ford School of Public Policy on behalf of EcoWorks. EcoWorks is a Detroit-based nonprofit with nearly 40 years of experience providing services at the intersection of sustainability, social justice, and community development. This one-year collaborative project was made possible by the Dow Sustainability Fellows Program at the University of Michigan, and was driven by the engaged support and guidance of our client Justin Schott at EcoWorks. We are also grateful for the support of our faculty advisor Dr. Tony Reames and our Dow Fellows project advisor Dr. Margaret Wooldridge. During this project, we also received insight from technical experts, without whom we could not have developed a defensible set of deliverables.

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INTRODUCTION AND BACKGROUND

PROJECT CONTEXT

Efficient, affordable housing is the bedrock for health, financial stability, and climate resilient neighborhoods. As a result of decades of systemic racism, low-income communities of color across the country tend to face the highest utility burdens, defined as the percentage of income that is spent on gas, electric, and water bills.[1] In low-income communities, the average energy burden is 13% of a household's annual income compared to the national average of 7.2%. In Detroit, the burden increases to 17% for single parent homes and up to 30% for the most vulnerable.[2] With Detroit's median household income at $29,481,[3] this could leave families with $20,000 or less to cover rent, food, healthcare, and any other necessities each year. There were more than 23,000 water shutoffs recorded in Detroit in 2019, and more than 50,000 electric shutoffs in Q1 of 2020 alone.[4,5]

Faced with high energy bills, families often have to make difficult decisions about which essential expenses to prioritize, resulting in tradeoffs between heat, food, and healthcare. Moreover, inefficient homes and degraded living conditions contribute to real health and safety issues, such as asthma, chronic stress, and a risk of avoidable accidents.[6] Unpaid utility bills can lead to shutoffs and cascade to home foreclosures, creating neighborhood blight, opening the area to gentrification, and eroding community vitality and identity. All of these factors reinforce cycles of systemic inequity.

Where government and utility programs to address these utility burdens exist, there are barriers to participation and insufficient resources to meet the scope of the need. State and federal assistance programs offer some utility bill credits for low-income communities, but ultimately, these bill credits do not enable a long term reduction of utility bills. Weatherization funding is available, but is an arduous process with a two-year wait list in Detroit. Many homes are disqualified for health and safety issues, such as leaky roofs, lead paint, and mold and asbestos, leaving those most in need without support. Utility assistance programs offer some direct-install options for low-income customers, but these are limited in scope and availability and often require an upfront investment, a barrier for low-income homeowners. While some low-income loan programs exist, these often have credit requirements or involve a level of financial risk or burden that is too high for the most needy families. Moreover, navigating the requirements and application process for many disparate programs places a time and energy burden on families that may be impossible to justify when heads of households are often working multiple jobs to provide essential needs.[7,8]

It has become clear that the need for utility burden relief is significant and that the existing safety net is insufficient. This underscores the urgency for the development of programs, coordinating entities, and comprehensive strategies for enabling long-term resiliency for families and communities.

ECOWORKS AND TURNKEY HOME RETROFITS

EcoWorks is a Detroit-based nonprofit, founded in 1981, focused on inclusive solutions to climate change and other community sustainability challenges. At the beginning of its 38-year history, EcoWorks began job training in basic weatherization and construction skills. In 2002, after years of energy education and energy efficiency upgrades, EcoWorks started Michigan Builds!, the first building standard in Michigan to combine energy efficiency and indoor health. One year later, EcoWorks began providing energy auditing services to commercial buildings. Ten years later, the organization became the first National Center for Healthy Homes Training, and was the first in the nation to also be a Regional Weatherization Training Center. In addition to the work directly focused on residential and commercial energy efficiency, EcoWorks works in local school systems to offer a program called Youth Energy Squad. This program cultivates the next generation of green leaders by engaging youth from diverse backgrounds in hands-on service learning projects that make their homes, schools, and communities more sustainable. EcoWorks has a long history of developing programs and identifying solutions that address critical needs in the community.

In order to address rising utility burdens faced by low-income homeowners in Detroit, EcoWorks' most recent Executive Director, Justin Schott, has been leading the charge to create a new program, Turnkey Home Retrofits (THR). The objective of THR (where ”turnkey‘ typically refers to homes that have been retrofitted and are in excellent, livable condition) is to lower utility bills for low-income Detroit homeowners by implementing comprehensive energy and water efficiency measures and home repairs through innovative financing mechanisms. The organization will serve to address the gap of Detroit homeowners not adequately served by existing programs, to minimize the burden of navigating a complex system of available rebates and credits, and to maximize the value brought to the homeowner for long-term family and community resilience. Moreover, literature suggests that a community-based approach like THR can be more effective at overcoming social, market, and regulatory barriers to low-income energy efficiency programming.[9]

THR will take responsibility for managing and directly paying clients' utility bills, coordinate home assessments and installation of utility efficiency, weatherization, and home repair measures, and manage applications for relevant rebate and credit programs.

THR will also maintain grant and social impact investment evaluation and reporting, establishing a value for concrete social benefits such as reduced asthma-induced hospitalizations, reduced carbon emissions, and reduced utility burdens and shutoffs. THR was envisioned with three funding streams: (1) household monthly payments at a set percentage (~7.5%) of income, (2) utility incentives and public assistance funds, and (3) social impact investments and grants from philanthropic institutions and private investors. While THR would initially be piloted by EcoWorks and Soulardarity (another community organization), it is envisioned to scale and exist as an independent organization.

METHODOLOGY AND RESULTS

This report details the methods and results of a financial model and metrics and evaluation plan to assess the viability of the THR model and to lay the groundwork for an initial pilot and eventual scaling for all Detroit homeowners in need.

The financial model is a planning tool designed to:

- Project the likely range of investment requirements (e.g., for efficiency, weatherization, and home repair measures, case management salaries, utility bills, and other operating costs)
- Assess the feasibility of the three primary revenue streams (i.e., client payments, public funds and utility incentives, and philanthropic funds or social impact investments)
- Create an interactive interface projecting costs of a cohort of homes over a 10-year time horizon with the ability to specify how many homes in a cohort, how they are allocated over investment level scenarios, and type of space and water heating

The metrics and evaluation plan includes a household survey and evaluation guide designed to:

- Measure health outcomes, efficiency gains, financial savings, community education and outreach, and client satisfaction
- Ensure ongoing funding streams (e.g., grants, impact investments) via the defensible demonstration of these impacts
- Enable continual improvement and effective operation of the organization

FINANCIAL MODEL

METHODS

To inform the approach and inputs for the financial model, the team engaged in a two pronged approach for information gathering. First, a literature review built a foundational understanding of the tools, databases, and research questions being addressed in the evaluation of low-income residential energy efficiency and weatherization projects, and brought awareness to potential challenges and limitations. The relevant literature and the data sources ultimately used can be found in Appendix B. Second, the team conducted a series of interviews with directors of similar programs, project implementers, and subject matter experts (e.g, residential energy efficiency, rain gardens, impact investing), who filled knowledge gaps, highlighted potential challenges, provided new leads, and validated the model approach. The key takeaways from these interviews are provided in Appendix C. These stakeholders can and should serve as important partners going forward.

MODEL APPROACH

The model was built utilizing a structured bottom-up approach, beginning with the creation of low, medium, and high investment scenarios for eligible homes, though it was not within scope to define eligibility. Efficiency, weatherization, and home repair measures were defined, costed, and allocated to each investment scenario based on subject matter expert interviews, industry research, and client preferences. Within the model, the user can select heating fuels (electric or gas) and toggle rooftop solar, automatically sized to meet total household demand minus projected savings. Utility savings are calculated within these investment scenarios, where water, electric, and gas savings of each parameter are applied to local utility rates to estimate the annual utility bill savings each household in the THR program might realize. The same framework is used to model revenues and subsidies that can be achieved through utility rebate and public assistance programs, considered on both a one-time, upfront basis and annually over a 10-year time period.

These investment scenarios feed up into projections for one home over the 10-year time period, creating an interactive dashboard that models revenues and expenses associated with a home at a selected investment level. In addition, other cost and revenue measures, such as utility bill payments, case management, and home assessments are estimated within the model to provide a complete picture of the financial outcomes of investing in one home in each investment scenario. The one-home projections then feed up into the highest-level view, which

demonstrates the financial outcome of the entire THR program (i.e., all homes being served) over a 10-year time period. This model is built as a function of an interactive, user-defined portfolio, where projections are based on the number of homes in a cohort and allocation of percent of the homes that will lie within each of the three investment scenarios. A second approach was developed to provide an alternative view: instead of a binary Y/N selection of measures for three investment scenarios, the second approach considers the percent allocation of all homes in a given cohort that would require each measure.

This financial model was developed to be an interactive tool that EcoWorks can use and update over time rather than a one time financial assessment of the program. Drop-down menus and variable input cells are clearly indicated on each user-facing tab, each annotated with sources for assumptions and calculations so that the client can update and change as the THR program and participant demographics evolve over time, and as primary data is acquired.

RESULTS

The main outcome of this research is an interactive financial model that EcoWorks can use for organizational planning and grant application purposes. See Appendix D for screenshots of the Excel tool interface.

An example set of outputs and 10-year cash flow projections using a pilot size of 100 homes can also be seen in Appendix E. Three sets of projections are shown for the following heating fuel scenarios: (1) gas space and water heating, (2) electric space and water heating, and (3) electric space and water heating with rooftop solar. Appendix F provides visibility to several technical limitations of the financial model.

FINANCIAL RETURNS AND THE POTENTIAL FOR IMPACT INVESTING

The model currently demonstrates that this program does not pay back solely on the basis of utility bill savings and thus is not financially sustainable without some form of gap financing, likely philanthropic or governmental support. Appendix E contains example summary projected cash flows outputs given current inputs and assumptions.

While the THR program is designed with a focus on retrofits, it will also provide some new services, such as air conditioning, and will improve homes' indoor environments, driving significant health benefits. Moreover, electrification and solar installation will reduce emissions and set homeowners up to reap the benefits of a decarbonized future. Because of these non-financial benefits, EcoWorks initially envisioned impact investing as a primary revenue stream for THR, but preliminary research and expert interviews suggest this is unlikely in the short term.

Ultimately, even if impact investors are willing to accept a lower financial return in exchange for social or environmental returns, they will still require some financial return. Research and interviews also suggested that other impact-oriented financing options would also require a financial return, including community financial development institutions (CDFIs), impact bonds, low- or zero-interest philanthropic loans, or low-cost capital from green banks. That said, if government agencies or other institutions are willing to pay back impact investors once THR has achieved certain non-financial outcomes, such as health and wellness as detailed in the Metrics and Evaluation section, it may become a viable option. Similarly, should government implement a price on carbon, it will become feasible to monetize the reduced carbon emissions driven by THR. Alternatively, direct grants from philanthropic institutions or direct funding from state, local, or federal government may be the most viable short term options for outcomes-based funding that will not require financial repayment to subsidize the THR program at no cost or risk to homeowners.

POST-THR ANNUAL BILL SAVINGS AND CARBON SAVINGS

HEATING FUELS	ANNUAL BILL SAVINGS ($)	ANNUAL CARBON SAVINGS (lb CO_2e)
Gas space + gas water	$981	25,214
Gas space + electric water	$949	26,073
Electric space + gas water	$94	11,853
Electric space + electric water	$63	12,712
Electric space + electric water + solar	$2,137	62,461

Table 1: Post-THR household annual bill savings and carbon savings by heating fuel, as projected by the model given current assumptions and inputs.

HOUSEHOLD UTILITY BILL SAVINGS AND CARBON EMISSIONS REDUCTIONS

The financial model quantifies household utility bill savings, reductions in household utility burdens, and reductions in carbon emissions as a result of THR's efficiency, weatherization, and home repair measures. Table 1 demonstrates annual utility bill and CO_2e emissions reductions by heating fuel type, per average THR home. Given current assumptions, the average pre-THR utility burden is 12.20%, and it can be reduced to 4.16% given medium- or high-level investment, electrification of heating fuels, and rooftop solar. Even so, the burden cannot be fully eliminated because water usage and unavoidable bill fees are included in the calculation of utility burden, in addition to other model limitations described in Appendix F.

ELECTRIFICATION AND THE COMPETING GOALS OF EXPANDING REACH VERSUS ACHIEVING DECARBONIZATION

At this time, the financial model demonstrates that it is ultimately more expensive to retrofit a home with electric air source heat pumps and heat pump water heaters than to retrofit with efficient gas furnaces and water heaters due to the cold climate in Michigan, high upfront costs, lack of sufficient utility rebates (due to misaligned utility and regulatory incentives), and the low costs of gas compared to electricity. Recent reports by reputable research and efficiency organizations validate these results, showing that cold-climate heat pump retrofits are not cost-effective in most current regulatory environments, though they can be for new builds.[10,11,12] Still, when paired with rooftop solar, electrification can produce the greatest household bill and carbon savings as demonstrated in Table 1, above. Depending on funding availability for THR, EcoWorks must consider these circumstances and strike a balance between serving as many homes as possible with cost-effective gas upgrades or fully electrifying a smaller number of homes to enable maximum decarbonization through solar. EcoWorks may also find funders and investors who are willing to give more support for electrification and decarbonization, funding the gap between high efficiency gas and electric space and water heating. Though both reach and decarbonization are important to EcoWorks, the organization will need to evaluate these considerations as technology improves, costs decrease, and incentives align.

METRICS AND EVALUATION

Turnkey Home Retrofit's financial model will rely in part on grant and investment opportunities. In order to secure grants and social impact investing, THR's pilot program must demonstrate that it is having the expected impact and resulting in desired outcomes. Therefore, a program evaluation framework must be developed to identify key data points that can be used to demonstrate program impacts. To inform the development of a program evaluation system for THR's pilot program, the team first conducted a literature review of previous metrics and evaluation plans for similar programs. Given the innovative nature of THR's model, the team developed a hybrid approach to evaluating the program's impacts and outcomes by combining a series of demographic, health, energy efficiency, financial, community education and outreach, and client satisfaction questions. Two primary deliverables were developed to address metrics and evaluation: (1) a model household-level survey for THR participating families and (2) a survey use and data use guide.

EVALUATION RATIONALE

Evaluation is a process by which a program, person, or innovation is critically examined. The evaluation of programs like THR involves the collection, organization, analysis, and maintenance of data about a program's activities, design, and impact.[13] The purpose of these types of program evaluations is to draw conclusions about the program's effectiveness, inform future decisions, aid in restructuring, highlight successes, and demonstrate impact.[14] The information collected by an evaluation that includes both quantitative and qualitative measures is called a mixed methods approach. The integration of quantitative and qualitative data will allow EcoWorks and THR to demonstrate concrete energy and cost savings while also providing in-depth insight into program participant experiences.[15] A thorough and rigorous evaluation is important for securing funding to scale pilots like THR into full programs.

PROGRAM EVALUATION DEVELOPMENT

ESTABLISHING A LOGIC MODEL

The first step in evaluation is to develop a logic model or theory of change for the program. A logic model is a graphic road map that details shared relationships among key elements of a program.[16] Key elements of THR and this project are resources (inputs), activities, outputs, outcomes, and desired impacts. Figure 1 is the logic model for the pilot program that incorporates all the key elements and organizes the outcomes by focus area. After reviewing over 50 evaluation guides and models for programs that relate to either energy or health, our team determined that a new model that combines elements of demographic, health, energy efflciency, financial, education and outreach, and client satisfaction is the best way to address both the impact and outcomes of this pilot program.

SELECTING INDICATORS TO MEASURE IMPACTS AND OUTCOMES

The indicators for this project can be found in the evaluation guide in Appendix G. To get an accurate measure of these indicators, both quantitative and qualitative questions were selected. When the purpose of a data point is to express a tangible quantity, our team established quantiflable questions. However, when the purpose was to gather experience-

related questions or feelings on a specific aspect of the program, we established qualitative and open-ended questions. There is a combination of both found throughout the survey in Appendix H.

ESTABLISHING DATA MAINTENANCE PROTOCOLS AND A GUIDE

After finalizing the questions in this evaluation, our team developed a short guide that covers the timeline for data collection, key milestones, and recommendations for how to analyze the data. As part of the guide, the team also established a plan for storing and maintaining the data for the pilot project. However, it was not within the project scope to execute any direct data collection. The purpose of establishing maintenance protocols is to ensure that the data can be analyzed in the future for funding requests, program improvement, or public relations purposes.

TURNKEY HOME RETROFITS LOGIC MODEL

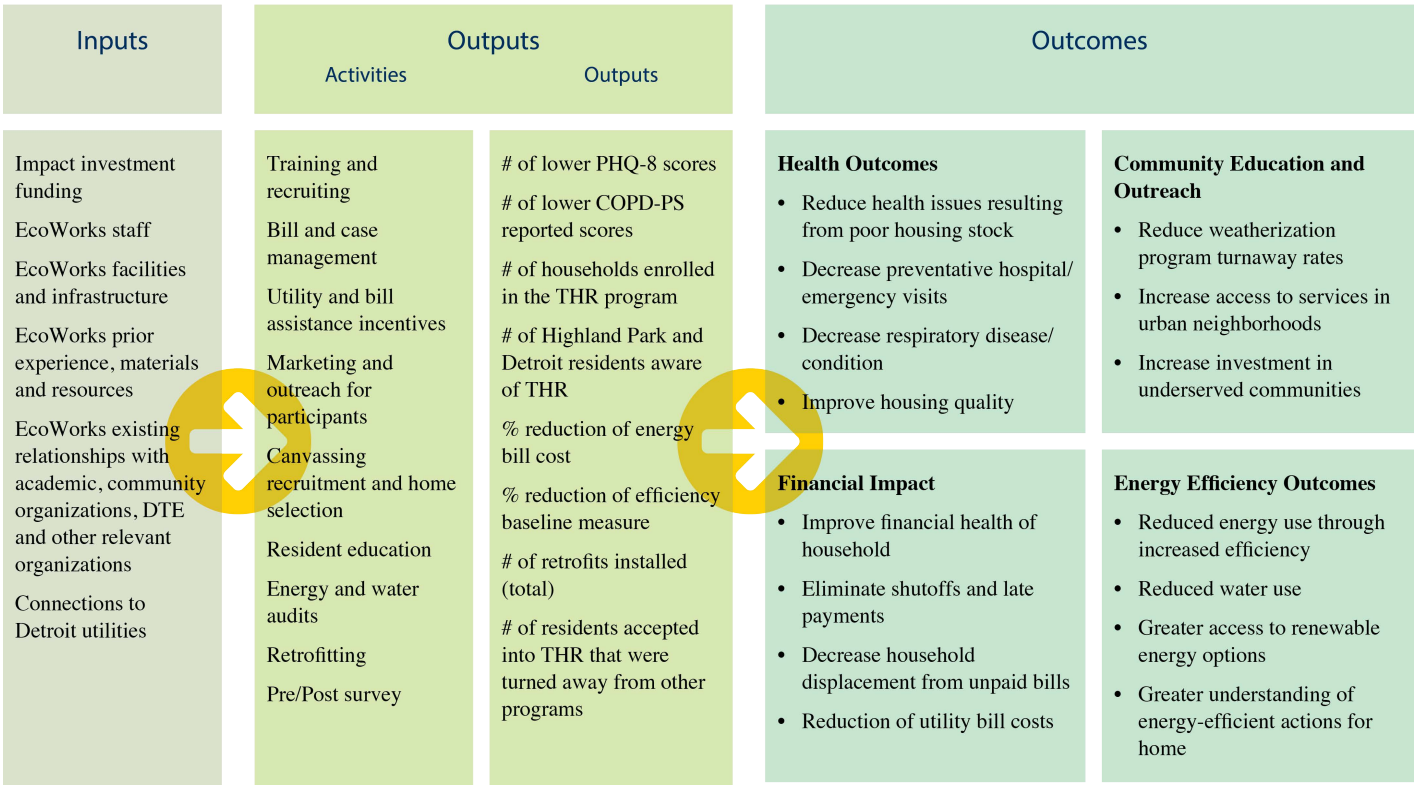


Figure 1: Logic model for the THR pilot program, including key inputs, outputs, and outcomes by focus area.

RESULTS

The primary results of this research are the survey (Appendix H) and the accompanying guide (Appendix G) designed to provide THR with the ability to measure outcomes of the pilot program. If implemented as outlined in the guide, there will be measurements for health, energy efficiency, financial, education and outreach, and client satisfaction outcomes. The survey will be conducted via Survey Monkey with local enumerators. The desired results of the pilot program are detailed in the guide.

LIMITATIONS

The data collected in the pilot program may be limited by the number of participants. In order to claim causality, the larger the sample size, the better. The minimum number of participants to enable the ability to claim causality is 30, and the participants must be randomly selected to receive the intervention (in this case, to become a client of the program) or not. This project is also limited because there are no direct models or research with which to compare results. Other relevant limitations are discussed in the survey guide (Appendix G).

CONCLUSIONS

RECOMMENDATIONS

See below the recommendations for EcoWorks as the organization pursues launching the THR program.

DATA AND INFORMATION

- **Implement the evaluation survey once every six months using highly trained community enumerators.** For the evaluation of the program to run as designed, it is important that the first survey should be conducted before the intervention, another shortly after the start of the program, and followed every six months thereafter. Engaging local residents as enumerators would be ideal as they may be able to better connect with THR participants.
- **Improve project data security by storing survey data outside of Survey Monkey on an EcoWorks server.** As much of Ecoworks' collected data is stored on Survey Monkey, EcoWorks should devise a more secure method of data storage. Researchers recommend not storing survey data on Survey Monkey as it is a shared platform and less secure. As significant resident information can be found on this, EcoWorks should use or invest in alternative data storing methods.
- **Validate financial model inputs with contractors and efficiency professionals.** The financial model is largely based on desk research and broad expert interviews. Due to time and in-person communication constraints in light of COVID-19, it was not validated with contractors. Leveraging EcoWorks' relationships with contractors to validate cost and savings estimates could provide a more accurate picture.
- **Update financial model with pilot data to improve accuracy.** Improve data quality in the financial model by using pilot data to produce a more accurate picture of the long term program performance before moving forward. Focusing primarily on low and medium investment homes initially may allow THR to collect data and quickly improve the model.

COST REDUCTIONS

- **Pair electrification with solar to maximize decarbonization and cost savings to homeowners.** EcoWorks can achieve the greatest household cost savings by replacing gas space and water heating with electric heat pumps paired with rooftop solar. That said, in the absence of adequate funding for electrification and solar, efficient gas technology will significantly reduce costs to the organization while still reducing homeowner bills and carbon emissions, allowing EcoWorks to reach the most homes.
- **Negotiate bulk rates with contractors.** Given the number of households that THR will serve, bulk rates with contractors and implementers can bring down measure and installation costs. This may prove effective for improving the financial feasibility of electric heat pumps, as described above.
- **Consider community solar when THR homes are in a focused area.** Consider community solar as an option for further reducing energy burdens where household rooftop installations may be prohibitively expensive.
- **Leverage the federal Solar Investment Tax Credit (ITC) while still available.** Take advantage of the federal Solar Investment Tax Credit (ITC) before it expires after 2021. THR may need to partner with an organization that has a more significant tax burden to fully reap the benefits.
- **Develop a method for phone-call survey distribution to avoid contact during the pandemic and reduce costs.** It would be beneficial to the program's budget and implementation to engage local volunteers that are trained by EcoWorks to make phone-call surveys, which are less expensive than field surveys. This may be the best method for engagement and data collection given the current pandemic and the limited budget of this pilot program.
- **Access additional behavioral savings through strategic and supportive case management.** EcoWorks should develop a case management approach that supports energy education and taps into motivations that enable behavior-based energy savings to prevent rebound effects, meet projected savings, and capture additional savings.

ADDITIONAL FUNDING SOURCES

- **Seek gap financing through philanthropic funding.** EcoWorks should seek foundation grants and program-related investments to provide the required gap financing. Initially, foundation funding appears necessary given that the model does not project financial returns. When non-monetary returns can be defensibly demonstrated and monetized or if the projections improve based on primary data, impact investors may prove a more promising option. A list of relevant foundations and grants to consider can be found in Appendix I.
- **Leverage electrification and decarbonization potential with climate-focused funders.** EcoWorks may find foundations and impact investors seeking to prioritize and invest in electrification and solar for full decarbonization. EcoWorks can leverage the financial model to make a clear appeal for this funding: "We have $x / house to fund efficiency measures and it will cost $y more to install electric heat pumps and rooftop solar. Can you help us close this gap to decarbonize these homes

and standardize these green building practices?"

STRATEGIC PARTNERSHIPS

- **Enable improvement of the financial model and metrics and evaluation plan by making them open source.** Make the financial model and metrics and evaluation framework publicly available to leverage the collective experience and expertise of organizations doing related work and to enable expanded impacts through implementation in other locales.
- **Build partnerships to secure funding and for measure-specific support.** A variety of government agencies and local, regional, and national nonproflts can act as strategic partners to gain access to additional funding, expertise, or measure-speciflc support. See Appendix J for a list of potential partnerships gleaned from expert interviews.
- **Partner with school energy teams to integrate student learning and data analysis of utility bills.** In an effort to strengthen partnerships within existing EcoWorks programs, student energy teams could be utilized to help with household utility bill analysis. If given the data without identifying information, students could help analyze energy consumption and demand changes, improving students' energy literacy and aiding the analysis of pilot data that could be verified by EcoWorks.

PROJECT IMPACTS

IMPACT AREA	OUTCOME
Reduced Carbon Emissions	The financial model for THR demonstrates varying levels of gas and electric savings dependent on the heating fuels and investment scenario mix. Applying emissions factors for the eGRID[17] region (a program of the U.S. EPA), the model demonstrates significant carbon dioxide-equivalent (CO_2e) emissions reductions. For a cohort of 100 homes with 50% of these homes allocated to the low investment scenario, 40% to the medium investment scenario, and 10% to the high investment scenario, the model (given current assumptions and inputs*) projects the following annual emissions reductions by fuel/solar scenario: • Gas space + gas water: 2,610,535 lbs CO_2e • Gas space + electric water: 2,794,913 lbs CO_2e • Electric space + gas water: 1,177,065 lbs CO_2e • Electric space + electric gas: 1,361,443 lbs CO_2e • Electric space + electric gas + solar: 7,151,401 lbs CO_2e *These are one set of static outputs of a dynamic tool and can easily change given updates to inputs and assumptions.
Cost Savings	THR demonstrates varying levels of utility bill savings and energy burden reduction dependent on the heating fuels and investment scenario mix. Annual household utility bill savings by fuel scenario for low, medium, and high investment scenarios are as follows (given current assumptions and inputs*): • Gas space + gas water: $1,029 $1,231 $1,371 • Gas space + electric water: $1,119 $1,331 $1,470 • Electric space + gas water: -$189** $353 $725 • Electric space + electric gas: -$99** $452 $825 • Electric space + electric gas + solar: $2,184 $2,191 $2,191 With current assumptions, the average pre-THR utility burden is 12.20%, and it can be reduced to 4.16% given medium or high level investment, electrification of heating fuels, and rooftop solar. *These are one set of static outputs of a dynamic tool and can easily change given updates to inputs and assumptions. **Negative numbers represent negative savings, or an increase in cost.
Health Benefits	THR expects to improve health outcomes related to reduced financial stress and improved home health, comfort, and safety. Through a series of pre- and post-intervention measurements, over the course of the implementation, the team anticipates decreased reported chronic obstructive pulmonary disease (COPD) symptoms and improved mental health outcomes, such as reduced stress and depression. Given these impacts, THR also looks to reduce healthcare utilization (specifically hospital and emergency room visits).
Social Justice Implications	THR seeks to alleviate injustices of high energy burdens among low income homeowners in Detroit. This program can be seen as distributive or corrective justice, improving living conditions and lowering utility bills for those paying disproportionate amounts of their income.
Community Impacted by Project	THR focuses on bringing services to low income homeowners in Detroit and Highland Park, cities that are majority Black and Latinx, populations which have historically been discriminated against and marginalized.
Community Benefits	As individual households and families become more resilient due to decreased energy burdens and healthier homes, neighborhoods are protected from blight and gentrification, property values rise, and communities preserve their identities.

APPENDICES

APPENDIX A: ACRONYMS AND ABBREVIATIONS

PROJECT SPECIFIC

- **THR** - Turnkey Home Retrofits
- **DTE** - DTE Energy (local gas and electric utility provider)

PUBLIC AGENCIES

- **BCAEO** - Bureau of Community Action and Economic Opportunity (MI)
- **DOE -** Department of Energy (US)
- **EGLE -** Department of Environment, Great Lakes, and Energy (MI)
- **EIA** - Energy Information Administration (US)
- **EPA** - Environmental Protection Agency (US)
- **LBNL** - Lawrence Berkeley National Laboratory (US)
- **MPSC** - Michigan Public Service Commission (MI)
- **NREL** - National Renewable Energy Laboratory (US)
- **DWSD** - Detroit Water and Sewage Department (City of Detroit)

PUBLIC PROGRAMS AND TOOLS

- **ACS -** American Community Survey (Census Bureau)
- **AHS -** American Housing Survey (Census Bureau)
- **HES -** Home Energy Saver (LBNL)
- **LIHEAP -** Low Income Home Energy Assistance Program
- **MEAP -** Michigan Energy Assistance Program
- **MEMD** - Michigan Energy Measures Database
- **NREMD** - National Residential Efficiency Measures Database (NREL)
- **RECS** - Residential Energy Consumption Survey (EIA)
- **TRM** - Technical Resource Manual
- **WAP** - Weatherization Assistance Program
- **WRAP** - Water Residential Assistance Program

ENERGY EFFICIENCY AND RENEWABLES

- **ASHP**- Air source heat pump
- **ccf** - Centum cubic feet
- **CEE** - Consortium for Energy Efficiency
- **CO_2e** - Carbon dioxide-equivalent
- **ESCO** - Energy services company
- **HPWH** - Heat pump water heater
- **HVAC** - Heating, ventilation, and air conditioning
- **kW** - Kilowatt
- **kWh** - Kilowatt-hour
- **PV**- Photovoltaic

APPENDIX B: FINANCIAL MODEL DATA SOURCES

The literature review enabled the team to identify the primary sources of data that would inform and estimate key inputs and variables to the model, listed in the table below. Many studies, especially program evaluations, had the beneflt of access to proprietary data sources, such as utility bills and WAP application data, and primary data collected in the field, such as audit data, surveys, and interviews.[18,19,20] Where demographic and housing stock data had to be estimated for an area, for example, survey data from the U.S. Census Bureau were most frequently used (e.g., census data, American Housing Survey, and American Community Survey).[21,22,23] For information on baseline consumption patterns, the U.S. Energy Information Administration (e.g., Residential Energy Consumption Survey and energy pricing data) was frequently referenced.[24] Where measure costs and savings were estimated, some studies used the tools of the National Renewable Energy Laboratory (i.e., National Residential Efflciency Measure Database) and the Lawrence Berkeley National Laboratory (i.e., Home Energy Saver).[25]

The team prioritized the most current version of the data, with many sources provideing location-representative data, whether for Highland Park, Detroit, Southeastern Michigan, Michigan, or the Midwest.

KEY INPUTS AND ESTIMATED VARIABLES	DATA SOURCES
Household income	U.S. Census Bureau
Home attributes (e.g., square footage, number of rooms, number of floors)	American Housing Survey (AHS), U.S. Census Bureau
Water, gas, and electricity rates	Water: City of Detroit Water and Sewage Department (DWSD) Gas and electricity: U.S. Bureau of Labor Statistics
Water, gas, and electric utility bills	American Community Survey (ACS), U.S. Census Bureau Residential Energy Consumption Survey (RECS), U.S. Energy Information Administration (EIA)
Household electric and gas consumption	Residential Energy Consumption Survey (RECS), U.S. Energy Information Administration (EIA)
Energy and water efficiency levels and sizing requirements	ENERGY STAR, U.S. Environmental Protection Agency (EPA) and U.S. Department of Energy (DOE)
Energy and water efficiency measure costs (including labor)	Michigan Energy Measures Database (MEMD), Michigan Public Service Commission (MPSC), National Residential Efflciency Measures Database, National Renewable Energy Laboratory (NREL), Marketplace and Comparison Tool, DTE Energy, desk research (Home Depot, FIXR), EcoWorks experience and insight
Energy and water efficiency measure savings	Michigan Energy Measures Database (MEMD), Michigan Public Service Commission (MPSC), Home Energy Saver, Lawrence Berkeley National Laboratory (LBNL), DWSD
Home repair and health and safety costs	Michigan Bureau of Community Action and Economic Opportunity (BCAEO), Michigan Department of Environment, Great Lakes, and Energy (EGLE), Wayne Metro, desk research (Home Depot, FIXR), EcoWorks experience and insight
Solar PV insolation levels, costs, and sizing	Global Solar Atlas, Energy Sage, Wholesale Solar
Administrative and operational costs	EcoWorks experience and insight
Potential default rates	SEE Action 2017

APPENDIX C: KEY TAKEAWAYS FROM EXPERT INTERVIEWS

THEME	STAKEHOLDER INSIGHTS AND CONTRIBUTIONS

Measures and Technologies	• Provided validation of relevant measures, model scenarios, and initial projections
	• Provided other savings experience insights
	  ○ HVAC and water heating will be the driver of savings, but insulation and lighting will be important, too
	  ○ Windows can drive savings but may be cost-prohibitive
	  • Where there are double-paned windows, storm windows rather than full window replacements will be more cost-effective
	  • Single-paned windows may need to be replaced
	• Provided insight to technical and financial barriers to ASHPs and HPWHs
	  ○ Suggested it may be premature for the low-income sector
	  ○ In addition to frequently cited cost concerns, mentioned that it can add costs if the household did not have AC before
	  ○ In addition to frequently cited cost concerns, mentioned that it can add costs if the household needs a non-gas stove and range
	  ○ Cost to install is high, and switching from gas to electric involves an added cost
	  ○ Given the Detroit climate, will likely need to keep the furnace as back-up heating
	  ○ May face contractor resistance because the technology is still new and requires a lot of work
	• Provided research showing LIHEAP and WAP performance measures
	• Provided insight on the challenges to cost-effectiveness of rain gardens in Detroit
	  ○ At a reduced cost (e.g., grants, SEAS partnership, EcoWorks negotiation), it might be cost-effective
	  ○ Discussed sizing needs and cost of implementation (DIY vs. professional install)
	• Suggested rain gardens as community gathering space
	• Emphasized the importance of education: gardens often do not survive in places where people do not receive education (workshop, hands-on, etc.)

General Program Design	• Suggested that THR may be able to use a waiver from the consumer to give over control of the utility bill and allow THR to apply for incentives on their behalf • Suggested incorporating a community workforce development component given high unemployment and the need for EE retroflts • Provided an example of a regulatory arrangement that allocates regular funding from the major utility to a similar, low-income-focused energy savings organization • Emphasized importance of trusted community networks
Financing	• Provided insight on gap financing opportunities, including impact investing and philanthropic program investments • Suggested looking into revolving loans and pay-for-performance models • Suggested looking into buying down interest with credit unions to be able to offer 0% loans • Provided thoughts, guidance, and contacts around the impact investing opportunity

THEME	STAKEHOLDER INSIGHTS AND CONTRIBUTIONS

Data and Tools	• Recommended looking at DTE's EEA for full measure costs
	• Recommended leveraging the DOE Home Energy Score to under the payback of certain retroflts
	• Provided an example of a solar PV sizing method
	• Provided summary statistics on water, electric, and gas bills
	• Provided references for aggregate model savings validation and insight on TRM limitations
	  o Reminded of critiques on engineering models
	  o Recommended conducting sensitivity analysis and robustness checks to see how numbers change
	  o Suggested keeping the key constraints top of mind and making a clear case for how the program mitigates those constraints
	• Confirmed understanding and assumptions of the Michigan Energy Measures Database (MEMD)

Potential Challenges	• Shared that on-bill financing for income-qualified utility customers has been challenging
	• Highlighted challenges of energy service company (ESCO) models
	  o Projects are nuanced and difficult to scale
	  o Requires a lot of customer interaction and people can be hesitant to have someone in their home

Model Programs	• General introduction to energy efflciency focused nonprofit space and some existing programs working with low-income homeowners
	  o E.g., Slipstream, SEEL, Duke Energy program
	• Provided example of a low-income home energy loan program (up to $30k for 15 years at 6% interest, based on history of paying utility bills [not credit]) making $1M loans annually, mostly grant and government funded
	• Provided example of a program that runs all low-income programming, created to address barriers to WAP participation
	  o No homeowner payments required for upgrades: program will pay price of measure less the incentive amount
	  o Have a list of low, medium, and high cost measures
	  o Provides auditing, project management, contractor relationship management, navigation of rebates and funding sources, energy conservation education, and direct installation

Local Insights	• Detroit's Efficient Housing Working Group is working on coordinating intake for existing programs, would be helpful for case management costs and revenue streams
Other Expertise	• Shared insights from research on US energy poverty • Provided insight on known health problems related to poor infrastructure • Suggested relevant literature on health impacts based from various weatherization and utility assistance

See several screenshots from the financial model below. Please note that these are static screenshots of a dynamic tool and not the sole outputs of analysis from this project. The financial modeling tool is available in a separate Excel file.

TURNKEY HOME RETROFITS CASHFLOW PROJECTION TOOL

OVERVIEW

This document provides an analysis of the various cost and revenue streams associated with a program concept known as "Turnkey Home Retrofits" (THR) that aims to lower residential utility burdens in Detroit. THR is being developed by EcoWorks and will be eventually piloted and scaled by EcoWorks and Soulardarity. The objective of this document is to compile a set of key inputs and assumptions to estimate and model the 10-year energy and financial savings THR. It is intended to be an interactive planning tool that can be updated as more accurate data is collected and as the assumptions and program design evolve.

CONTENTS

Visible Tabs - for all users	
INPUT: Assumptions	User-defined assumptions such as home characteristics, income levels, average utility bills, and other inputs.
Cohort Projections_Scenarios	Projects the cashflows of the program over a 10-year period based on a defined number of homes in a cohort and an investment scenario mix. Measures and rebates for each investment scenario are defined in the *Measure Costs + Savings_Scenarios and % Allocation* and *Upfront Rebates_Scenarios and % Allocation* tabs.
Cohort Projections_%Allocation	Projects the cashflows of the program over a 10-year period based on number of homes in cohort and % of homes reciveing each measure and rebate. % of homes allocated for each measure is defined in *Measure Costs + Savings_Scenarios and % Allocation* and *Upfront Rebates_Scenarios and % Allocation* tabs.
One Home Projections_Scenarios	Projects the financial performance of one home in a given investment scenario, over a 10-year time period. User's can select Low, Medium or High investment levels as defined in the *Measure Costs + Savings_Scenarios and % Allocation* and *Upfront Rebates_Scenarios and % Allocation* tabs. However, this view is not available for the % allocation method.
Measure Costs + Savings_Scenarios and % Allocation	Defines the costs and electric, natural gas, and water savings associated with retrofit measures that will be implemented as a part of the THR program. Additionally, this tab defines three basic investment scenarios (low, medium, and high) and a separate % of homes allocation method that feed up into the respective One Home and Cohort Projections tabs. Scenarios and % allocation can be modified as described below, but the foundational philosophy was as follows:
Low	Homes in this scenario require basic weatherization and efficiency measures, but do not require significant weatherization or home repairs.
Medium	Homes in this scenario require more comprehensive weatherization and efficiency measures, and basic home repairs.
High	Homes in this scenario require all weatherization and efficiency measures as well as comprehensive home repairs.
% Allocation	This feeds into a separate method for projecting costs and revenues associated with the THR program. Rather than creating defined investment level scenarios, this allows the user to allocate what percent of homes in the THR program will recieve the specified measure

Overview / Instructions | Cohort Projections_Scenarios | Cohort Projections_% Allocation | One Home Projections_Scenarios

Input Cell
Calculation Cell

INVESTMENT SCENARIOS

LOW	MED	HIGH
$71,550	$92,602	$109,818

UPFRONT CREDIT/REBATE

$14,320	$17,330	$21,155

Weighted Average Investment	$83,798
Payback (Years)	29
Internal Rate of Return (IRR)	-18.38%

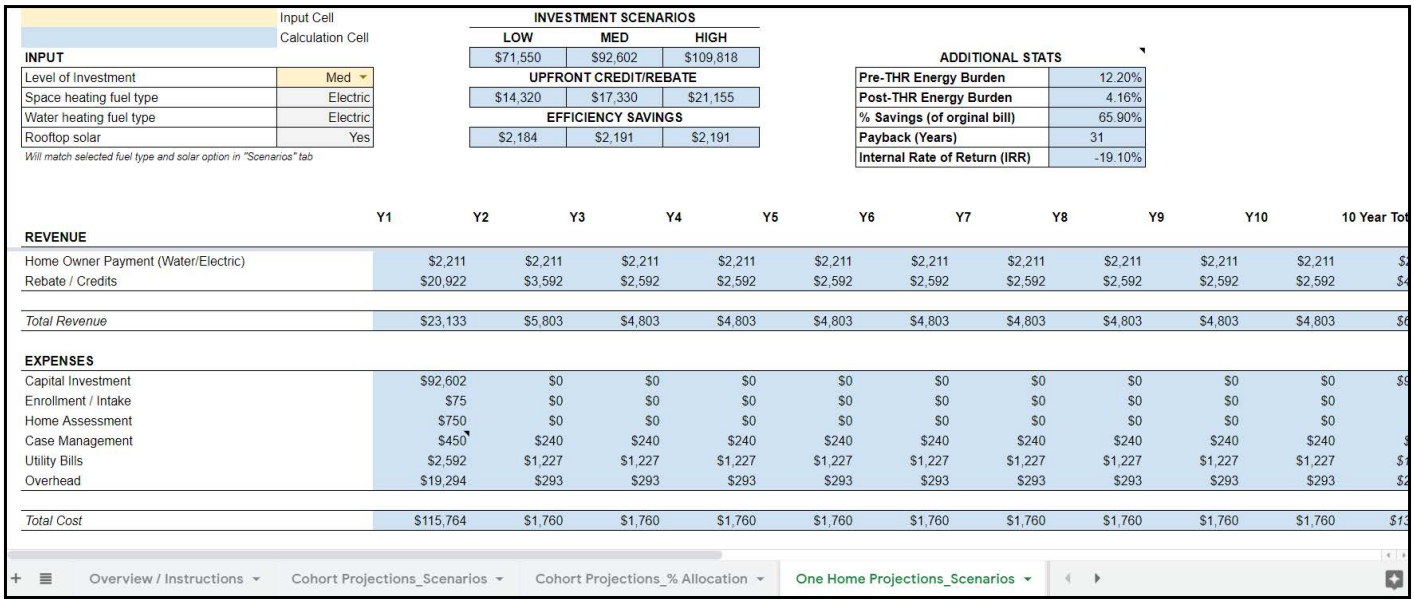
INPUTS

Number of Homes	100
% Low Investment	50%
% Med Investment	40%
% High Investment	10%

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	10 Year Total
REVENUE											
Home Owner Payment	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	*$2,211,075*
Rebate / Credits	$1,620,706	$359,200	$259,200	$259,200	$259,200	$259,200	$259,200	$259,200	$259,200	$259,200	*$4,053,506*
Total Revenue	$1,841,813	$580,308	$480,308	$480,308	$480,308	$480,308	$480,308	$480,308	$480,308	$480,308	*$6,264,581*
EXPENSE											
Capital Investment	$8,379,780	$0	$0	$0	$0	$0	$0	$0	$0	$0	*$8,379,780*
Enrollment / Intake	$7,500	$0	$0	$0	$0	$0	$0	$0	$0	$0	*$7,500*
Home Assessment	$75,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	*$75,000*
Case Management	$45,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	*$261,000*
Utility Bills	$241,434	$123,053	$123,053	$123,053	$123,053	$123,053	$123,053	$123,053	$123,053	$123,053	*$1,348,908*
Non-payments / Defaults	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	*$33,166*
Overhead	$1,749,743	$29,411	$29,411	$29,411	$29,411	$29,411	$29,411	$29,411	$29,411	$29,411	*$2,014,438*
Total Cost	$10,501,773	$179,780	$179,780	$179,780	$179,780	$179,780	$179,780	$179,780	$179,780	$179,780	*$12,119,792*
Annual Net	-$8,659,959	$400,528	$300,528	$300,528	$300,528	$300,528	$300,528	$300,528	$300,528	$300,528	*-$5,855,211*

Overview / Instructions | Cohort Projections_Scenarios | Cohort Projections_% Allocation | One Home Projections_Scenarios

APPENDIX D: FINANCIAL MODEL INTERFACE CONTINUED



	Input Cell
	Calculation Cell

INPUT

Level of Investment	Med
Space heating fuel type	Electric
Water heating fuel type	Electric
Rooftop solar	Yes

Will match selected fuel type and solar option in "Scenarios" tab

INVESTMENT SCENARIOS

LOW	MED	HIGH
$71,550	$92,602	$109,818

UPFRONT CREDIT/REBATE

$14,320	$17,330	$21,155

EFFICIENCY SAVINGS

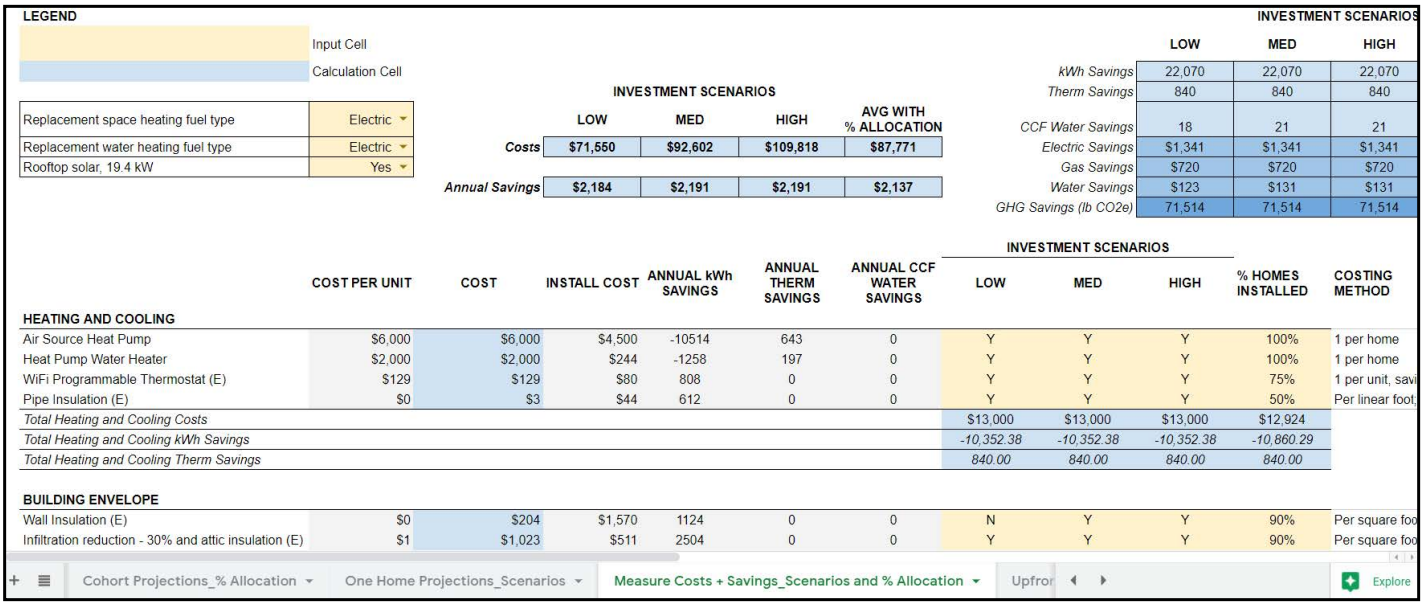
$2,184	$2,191	$2,191

ADDITIONAL STATS

Pre-THR Energy Burden	12.20%
Post-THR Energy Burden	4.16%
% Savings (of orginal bill)	65.90%
Payback (Years)	31
Internal Rate of Return (IRR)	-19.10%

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	10 Year Tot
REVENUE											
Home Owner Payment (Water/Electric)	$2,211	$2,211	$2,211	$2,211	$2,211	$2,211	$2,211	$2,211	$2,211	$2,211	$2
Rebate / Credits	$20,922	$3,592	$2,592	$2,592	$2,592	$2,592	$2,592	$2,592	$2,592	$2,592	$4
Total Revenue	$23,133	$5,803	$4,803	$4,803	$4,803	$4,803	$4,803	$4,803	$4,803	$4,803	$6
EXPENSES											
Capital Investment	$92,602	$0	$0	$0	$0	$0	$0	$0	$0	$0	$9
Enrollment / Intake	$75	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Home Assessment	$750	$0	$0	$0	$0	$0	$0	$0	$0	$0	
Case Management	$450	$240	$240	$240	$240	$240	$240	$240	$240	$240	$
Utility Bills	$2,592	$1,227	$1,227	$1,227	$1,227	$1,227	$1,227	$1,227	$1,227	$1,227	$1
Overhead	$19,294	$293	$293	$293	$293	$293	$293	$293	$293	$293	$2
Total Cost	$115,764	$1,760	$1,760	$1,760	$1,760	$1,760	$1,760	$1,760	$1,760	$1,760	$1

Overview / Instructions | Cohort Projections_Scenarios | Cohort Projections_% Allocation | One Home Projections_Scenarios



LEGEND

	Input Cell
	Calculation Cell

Replacement space heating fuel type	Electric
Replacement water heating fuel type	Electric
Rooftop solar, 19.4 kW	Yes

INVESTMENT SCENARIOS

	LOW	MED	HIGH	AVG WITH % ALLOCATION
Costs	$71,550	$92,602	$109,818	$87,771
Annual Savings	$2,184	$2,191	$2,191	$2,137

INVESTMENT SCENARIOS

	LOW	MED	HIGH
kWh Savings	22,070	22,070	22,070
Therm Savings	840	840	840
CCF Water Savings	18	21	21
Electric Savings	$1,341	$1,341	$1,341
Gas Savings	$720	$720	$720
Water Savings	$123	$131	$131
GHG Savings (lb CO2e)	71,514	71,514	71,514

	COST PER UNIT	COST	INSTALL COST	ANNUAL kWh SAVINGS	ANNUAL THERM SAVINGS	ANNUAL CCF WATER SAVINGS	INVESTMENT SCENARIOS LOW	MED	HIGH	% HOMES INSTALLED	COSTING METHOD
HEATING AND COOLING											
Air Source Heat Pump	$6,000	$6,000	$4,500	-10514	643	0	Y	Y	Y	100%	1 per home
Heat Pump Water Heater	$2,000	$2,000	$244	-1258	197	0	Y	Y	Y	100%	1 per home
WiFi Programmable Thermostat (E)	$129	$129	$80	808	0	0	Y	Y	Y	75%	1 per unit, savi
Pipe Insulation (E)	$0	$3	$44	612	0	0	Y	Y	Y	50%	Per linear foot
Total Heating and Cooling Costs							$13,000	$13,000	$13,000	$12,924	
Total Heating and Cooling kWh Savings							*-10,352.38*	*-10,352.38*	*-10,352.38*	*-10,860.29*	
Total Heating and Cooling Therm Savings							*840.00*	*840.00*	*840.00*	*840.00*	
BUILDING ENVELOPE											
Wall Insulation (E)	$0	$204	$1,570	1124	0	0	N	Y	Y	90%	Per square foo
Infiltration reduction - 30% and attic insulation (E)	$1	$1,023	$511	2504	0	0	Y	Y	Y	90%	Per square foo

Cohort Projections_% Allocation | One Home Projections_Scenarios | Measure Costs + Savings_Scenarios and % Allocation | Upfro | Explore

APPENDIX E: COHORT PROJECTIONS FROM FINANCIAL MODEL

This appendix shares demonstrative 10-year projections for the EcoWorks THR program for three different scenarios, (1) gas space and water heating, (2) electric space and water heating and (3) electric space and water heating plus rooftop solar. In this example, a cohort size of 100 homes with 50% of these homes allocated to the low investment scenario, 40% to the medium investment scenario, and 10% to the high investment scenario.

It is important to note that these are example cash flow projections and one of many potential outputs of the flnancial model tool that was created by the Dow Sustainability Fellows team. These projections could easily change with a change in number of homes in a cohort, percent allocation of homes to each investment scenario, or which retrofit measures are indicated for each investment scenario. Additionally, a secondary form of projecting cash flows is available in the tool, allowing the user to indicate what percentage of homes will receive each retroflt measure, creating another possible set of projections.

GAS SPACE AND WATER HEATING

REVENUE	**Y1**	**Y2**	**Y3**	**Y4**	**Y5**	**Y6**	**Y7**	**Y8**	**Y9**	**Y10**
Homeowner Payments	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108
Rebates / Credits	$876,899	$359,200	$259,200	$259,200	$259,200	$259,200	$259,200	$259,200	$259,200	$259,200
Total Revenue	$1,098,007	$580,308	$480,308	$480,308	$480,308	$480,308	$480,308	$480,308	$408,380	$480,308
EXPENSES										
Capital Investment	$2,249,159	$0	$0	$0	*$0*	$0	$0	$0	$0	$0
Enrollment / Intake	$7,500	$0	$0	$0	*$0*	$0	$0	$0	$0	$0
Home Assessment	$75,000	$0	$0	$0	*$0*	$0	$0	$0	$0	$0
Case Management	$45,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000
Utility Bills	$293,623	$227,432	$227,432	$227,432	$227,432	$227,432	$227,432	*$227,432*	*$227,432*	*$227,432*
Defaults	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317
Overhead	$534,057	$50,286	$50,286	$50,286	$50,286	$50,286	$50,286	$50,286	$50,286	$50,286
Total Expenses	$3,207,656	$305,035	$305,035	$305,035	$305,035	$305,035	$305,035	$305,035	$305,035	$305,035
Annual Net	-$2,109,649	$275,273	$175,273	$175,273	$175,273	$175,273	$175,273	$175,273	$175,273	$175,273
Net to Date	-$2,109,649	-$1,834,376	-$1,659,104	-$1,483,831	-$1,308,559	-$1,133,286	-$958,014	-$782,741	-$607,469	-$432,196

APPENDIX E: COHORT PROJECTIONS FROM FINANCIAL MODEL CONTINUED

ELECTRIC SPACE AND WATER HEATING

REVENUE	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Homeowner Payment	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108
Rebate / Credits	$444,999	$359,200	$259,200	$259,200	$259,200	$259,200	$259,200	$259,200	$259,200	$259,200
Total Revenue	$666,107	$580,308	$480,308	$480,308	$480,308	$480,308	$480,308	$480,308	$480,308	$480,308
EXPENSES										
Capital Investment	$3,035,659	$0	$0	$0	$0	$0	$0	$0	$0	$0
Enrollment / Intake	$7,500	$0	$0	$0	$0	$0	$0	$0	$0	$0
Home Assessment	$75,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Case Management	$45,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000
Utility Bills	$340,121	$320,428	$320,428	$320,428	$320,428	$320,428	$320,428	$320,428	$320,428	$320,428
Defaults	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317
Overhead	$700,656	$68,886	$68,886	$68,886	$68,886	$68,886	$68,886	$68,886	$68,886	$68,886
Total Expenses	$4,207,253	$416,630	$416,630	$416,630	$416,630	$416,630	$416,630	$416,630	$416,630	$416,630
Annual Net	-$3,541,147	$163,678	$63,678	$63,678	$63,678	$63,678	$63,678	$63,678	$63,678	$63,678
Net to Date	-$3,541,147	-$3,377,469	-$3,313,791	-$3,250,113	-$3,186,436	-$3,122,758	-$3,059,080	-$2,995,403	-$2,931,725	-$2,868,047

ELECTRIC SPACE AND WATER HEATING + ROOFTOP SOLAR

REVENUE	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Homeowner Payment	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108	$221,108
Rebate / Credits	$1,620,706	$359,200	$259,200	$259,200	$259,200	$259,200	$259,200	$259,200	$259,200	$259,200
Total Revenue	$1,841,813	$580,308	$480,308	$480,308	$480,308	$480,308	$480,308	$480,308	$480,308	$480,308
EXPENSES										
Capital Investment	$8,379,780	$0	$0	$0	$0	$0	$0	$0	$0	$0
Enrollment / Intake	$7,500	$0	$0	$0	$0	$0	$0	$0	$0	$0
Home Assessment	$75,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Case Management	$45,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000	$24,000
Utility Bills	$241,434	$123,053	$123,053	$123,053	$123,053	$123,053	$123,053	$123,053	$123,053	$123,053
Defaults	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317	$3,317
Overhead	$1,749,743	$29,411	$29,411	$29,411	$29,411	$29,411	$29,411	$29,411	$29,411	$29,411
Total Expenses	$10,501,773	$179,780	$179,780	$179,780	$179,780	$179,780	$179,780	$179,780	$179,780	$179,780
Annual Net	-$8,659,959	$400,528	$300,528	$300,528	$300,528	$300,528	$300,528	$300,528	$300,528	$300,528
Net to Date	-$8,659,959	-$8,259,432	-$7,958,904	-$7,658,376	-$7,357,849	-$7,057,321	-$6,756,794	-$6,456,266	-$6,155,738	-$5,855,211

TIME VALUE OF MONEY AND COST OF CAPITAL

This model focuses on projecting cash flows over a 10-year time period. It does not consider concepts such as time value of money or cost of capital since the sources of gap financing remain undecided and thus we did not choose interest and discount rates. Ideally, cost of capital will be zero if donated by philanthropic or public partners.

MULTIPLE OR OVERLAPPING COHORTS

The model considers only one cohort over a 10-year period. To consider multiple cohorts or cohorts that overlap, such as starting a cohort every two years, the 10-year model can be duplicated in the desired time frame and all expenses and revenue from each year summed.

RELOCATION COSTS

Relocation costs for THR clients were not considered. If the residents must leave their home during the retrofit construction process and THR will cover the costs, this will be an additional cost for the program.

MEMD DATA

We chose to primarily use data from the Michigan Energy Measures Database due to its comprehensiveness of measures, the consistency of a single source for both measure costs and savings, and its use by all Michigan utilities. That said, several stakeholders expressed concerns about the accuracy of this data and suggested that savings could be inflated due to perverse utility incentives to meet mandated savings targets. One study from the literature review highlighted the limitations of TRMs in accurately and consistently representing expected savings.[26] Moreover, there is wider criticism around the validity of savings projected by engineering models rather than in-field measurements. One well-known study by economists found that the costs to weatherization were twice the benefits, and that engineering savings estimates were sometimes more than two and a half times that of the measured savings for certain weatherization measures.[27] A series of critical responses questioned the methods and resoundingly affirmed the energy consumption savings of around 10-20% for households in addition to the financial, comfort, health, and safety benefits of weatherization.[28,19,30,31] We did not adjust for such possible savings distortions in the MEMD or in engineering estimates more broadly. We recommend validating the measure cost and savings data with local contractors as well as including primary data where possible.

SOLAR SIZING

The solar sizing and savings estimates would benefit from contractor validation, including the average insolation value for the Detroit area and whether it sufficiently considers the seasonal variability of generation. Moreover, the baseline household demand was drawn from EIA RECS and adjusted for electrification with industry report data. Therefore, it would benefit from validation of these household demand numbers in order to accurately estimate and properly size solar PV systems.

NET METERING AND SOLAR OUTFLOW CREDITS

The model does not currently consider the outflow credits that a household might receive should their PV system generate in excess of their demand per DTE's new distributed generation program, formerly a net metering program. Net metering policies have traditionally paid the owners of residential solar PV systems the retail electricity price for the energy their solar installation sends back to the grid in excess of their household use. These policies have been crucial in making solar a good investment.[32] In the past, DTE has had a net metering program in which customers received credit at the full retail rate for all excess power produced, and credits could be applied at the end of the billing period to offset any purchased electricity consumed during the night or other low-production periods and carried forward indefinitely.[33] Sweeping energy reforms passed in 2016 required Michigan utilities to create new distributed generation programs to replace existing net metering programs, and DTE's new program went into effect in May 2019. The core of DTE's new program is called an "inflow/outflow tariff," where inflow and outflow are measured and netted instantaneously rather than monthly.[34] The outflow credit is based on the power supply component of the customer's retail rate, minus transmission charges, so customers are compensated at a lower rate.[35] Overall, the changes have detrimental impacts on Michigan solar customers' savings and payback periods, and thus limit the cost-effectiveness of solar for THR clients.

VALIDATION OF SAVINGS

We identified several sources for "ballpark" validation of the model, particularly for the aggregate savings that the model projects. These sources included two retrospective program evaluations of WAP[36,37] as well as data from a Wisconsin weatherization program evaluation.[38] These evaluations each demonstrated significant gas and electric savings (generally between 12-20% of pre-WAP consumption), using one to four major measures. The current financial model for THR includes a much more comprehensive set of measures, and so should produce even greater savings. Still, the program may find diminishing returns when going beyond these "major measures" as defined by the WAP evaluations, such that smaller measures may save marginally more electricity but may not be worth the added costs.

HOUSHOLD ELIGIBILITY

It was not within the scope of this project to consider household eligibility.

APPENDIX G: SURVEY GUIDE

FOCUS OF THE EVALUATION

Impact evaluation will address the health, energy efficiency, financial, and community education and outreach impacts of the THR program. Information from these four domains can be used to not only interpret and explain the outcomes of the program; it can also provide valuable input for the continuation of the program.[39] To better understand where the gains were achieved due to THR, the impact evaluation focuses on the measurable domain indicators. Gathered through household surveys, outcomes are measured in time intervals to determine impact and possible implications.

PROGRAM EVALUATION DESIGN

After considering several designs, the team recommends a quasi-experimental interrupted time series (ITS) design with multiple pre- and post-follow-ups, which is suitable for an intervention in its early stages. This design is chosen because selection is not randomized, there is not an established control group and it is unethical to remove the intervention once a household is enrolled. Although this design does increase threat to validity, the time intervals allow the intervention group to be its own control. Multiple post-tests will also increase validity and enable EcoWorks to assess the sustainability of intervention impacts. For limitations, refer to the threats to validity section. The design will follow the sequence demonstrated in the following diagram.

$\mathbf{O_1\ O_2\ O_3\ X\ O_4\ O_5}$	**Legend** X = Completion of weatherization services O_1-O_3 = Baseline evaluation of impact measures, as described O_4-O_5 = Follow up evaluation of process and impact measure time of completion of all weatherizations, six month follow up, and 12 month follow up, respectively.

This design was selected because substantial changes in health, energy efficiency, and finances take time and the team expects to see compounded results, or perhaps delayed results, over a longer term. The key advantage to this design is that it evaluates intervention effects while accounting for pre-intervention trends. The use of this longitudinal data can be helpful in assessing whether THR effects are short-lived or sustained over time. Program evaluation development for this design is outlined in the following section.

EVALUATION DEVELOPMENT

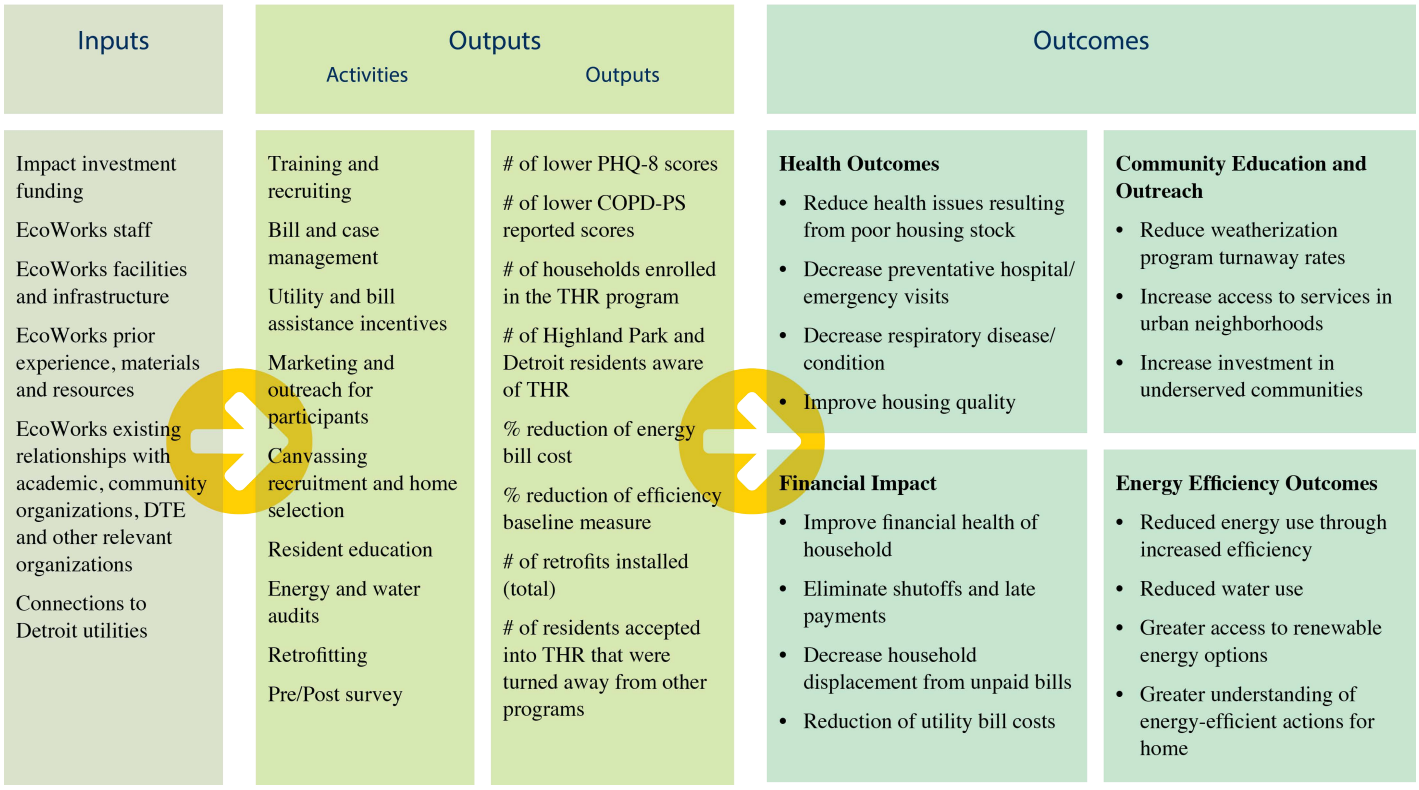
Step One: Establish Logic Model	Developed a logic model and considered the theory of change for the THR program. The logic model details shared relationships among key elements of a program including resources, activities, outputs, outcomes, and desired impacts.
Step Two: Determine Basic Structure of Evaluation	Reviewed over 50 evaluation guides and models for programs that relate to either energy or health. The team determined that a new model that combines elements of demographic, health, energy efficiency, financial, education and outreach, and client satisfaction would be the best way to address both the impact and outcomes of this pilot program.
Step Three: Determine Desired Outcomes or Impacts	Developed a series of desired outcomes and impacts based on established domains. Outcomes are established prior to indicators because the indicators are chosen depending on the desired use of the data.

Step Four: Develop Indicators to Measure Outcomes and Impacts	Selected measurable indicators, both quantitative and qualitative, to express tangible quantity and experience-related data.
Step Five: Organize Questions	Developed a spreadsheet of potential questions ranked by importance. Following the final selection process with the client, questions were input into Survey Monkey.
Step Six: Develop a Guide to Data Collection and Analysis	Created a short guide for the timeline for data collection, key milestones, and recommendations for data analyis.
Step Seven: Establish Data Maintenance Protocols	Established a plan for where to store and maintain the data for the pilot project.

Rigorous process evaluation is a key component of our evaluation; however, EcoWorks has an established process evaluation protocol that will be used to further assist this plan.

LOGIC MODEL

TURNKEY HOME RETROFITS LOGIC MODEL



PROGRAM EVALUATION METHODS AND IMPACTS

To better understand where the greatest gains were achieved after THR intervention, the impact evaluation will focus on the health, energy efficiency and financial aspects of each household. Because THR is a new program, the potential to lay the groundwork for identifying how weatherization and utility assistance programs impact households' health in Detroit is great. Due to limited research outlining the casual relationship between health and weatherization or utility programs, many measures do not exist and this program can provide further insight. Understanding the importance of community education and outreach in the promotion of health, we will also evaluate the spread energy education in this community. In order to measure the impact of THR, we will be assessed through the objectives in the next section.

IMPACT EVALUATION METHODS AND MEASURES

Impact measures will be evaluated through regularly administered surveys, administered at baseline via an EcoWorks interviewer and at multiple time periods either on their own or via the Survey Monkey website. These measures are in addition to utility bill metrics provided by DTE that are evaluated separately by EcoWorks staff. The preliminary measures are taken every two months to track the pre-intervention metrics. The pre-intervention outcome data is used to establish an underlying trend that is assumed to continue unchanged in the absences of the intervention (i.e. the counterfactual scenario). Therefore, any change in the intervention period is attributed to the impact of the intervention. Research suggests that electronic surveys yield higher response rates than other forms of evaluation, including paper surveys.[40] Important to note for measures, health impacts relationship to utility assistance and weatherization assistance programs have not been adequately evaluated and therefore, validated measures may not be developed.

Health Outcomes

To evaluate health outcomes, participants will be asked the eight-item Patient Health Questionnaire depression scale (PHQ-8), which is a well studied and valid diagnostic measure for depressive disorders.[41] Within this measure, participants are asked the number of days over the past two weeks that they have experienced a specific depressive symptom. Evidence suggests that a PHQ-8 score equal to 10 and above signifies current depression status, which has an 88% specificity and 88% sensitivity for major depression.[42]

Using this scale the team has established the following evaluation objectives:

1. Do participants show a decrease in depressive symptomatology as measured by the PHQ-8?
    a. By the end of the program, 60% of participants who initially reported PHQ-8 scores >10 will reduce their scores to under 10.
2. Did participants report lower COPD symptoms?
    a. By the end of the second post test, 60% of households that reported scores >5 will report reduced scores under 5.
    b. Participants that reported emergency rooms visits in the pre-test will report none or a lower number of visit in the post-test.
3. Did participants report lower stress scores during the program?
    a. By the end of the program, 60% participants that scored >6 will report scores less than 6 in both pretest
    b. Participants that reported initial scores <6 will report scores under 5 in at least one of the post tests.

COPD is measured through the COPD Population Screener (COPD-PS) and emergency room visits. COPD-PS is a five-item screener for COPD in clinical settings. In a study comparing COPD screeners and assessments, the COPD-PS questionnaire demonstrated the highest positive predictive value (compared to IPAG and LFQ) when paired with a spirometry test.[43] COPD-PS has accurately classified the status of those at risk of COPD while positively predicting airflow obstruction (AO).[44] High scores were associated with more severe AO, bronchodilator use, and overnight hospitalization for breathing problems.

A score greater than five was associated with a positive predictive value of 56.8% and negative predictive value of 86.4%. COPD-PS accurately classified physicians reported COPD indicating a brief and accurate questionnaire that can identify individuals' likelihood of having COPD. Emergency rooms visits or hospital admissions of potential COPD patients is a norm because of acute exacerbations that may progress to respiratory failure. Studies have defined the major predictor of exacerbation to be past exacerbations.[45] Hospitalization utilization also generates the majority of COPD-related health care expenses. Identifying individuals that use the emergency department or hospital is clinically important to decrease mortality and to address the root causes like infrastructure or lifestyle.[46]

PSS-4 is a four-item scale that is appropriate in situations requiring a very brief measure of stress perceptions. It was previously employed when collecting perceived stress levels over the phone during follow-up interviews. It is not a diagnostic instrument, but intended to make comparisons of subjects' perceived stress related to current, objective events such as THR. The short version, PSS-4, is an economical and simple psychological instrument to administer, comprehend, and score. It measures the degree to which situations in one's life over the past month are appraised as stressful. Items were designed to detect how unpredictable, uncontrollable, and overloaded respondents find their lives. PSS-4 scores are obtained by summing across all four items. Scoring items 2 and 3 require reverse coding. This involves assigning the opposite score. For example, a score of 0=4, 1=3, 2=2, 3=1, and 4=0. The higher the score, the more perceived stress.

Energy Efficiency Outcomes

The outcomes for energy efficiency in this program will be measured in two ways: through analysis of utility bills (electric, natural gas, and water) and ten survey questions. The purpose of the survey questions in this section is to assess the efficacy of energy efficiency measures implemented in the home prior to or during the study, the comfort of the home, concerns for the future, and any problems in the home in prior months. Energy efficiency outcomes and home comfort will be a main impact of this program and measuring changes over the course of the study can show improvements made as a result of the program. Many questions were derived from information provided in the National Energy Literacy Survey.

The style of energy efficiency survey questions are open-ended, frequency, and select all that apply. Open-ended questions are designed to provide important qualitative data and useful anecdotes to the outcomes of the program. The frequency questions, with "always, usually, sometimes, and never" as options, are designed to understand how often an event or feeling occurs. The goal of these questions is to see desired increases or decreases in the events or feelings throughout the course of the program. Finally, the select all that apply questions allow participants to respond with a list of problems they face or a list of efficiency measures they've tried. These are useful for setting a baseline of what has been done in the home and also for continued tracking of measures or issues that change over the course of the program.

Utility bill energy efficiency outcomes will also be measured by EcoWorks and the pilot program. Utility bills are requested in this section of the survey and can be used to track changes in energy or other utility use over time. To establish a baseline of energy use in the first round of surveys, 14 months of utility bills should be requested for electric, natural gas, and water. EcoWorks has an existing framework for analyzing utility bills they will use to track changes in energy use for each home.

Financial Impact

THR aims to achieve household affordability, improve financial health, eliminate utility shutoffs, and increase neighborhood activities. The financial impact of this study is set to be measured by questions scaled to issues participating families may have faced in the previous 12 months. The questions will address changes in consumption habits as a result of financial strain. These questions will use a select all that apply format and focus on changes in nutrition, water use, and major difficulty paying other bills. The goals of THR include reducing the financial burden of paying utility bills. This will be measured by recording fewer instances of challenges paying other bills and stable food consumption. These questions were developed in conjunction with EcoWorks to address primary concerns uncovered by the organization.

Community Education and Outreach

Community Education and Outreach is measured through open-ended qualitative survey questions. These questions will also compliment and validate previous domains. This section also gives more inference on the problem and program impacts. DTE and other weatherization programs have lengthy wait lists and high turn-away rates due to home infrastructure conditions such as pests and mold, decreasing access to services. Tracking the number of programs participants have applied to can measure the impact of THR on increasing access to services in urban neighborhoods while increasing investment in under-served communities. Understanding the effect of utility assistance and weatherization, measuring participant reason for applying offers information on whether their needs were met through this program. The Oakridge National Laboratory found that in their client satisfaction survey (N=665), respondents reported that they wanted to reduce energy bills and to improve the comfort of their homes compared to environmental reasons.[47] This all helps EcoWorks understand their population and outcomes of the program.

THREATS TO VALIDITY

Even without randomization, this design is fairly strong and straightforward. Although this ITS design has significant strengths, the key threat to internal validity is the possibility that factors other than the intervention are affecting the observed changes in outcome level or trend. Changes over time in factors may not be fully accounted for by the pre-intervention trend. Similarly, the pre-intervention time period, particularly when short, may not capture seasonal changes in an outcome. The addition of a control group can be particularly useful for assessing the presence of seasonal trends and other potential time-varying confounders. This could be addressed by having a cyclic control group who transitions into the intervention after the initial group has reported their last metric. In addition to including a control group, several analysis-phase strategies can be employed to strengthen causal inference, including adjustment for time-varying confounders and accounting for autocorrelation.

History is a threat to our population, as it is possible that program participants will experience historical events such as COVID-19 and presidential leadership change during the course of the intervention that may influence their behaviors, access to resources, and engagement. However, we postulate that exposure to these events will be limited since the program is expected to start after such events (COVID-19 may be an exception). Other potential threats are testing and attrition, but due to the simple nature of the survey questions and the engagement necessary for the program, we do not perceive these to be highly significant or influential on outcomes. Due to the study design and lack of randomization, this evaluation is mainly generalizable to other Detroit and Highland Park residents or other similar communities. While external validity is unfortunately limited, the hope is that preliminary evaluation can spawn literature and greater inference on how to improve the program going forward.

General Information

Date (MM/DD/YYYY):

Interviewer Name:

Household ID:

Please provide us with your first and last name.

First Name:

Last Name:

Household Information:

What is your home address and personal contact information?

Address Line 1

Address Line 2

City

State

Zip Code

Phone Number

Alternative Phone Number

Preferred Email

How many people live in your household?

Adults (18+)

Children (1 month- 17)

Total

What is the highest level of education among occupants

- ◯ Some High School
- ◯ High School or GED
- ◯ Some College
- ◯ Bachelor's Degree
- ◯ Master's Degree
- ◯ Doctorate Degree
- ◯ Trade School/ Technical/ Vocational training
- ◯ Prefer not to say

Describe your home type

- ◯ 1-2 bdrm apt
- ◯ 1-2 bdrm detached
- ◯ 3 bdrm apt

- ◯ 3 bdrm detached
- ◯ 4-5 bdrm detached
- ◯ 6+ bdrm detached
- ◯ [ ] Other

What is your annual household income?

- ◯ Less than $15.000
- ◯ $15,000 - $29,999
- ◯ $30,000 - $49,999
- ◯ $50,000 - $74,999
- ◯ $75,000 - $99,999
- ◯ 100,000 - $200,000
- ◯ Prefer not to say

What is your current employment status?

- ◯ Employed, working full-time
- ◯ Employed, working part-time
- ◯ Not employed, looking for work
- ◯ Retired
- ◯ Disabled, not able to work
- ◯ Prefer not to say

Which health insurance coverage provider are you currently enrolled with?

- ◯ Medicaid
- ◯ Medicare
- ◯ Private health insurance
- ◯ Uninsured

- ◯ Other (Please specify)

Household Health

Has your family received food assistance (SNAP, WIC, etc.) within the past 12 months?

- ◯ Yes
- ◯ No

In the past two weeks, how often have you been bothered by the following problems?

	Not at all	Several days	More than half the days	Nearly every day
Little interest or pleasure in doing things	◯	◯	◯	◯
Feeling down, depressed or hopeless	◯	◯	◯	◯
Trouble falling or staying asleep or sleeping to much	◯	◯	◯	◯
Feeling tired or having little energy	◯	◯	◯	◯
Poor appetite or overeating	◯	◯	◯	◯
Feeling bad about yourself, or that you are a failure, or have let yourself or your family down	◯	◯	◯	◯

	Not at all	Several days	More than half the days	Nearly every day
Trouble concentrating on things, such as reading the newspaper or watching television	○	○	○	○
Moving or speaking so slowly that other people could have noticed. Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual	○	○	○	○

In the past 3 months, how much of the time did you feel short of breath?

- ○ None of the time
- ○ A little of the time
- ○ Some of the time
- ○ Most of the time
- ○ All of the time

Do you ever cough up any “stuff,” such as mucus or phlegm?

- ○ No, Never
- ○ A few times a month
- ○ Most days a week
- ○ Yes, everyday

Have you smoked at least 100 cigarettes in your ENTIRE LIFE?

- ○ Yes

- ○ No
- ○ Do not know
- ○ Prefer not to say

Please select the answer that best describes you in the past 12 months. I do less than I used to because of my breathing problems.

- ○ Strongly disagree
- ○ Disagree
- ○ Neither agree nor disagree
- ○ Agree
- ○ Strongly agree
- ○ unsure

In the past 6 months has anyone in the household visited the emergency room?

- ○ Yes
- ○ No

In the last month

	Never	Almost Never	Sometimes	Fairly Often	Very Often
how often have you felt that you were unable to control the important things in your life?	○	○	○	○	○
how often have you felt confident about your ability to handle your personal problems?	○	○	○	○	○

	Never	Almost Never	Sometimes	Fairly Often	Very Often
how often have you felt that things were going your way?	○	○	○	○	○
how often have you felt difficulties were piling up so high that you could not overcome them?	○	○	○	○	○

Energy Efficiency

Are you able to provide utility bills for the last 14 months, including natural gas, electric, and water?

- ○ Yes
- ○ No
- ○ Do not know
- ○ Already Completed

Do you know approximately what year your home was built?

- ○ Yes
- ○ No
- ○ Not Sure
- ○ Prefer not to say

If yes, when (or N/A)?

How often do you or other members of your household feel comfortable in your home in regards to temperature?

- ◯ Always
- ◯ Usually
- ◯ Sometimes
- ◯ Rarely
- ◯ Never

How often do you or other members of your household feel comfortable in your home in regards to air quality

- ◯ Always
- ◯ Usually
- ◯ Sometimes
- ◯ Rarely
- ◯ Never

How often do or the other members of your household find the house too drafty?

- ◯ All of the time
- ◯ Most of the time
- ◯ Some of the time
- ◯ Never

Which of the following energy savings measures have you installed or practiced in your home? Select all that apply.

- ☐ Replace lightbulbs with energy-efficient LEDs
- ☐ Use smartpower strips
- ☐ Replaced windows
- ☐ Upgraded HVAC

- [ ] Use smart thermostat
- [ ] Installed energy-efficient appliances
- [ ] Shortened shower lengths
- [ ] Weatherized home
- [ ] Insulated home
- [ ] Other (describe)

How concerned are you about future increases in energy or other utility prices?

- ○ Very concerned
- ○ A fair amount of concern
- ○ A little concern
- ○ No concern

What methods do you use to heat your home? Select all that apply.

- [ ] Gas fired boiler or central heating
- [ ] Electric room heaters
- [ ] Storage heaters
- [ ] Warm air system
- [ ] Open fire
- [ ] Wood burning stove
- [ ] Solar thermal
- [ ] Opening oven
- [ ] Other (Describe)

Have you experienced any of the following problems with your home in the past six months? Select all that apply.

- [ ] Mildew odor or musty smell
- [ ] Received a shut off warning for utilities
- [ ] Had pests (cockroaches, insects, mice, etc)
- [ ] Water leaks in ceiling or pipes
- [ ] Had structural problems (walls and flooring)
- [ ] Flooding
- [ ] Other (Describe)

What upgrades would you ideally like for your home?

Financial Impact

During the past 12 months have you experienced any of the following? Select all that apply:

- ☐ Received an eviction notice due to not paying rent
- ☐ Changed residence to save money
- ☐ Gained a housemate to increase income
- ☐ Postponed paying rent
- ☐ Postponed paying property tax
- ☐ Had utilities shut off due to late payment or non-payment

During the past 12 months have you done any of the following?

- ☐ Used less water for showers/bathing
- ☐ Washed clothes with cold water
- ☐ Changed shopping habits to save money

During the past 12 months have you

	Yes	No	Prefer not to say
Worried about affording nutritious food?	○	○	○
Changed eating habits due to finances?	○	○	○

Community Education & Outreach

Have you applied to other programs:

	Yes	No	Prefer not to say
Energy assistance programs?	○	○	○
Weatherization Programs?	○	○	○

Why did you apply for THR? Select all that apply.

- ☐ Reduce energy bills
- ☐ Make home more comfortable
- ☐ Support environment efforts to conserve energy
- ☐ Receive free services
- ☐ Improve health and/or safety
- ☐ Other (Describe)

How have (or lack of) retrofits affected your financial security, health and wellbeing?

APPENDIX I: POSSIBLE FUNDING SOURCES

FOUNDATIONS

- Erb Family Foundation
- Kresge Foundation
- Ford Foundation
- Community Foundation for Southeast Michigan

SPECIFIC GRANT PROGRAMS

Neighborhood Enhancement Program (NEP)

- Funder and administrator: Michigan State Housing Development Authority (MSHDA)
- Description: Grant funding to nonprofit agencies statewide engaged in activities directly tied to stabilization and enhancement of neighborhoods. There are three eligible neighborhood components: beautification, neighborhood public amenity enhancements, and housing enhancements to owner-occupied single-family homes.
- Amount: Approximately $2 million will be available for 2019 applications for the state of Michigan, and approved organizations typically receive around $50,000 each.
- Eligibility: Serve residents in neighborhoods where 51% of the residents are at or below 120% Area Median Income (AMI).

Neighborhood Impact Program (NIP)

- Funder: Federal Home Loan Bank of Indianapolis (FHLBI)
- Administrator: Chemical Bank, LevelOne, Flagstar, First Independence Bank
- Description: Grants to assist homeowners in making repairs to their homes, including deferred maintenance.
- Amount: Up to $7,500
- Eligibility: Homeowners must own and occupy a single-family home, condominium, or modular unit (plus duplexes, with certain restrictions) for at least six months prior to enrollment and be current on mortgage payments; incomes at or below 80% of AMI

Honnold Foundation Community Fund and Core Fund

- Funder / Administrator: Honnold Foundation
- Description: There are two different funds focused on funding solar installation, a large scale "Core Fund" and a smaller scale "Community Fund." The Community Fund may be a good option for the pilot and help get a foot in the door for later funding through the Core Fund.
- Amount: Dollar amount not specified, cost of solar installation
- Eligibility: The Core Fund supports large-scale solar energy initiatives worldwide, with a special focus on projects that are innovative, grassroots, and community-driven. The Community Fund is a domestic program that funds solar installs for Black, Indigenous, and People of Color-led nonproflts in regions heavily impacted by pollution.

LOANS AND OTHER FUNDING PROGRAMS

0% Interest Home Repair Loan Program

- Administrator: City of Detroit - Housing & Revitalization Department
- Funder: City-led partnership with the Detroit Local Initiatives Bank of America. Funding also Support Corporation (LISC) and from U.S. Housing and Urban Development (HUD) Community Development Block Grant funds
- Description: 10-year, interest-free loans for specific repairs including: correcting health and safety hazards including lead, mold, and asbestos (required); kitchen and bathroom remodeling; electrical repairs; furnace replacement; roof replacement; repairs to existing attached or unattached garages and existing driveways; plumbing; door and window replacements; porches and structural support.
- Amount: 10-year, interest-free loans from $5,000 to $25,000
- Eligibility: Have owned and lived in home for at least six months. FICO credit score for this program is 560. Have to use an approved contractor.

Home Energy Loan Program

- Administrator: Michigan Saves
- Funder: State of Michigan, US Department of Energy
- Description: Michigan Saves makes financial capital available to customers through a network of lenders that offer favorable terms based on a negotiated contract. This program helps Michigan families and households reduce costs by flnancing air sealing, heating and cooling systems, insulation, appliances, and more. Homeowners make the upgrades with the help of our authorized contractors through an authorized lending partner.
- Amount: Homeowners are eligible for rates ranging from 4.99% to 7% APR, though most customers flnance at 5.50% APR. Terms are available up to 12 years with loan amounts ranging from $1,000 to $40,000.
- Eligibility: When applying, you will be asked to provide your individual gross yearly income. If further clarification is needed, you may be asked by the lender to provide proof of income through a pay stub, W-2, or other documentation.

ORGANIZATION	PARTNERSHIP OPPORTUNITIES
Soulardarity's Polar Bear Sustainable Energy Cooperative	Soulardarity is considering developing a worker co-operative to implement weatherization and energy efficiency retroflts. This co-op could serve as a workforce for implementing THR which could function as a social enterprise, serving customers that can afford the full cost of these measures and using profits to subsidize these measures for low income homeowners. If this moves forward, EcoWorks could employ this cooperative to implement THR retrofits or partner with Soulardarity to administer low income homeowner programs.
Friends of the Rouge and Sierra Club	Friends of the Rouge is invested in expanding implementation of rain gardens across Detroit to reduce the DWSD drainage fee. They have a "train the trainer" program and see potential to partner with THR to help construct a cohort's rain gardens, reducing costs through economies of scale of materials and labor. Friends of the Rouge has a partnership with Sierra Club that provides significant funding for this initiative.
Slipstream	Slipstream, based in Chicago, IL and Madison, WI also works in Michigan and is very interested in the development of the THR project. Slipstream implements other energy efficiency measures and seeks to improve the services they can provide to low income households. They have a team that looks at financing and metrics and evaluation and may be interested to financially or programmatically support a pilot. If it proves successful, they could implement a similar program in the other territories in which they operate.
Walker-Miller Energy Services	Walker-Miller is developing a one-for-one program for energy efficiency retrofits with the working name "Detroit Energy Economic Partnership (DEEP)". They will work with affluent homeowners on effIciency retrofits and create opportunities to subsidize similar retroflts for low income homeowners. This could be a great opportunity to partner with Walker-Miller to be an implementation partner for the funding they raise or to collaborate with them as contractors. Additionally, Walker-Miller would be a great resource to validate costs and savings in the flnancial model and prioritize measures for each scenario. Our contacts here expressed interest in staying engaged.
City of Detroit Office of Sustainability and Wayne Metro	The City of Detroit and Wayne Metro are collaborating to develop an integrated eligibility program to streamline applications to state- and city-sponsored programs. EcoWorks could propose the THR program as a pilot to test and integrate into the new system.
Michigan Department of Health and Human Services	Once the feasibility and effectiveness of THR is proven through a pilot, MDHHS may have interest in partnering with EcoWorks to expand the program and replicate elsewhere in the state.
University of Michigan Dow Sustainability Fellows Program	EcoWorks should consider continuing to work on this project with the Dow Sustainability Fellows program at the University of Michigan. The groundwork for the financial model and the evaluation framework has been laid by our team, but a second phase could help with implementing or designing other key components of the pilot program.
University of Michigan Urban Energy Justice Lab	This lab, led by Dr. Tony Reames, is focused on the study of energy-related topics through a justice lens, primarily in an urban context. Given close proximity to Detroit and expertise of faculty and students, there are many partnership opportunities going forward, including student consultative projects, research partnerships, and funding partnerships.

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