Michigan Energy Waste Reduction and Demand Response 2021 to 2040 Potential Study – Research Plan

Prepared for:

LARA
MPSC

State of Michigan Public Service Commission

Submitted by:

Guidehouse Inc.
South State Commons
2723 South State Street
Ann Arbor, MI 48104

guidehouse.com

October 14, 2020

Table of Contents

List of Figures

List of Tables

Disclaimer

This report was prepared by Guidehouse Inc. (“Guidehouse”) for the State of Michigan Public Service Commission. The work presented in this report represents Guidehouse’s professional judgment based on the information available at the time this report was prepared. Guidehouse is not responsible for the reader’s use of, or reliance upon, the report, nor any decisions based on the report. GUIDEHOUSE MAKES NO REPRESENTATIONS OR WARRANTIES, EXPRESSED OR IMPLIED. Readers of the report are advised that they assume all liabilities incurred by them, or third parties, as a result of their reliance on the report, or the data, information, findings and opinions contained in the report.

Executive Summary

This Research Plan provides details of the Guidehouse, Inc. (Guidehouse) study of Michigan's technical, economic, and achievable energy waste reduction (EWR) and demand response (DR) potential for 2021 to 2040. The study is being conducted for the Michigan Public Service Commission (MPSC).

The intent of this document is to detail Guidehouse's approach to implementing the full project scope, based on our June 5, 2020 technical proposal. The Research Plan details how Guidehouse will gather and analyze project data and model the estimated potentials. The Research Plan summarizes planned stakeholder engagement, our process for drafting and finalizing the reports, and includes the project's planned schedule and assumptions.

The Research Plan includes the following sections:

- Workplan Tasks – Section 1
- Stakeholder Collaboration – Section 2
- Project Management – Section 3
- Deliverables and Assumptions – Section 4
- Preliminary Measure List – Appendix A (details the draft Measure List)
- Data Request – Appendix B
- Acronyms List – Appendix C

1. Workplan Tasks

This Research Plan combines the EWR and DR tasks into a single set of coordinated project tasks. Details of each task and subtask are presented in this section.

1.1 Task 1: Conduct Project Initiation Meeting

The Guidehouse team facilitated a Project Initiation Meeting to kick-off the project with the MPSC Commissioners and staff. The meeting was conducted by video teleconference on September 29, 2020. The overarching goal of the Project Initiation Meeting was to review Guidehouse's final team organization and how we intend to approach key tasks and activities across sectors, market segments, fuels, end uses and technologies. The objectives of the meeting are summarized in Table 1.

Table 1. Project Initiation Meeting Objectives

Topic	Objective
Introduce key team members	Identify roles and responsibilities of the Guidehouse and the MPSC project teams.
Review Project Plan (scope, data, modeling)	Provide an overview of Guidehouse's project approach to gathering, analyzing, and modeling project data, and an opportunity for the project teams to discuss the approach.
Confirm key schedule milestones and deliverables	Identify Guidehouse's schedule for key product deliverables and opportunities for MPSC review and feedback.
Share project management and communication protocols	Ensure the information needs of both the MPSC and Guidehouse teams are satisfied.
Inform Research Plan development (this document)	Identify opportunities to refine Guidehouse's project approach in response to the MPSC's specific feedback.

The meeting was attended by 19 representatives from the MPSC, including the three Commissioners, and nine members of the Guidehouse project team. The agenda was:

Part I (with Public Service Commissioners)

1. Introduction and Meeting Overview
2. Key Objectives and Approach
3. Schedule Overview

Part II

4. Technical Approach
5. Detailed Schedule
6. Deliverables
7. Collaboration
8. Data Request Preview

1.2 Task 2: Develop Research Plan

Guidehouse has developed a draft Research Plan (this document submitted October 14, 2020). Based on the MPSC's feedback, we will submit a final Research Plan to meet the work scope requirements and the MPSC project objectives. The Research Plan incorporates and expands on the discussions and decisions made during the Project Initiation Meeting. Specifically, the Research Plan details the methodology to provide post modeling results for individual utility jurisdictions, and engaging stakeholders. For a summary of project tasks, including objectives and deliverables, see Table 12. Project Tasks Summary.

The Research Plan addresses which data will be used to develop each of these key variables:

- Most recent assessment of the residential, commercial, and industrial (C&I) building stocks, including saturations of equipment by efficiency level and estimates of consumption
- Rate of adoption of new energy-consuming amenities (such as residential central cooling)
- Estimates of total EWR and DR technology adoption rates
- Customer willingness to adopt new technologies
- Within- and across-program EWR and DR technology adoption rates, including interrelationships and interactions of technologies, such as Wi-Fi thermostats and networked light emitting diodes (LEDs) that provide both EWR and DR impacts, as appropriate, based on the final measure list

The Research Plan further describes how the following MPSC requirements will be met:

- Step-by-step plans to complete the project, with additional detail delineating all tasks, milestones, research activities, meetings, schedule, deliverable dates, etc.
- Sources of data for efficiency measures and building code information, as well as default information for penetrations and end-use breakdowns (discussed in Task 3)
- A more detailed description of the models Guidehouse will use to calculate EWR and DR potentials, including algorithms used to calculate savings, costs, and EWR and DR interaction effects, as applicable, using all proposed data sources (discussed in Task 4)
- Provide the MPSC with a detailed data request (see Appendix B) of all information needed to complete the study
- Proposed method for considering dual baselines for retrofit/early replacement measures (discussed further in Tasks 3 and 4)
- Brief summary of codes and standards on measure selection (discussed further in Task 3)
- Discuss research to be conducted or leveraged (discussed in Task 3)
- An outline describing what will be included in the final reports (see Task 5 and 6)

Guidehouse will facilitate data requests directly with MI utilities[1] to obtain the following data necessary to populate baseline conditions and calibrate adoption rates in the EWR potential model; details are provided in the Appendix B Excel workbook. The MPSC will provide utility contact information in order for Guidehouse to

[1] The MPSC will specify the utilities to include in the study.

request:

- **Customer information**: this information includes number of customers, sales, and peak demands by market segment, delivery pathway, or sector (residential, commercial and industrial), recent customer survey results, available load research information, summaries of energy audit results, customer contact information and other related customer information
- **Electric and gas forecast information**: results, information, data, and forecast model structures for each MI utility's most recent electric and gas forecasts, by sector, pathway, and segment, as available
- **EWR and DR Program tracking data, annual reports and evaluation studies**: Program and measure savings, costs, load shapes, and measure lives, including data contained in each MI utility's residential and non-residential program tracking databases, annual reports, and evaluation studies, including not yet published draft reports, and published studies
- **Avoided costs of electricity and natural gas** by subcategory, as appropriate (e.g., annual energy, energy by costing period, peak demand, etc.)
- **Discount rates and other economic parameters**: Weighted average cost of capital, electricity and gas rates, and other information needed to support cost-effectiveness analysis, customer payback and decision-making, non-energy impacts, etc.
- **Supporting Studies:** The Michigan Energy Measures Database (MEMD) will be the primary source for measure information, supplemented by the following studies:
    - Any available data from ongoing 2020 MI Housing Baseline Study, conducted by Cadmus
    - 2016 Commercial & Industrial Baseline Study, conducted for DTE Energy by Guidehouse
    - 2016 Residential Baseline Study, conducted for DTE Energy by Guidehouse
    - 2014 Consumers Energy Residential Appliance Saturation and Home Characteristics Study, conducted by Cadmus
    - 2016 Non-Residential Energy Efficiency Baseline Study, conducted for Consumers Energy by EMI Consulting, Inc.
    - 2011 MI Residential Baseline Study, conducted by MPSC
    - 2015 Residential Energy Consumption Survey (RECS), conducted by EIA
    - 2014 Manufacturing Energy Consumption Survey (MECS), conducted by EIA
    - 2012 Commercial Building Energy Consumption Survey (CBECS), conducted by EIA
    - 2017 American Housing Survey, conducted by the U.S. Census Bureau
    - If available, any potential study data currently being analyzed by MI utilities
    - Results from ongoing studies, including:
        a. Residential and commercial load shape study, expected January 2021
        b. Statewide C&I Boiler Tune-Up and HVAC Controls study, expected December 2020

1.3 Task 3: Conduct Research Identified in the Research Plan

1.3.1 Market Characterization

Potential study market characterizations define the parameters by which EWR and DR measures scale to the customer segment, sector, and territory levels. Additionally, inputs such as avoided costs and retail rates are

used to calculate economic measures screens, inform customer adoption metrics and historic program achievements, and evaluation results provide the basis for model calibration that yield achievable potential scenarios.

1.3.1.1 EWR Market Characterization

The EWR market characterization will involve the collection of four categories of model input data, shown in Table 2. Guidehouse will work with stakeholders to determine the segmentation desired for the study results. A stakeholder request for additional disaggregation to provide utility jurisdiction-specific results was discussed during the Project Initiation Meeting. Guidehouse will conduct a post-processing segmentation step based on region (Upper Peninsula, Lower Peninsula) results to inform utility service territory potential estimates. Energy waste reduction potential results will be presented at the utility service territory level, but will not be calibrated to this segmentation in the DSMSim™ model.

Guidehouse will use a combination of utility data requests and secondary research to develop the key model inputs presented in Table 2.

Table 2. EWR Market Characterization Data Categories

Data Category	Description
Segmentation	• Region (Lower Peninsula, Upper Peninsula) • Sector and Segment • End Use
Utility / Customer Data	• Building Stock (# of Homes, 1000 sq. ft. building space, sector consumption) • Sales Forecast • Load Shapes • End Use Allocations (% of segment consumption) • Space Heating and Hot Water Fuel Type Distribution • Line Losses
Economic Inputs	• Avoided Costs • Retail Rates • Discount Rates • End Use Allocations (% of segment consumption) • Space Heating and Hot Water Fuel Type Distribution
Design Framework	• Fixed and Variable Program Administrative Costs • Historic Program Achievements • Incentive Strategy

Source: Guidehouse

Guidehouse will collect the following list of data from the utilities. As needed, secondary sources will be leveraged.

- Energy and demand forecasts by fuel and sector (and subsector, if available)
- Customer forecasts and customer databases
- Avoided costs, which may be different for utilities located in the Midcontinent Independent System Operator (MISO) territory or the PJM Interconnection (PJM) territory
- System and/or sector load profiles
- Economic assumptions (inflation rate, discount rate, etc.)
- Transmission and distribution line loss assumptions

- Non-energy benefits
- Demand-side Management (DSM) program costs and savings history and tracking databases

1.3.1.2 DR Market Characterization

Demand response market characterization involves market segmentation for DR analysis and development of baseline customer count and peak demand projections by market segments.

Market Segmentation

The market segmentation for the DR potential assessment will leverage the EWR segmentation approach. One key difference between market segmentation for DR and EWR is the segmentation of C&I customers by size based on maximum demand value (referred to as customer class). Within each customer class, Guidehouse will further segment customers by dwelling types for residential, and by building/business types for non-residential, and be consistent with the EWR segmentation approach. Within each customer segment, Guidehouse will develop a breakdown of the summer and winter peak demand by end use.

Table 3 shows the different levels of market segmentation for the DR potential assessment (briefly described below).

Table 3. Representative Market Characterization Approach for DR Potential Assessment

Level	Description
1. Region	• Lower Peninsula, Upper Peninsula
2. Sector	• Residential, Commercial and Industrial (C&I), Irrigation

3. Customer Class	• Residential
	• C&I customers (based on maximum demand values)[2]:
	  ○ Small C&I, <=30 kW
	  ○ Medium C&I, >30 and <=200 kW
	  ○ Large C&I, >200 and <=1000 kW
	  ○ Extra Large C&I, >1000 kW
	• Irrigation / water pumping customers

4. Segment / Building Type (for each customer class)	• Residential customers[3]
	  ○ Single Family
	  ○ Multifamily
	• C&I customers, by business type, for example.
	  ○ Commercial – Office, Retail, Education, Warehouse, Restaurant, Health, Grocery, Lodging, Other
	  ○ Industrial –. Primary Metals, Automobile Manufacturing, Plastics and Rubber, Food, Fabricated Metals, Chemicals, Equipment, Paper, Others

5. End Use	• Residential – space cooling, electric water heating, lighting, appliances, others. • C&I – HVAC, lighting, water heating, refrigeration, industrial processes, water pumping, thermal energy storage, etc. • Irrigation – irrigation / water pumping. • Cross-cutting – battery, electric vehicles

Source: Guidehouse

[2] The proposed size thresholds consistent with the 2017 State of Michigan Demand Response Potential Study. Guidehouse will discuss this approach with the MPSC and modify, if needed.

[3] Within the residential dwelling types, we can segment further by market rate and income, depending on the available data.

Define Peak Period and Develop Baseline Projections

Once the market segments are defined, the next step is to select the base year, which is the latest year with available customer count and load data. The base year for the demand response analysis will be consistent with the EWR study.

The baseline projection for DR potential assessment entails the following:

- **Customer Count Projections** by customer class and dwelling / business / industry type for Upper Peninsula and Lower Peninsula (Levels 1, 2, 3 and 4 in Table 3**Error! Reference source not found.**)
- **Peak Demand Projections** by customer class, dwelling / business / industry type, and end use for Upper and Lower Peninsula (Levels 1, 2, 3, 4 and 5 in Table 3**Error! Reference source not found.**)

For customer count projections, Guidehouse will use data provided by revenue class and by standard industrial classification (SIC) code. The DR analysis will use the same mapping of SIC code to segment as the EWR study.

Guidehouse will use a bottom-up approach for developing the peak demand projections by customer class, dwelling / business / industry type and end use, and calibrate this to available peak demand forecasts for the Upper Peninsula and Lower Peninsula. Table 4 represents our bottom-up approach for developing baseline peak demand projections.

Table 4. Baseline Peak Demand Projection Approach

Approach	Detail
Define Peak Period	Defined peak period through analysis of 8760 system load data or use pre-determined peak period definition.
Calculate Coincident Peak Demand Factors by Customer Class and Segment	Use available load profiles by customer class and segment / business type to determine coincident peak demand factors by customer class and segment.
Apply Coincident Peak Factors to develop Baseline Peak Demand Projections	Apply coincident peak demand factors and end-uses to forecasted retail energy sales to estimate coincident peak demand by customer class, segment / business type, and end use.
Calibrate Bottom-Up Peak Demand projections to System Peak Forecast Data	Compare bottom-up peak demand projections with total forecasted system peak demand and calibrate bottom-up estimates to the forecasted values.
Develop Separate Peak Demand Projections for Electric Vehicles (EVs)	Combine EV adoption forecast with changing profile information to develop peak demand projections from EVs.

Source: Guidehouse

1.3.2 EWR Measures and DR Options Characterization

The first step in the potential estimation process is to characterize the savings and costs associated with EWR and DR measures. Guidehouse's process for identifying and characterizing potential measures includes developing a comprehensive list of efficient technologies and actions to be included in the residential and non-residential sectors, respectively. Each measure will have an estimate of typical savings and costs for a defined unit quantity (e.g., per each, per ton, per 1000 square foot, or per horsepower). Documentation for this analysis will contain report names and source links for reviewers to trace each input's origin.

The initial EWR measure list for this analysis will be compiled based on the MEMD and recent Guidehouse studies. To ensure that the EWR measure list is comprehensive and addresses MPSC's strategic priorities, Guidehouse will consider which EWR measures to include based on:

1. MI utility EWR portfolios and/or the MEMD expected savings
2. Impact (high, moderate, low)
3. MPSC priorities
4. Degree of market maturity

Once the measure list has been prioritized, Guidehouse will identify the top 100 EWR measures, including electrification and near-term emerging technology measures, as well as the recommended DR options, and provide these to the MPSC for review. Guidehouse will develop detailed measure characterizations for the final approved list of 100 EWR measures and selected DR options.[4]

1.3.2.1 EWR Measure Characterization Approach

Guidehouse's approach to EWR measure assessment will:

- Identify whether a measure is included in the MEMD and/or typically included in MI utility EWR portfolios
- Group measures by savings potential (high, moderate, low)
- Categorize measures as either mature, conventional or emerging
- Determine measure applicability by (1) existing buildings, (2) new construction, or (3) both

EWR resources are defined as measures that will modify the net consumption of electricity or gas on the retail customer's side of the meter across the various sectors and end uses as determined during the measure screening and market characterization processes. Typical end uses include:

- **Residential**: Appliances, Consumer Electronics, Lighting, Shell (Envelope), Domestic Hot Water, HVAC, Whole Home, Miscellaneous
- **Non-Residential (Commercial and Industrial)**: Domestic Hot Water, Consumer Electronics, HVAC, Industrial, Custom, Lighting, Commercial Kitchen, Refrigeration, Appliance, Swimming Pool, Compressed Air, Shell (Envelope), Data Center

The EWR measure list will be informed by: (1) previous MI Potential Studies; (2) the MEMD; (3) MPSC and stakeholders; (4) other EWR potential studies conducted by Guidehouse. In addition, we will review recent Michigan program design, evaluation and baseline studies to ensure all appropriate technologies are assessed, and consider specific technologies requested by the MPSC.

[4] Guidehouse's experience is that the top 20 residential EWR measures typically provide around 90% of the electricity and demand savings; and the top 25 C&I EWR measures typically provide about 90% of the C&I electricity and demand savings. Additionally, the top 15 residential gas measures typically provide around 90% of the residential therms savings, and the top 15 C&I gas measures typically provide about 90% of the C&I therms savings.

Guidehouse plans to provide a draft measure list to the MPSC for review and feedback. Guidehouse will update the list based on MPSC feedback, by November 20, 2020. The November 20 list will be distributed to project stakeholders by November 23, 2020, and we will solicit feedback at the first stakeholder meeting, expected during the week of November 30, 2020. The MPSC and stakeholder feedback will be incorporated into the final measure list.

To represent the savings beyond the top 100 EWR measures, using a top down approach, we will characterize the low impact end uses that comprise the remaining approximately ten percent of potential at the end-use level. In this way, the analysis will provide a comprehensive assessment of potential. As appropriate, Guidehouse will employ the following approach when analyzing measure energy savings:

1. **MEMD Data**: Guidehouse will rely on the MEMD for unit energy savings, demand savings, and measure life calculations for the majority of measures, where the MEMD efficiency levels cover the range of commercially-available technologies and expected emerging technologies.
2. **Program Evaluation Data**: Some measures are not included in the MEMD, but have program evaluation data available; Guidehouse will reference program evaluation results when possible.
3. **Engineering Analysis**: Measures without MEMD or evaluation data will be characterized using engineering best practices. We may access sources such as regional technical reference manuals (TRMs). When a documentable source is not available, Guidehouse will rely on savings analysis acquired through our evaluation of DSM portfolios.

As applicable, we will characterize each EWR measure by estimating the following measure parameters:

- **Measure Replacement Methodology:** Each EWR measure will be defined as retrofit/early retirement, replace on burnout (ROB), dual baseline, new, or behavior, to guide baseline definitions and incremental cost calculations.
- **Measure Description:** Technical definitions of the baseline (code or existing) and technology will be provided, detailing characteristics such as capacity, efficiency, size, and fuel type. Definitions of baseline technologies will account for any anticipated changes to state or federal codes and standards.
- **Annual Savings Estimations:** The annual energy consumption (kWh or therms) and coincident peak demand (kW) for both the baseline and efficient technology will be assessed and the variance used to define annual savings.
- **Lifetime Savings Estimations:** Effective useful life for each measure will be used to extrapolate annual savings out to lifetime energy and demand savings.
- **Seasonal Distribution of Savings:** Summer/Winter and On/Off Peak ratios will be determined to accurately calculate avoided cost benefits for each measure.
- **Measure and Related Costs**: Incremental EWR measure costs will be calculated based on the measure applicability and account for all material, labor, and operations and maintenance costs associated with the baseline, code, and/or efficient technology. Measure costs will also factor enablement costs, incentives, and other programmatic costs for administering programs.
- **Program Attrition:** Measures may include breakouts to programs as a percentage of their total achievable potential. This allows modelers to assign varying programmatic costs to these groups. Due to the number of utilities and programs, the team may recommend combining individual programs into similar high-level program types for region or statewide consistency.

- **Net-to-Gross Ratio:** Resources will be assigned a Net-to-Gross Ratio (NTGR) to account for any free riders and/or spillover that may result as an influence of the DSM program. The NTGR will be applied to both benefits and costs in assessing cost-effectiveness.
- **Measure Densities and Saturations:** The market density of each EWR measure will be determined for the baseline and efficient conditions. Densities will be defined as the number of each technology per home for residential and per 1000 sq. ft. for the commercial and industrial sectors. Saturations are defined as the percent penetration of the existing technology.

Guidehouse is intimately familiar with codes and standards through our work developing standards for the U.S. DOE, and we are accustomed to including a time-varying estimate of both savings and costs, where appropriate, to reflect changes to the baseline and/or efficient measure assumptions resulting from codes and standards. Mutually exclusive cost-effective measures applicable to the same end use will be prioritized in terms of cost-effectiveness, in keeping with the objective to maximize the net benefits to all end users. As future codes and standards come into effect, the energy savings from existing measures subject to the codes and standards will diminish. Guidehouse will account for the impact of codes and standards applying baseline energy and cost multipliers which will reduce the baseline equipment consumption starting from the year when individual codes and standards begin to take effect. Guidehouse will discuss with MPSC stakeholders a potential scenario of analyzing codes and/or standards advocacy and support as a measure, including the implications of doing so on baselines and savings across other impacted measures.

Guidehouse will work with the MPSC to identify critical market indicators and increase understanding of the current and evolving state of the lighting market, especially regarding the continued transformation of the LED market. Note that our approach is not to speculate about potential federal regulations or standards.[5] We will work to expand knowledge of consumer usage patterns, awareness, understanding, and purchase of energy efficient equipment beyond lighting, to technologies such as plug loads, appliances, and systems.

We will base measure costs on the incremental equipment cost between the baseline and efficient technologies for ROB and new applications, as applicable. Retrofit measure costs will include the full material cost of the efficient measure and associated labor rates for removal of existing equipment and installation of the efficient technology. Dual baseline measures will take into account both the initial retrofit measure cost and savings, and that of the portion of measure life once a new code or standard is projected to become effective. As applicable, we will access Guidehouse's documentation of incremental costs derived from our Codes and Standards analyses performed for the U.S. DOE.

1.3.2.2 DR Options Characterization Approach

Characterizing DR options includes two key steps, which are described below:

1. Develop DR options and map applicable options to customer classes and end uses
2. Develop key assumptions for potential and costs

Develop DR options and map applicable options to customer classes and end uses

[5] Guidehouse will apply code vectors and NTG ratios in the EWR model to reflect market transformation for customers are going beyond standards / requirements.

Guidehouse will consider a comprehensive list of DR programs, presented in Table 5, which is based on our extensive experience in conducting DR potential studies, exisitng DR programs currently offered in MI, and emerging industry trends.

Table 5. Proposed List of DR Options by Customer Segment

DR Options	Brief Description	Eligible Customers
Direct Load Control (DLC) - Switch for Space cooling and heating, Water Heating	Control of space cooling and heating equipment (central AC, heat pumps, electric furnaces), and electric water heating using load control switches.	All residential, small C&I, and medium C&I customers with eligible end uses
Direct Load Control (DLC) - Smart Thermostat BYOT	Bring Your Own Thermostat (BYOT) program with space cooling and heating control using smart thermostats.	All residential, small and medium C&I customers with smart thermostats
Direct Load Control (DLC) - Smart Thermostat-Direct Install[6]	Direct Install smart thermostat program that controls space cooling and heating using a smart thermostat installed by the utility.	Residential, small and medium C&I with central A/C and heat pumps[7]
Smart Appliances Control (including Room AC)	Remote control of Wi-Fi enabled smart appliances; appliances may also be controlled using a smart plug.	Residential customers with smart appliances
Behavioral DR	Modifications in demand during peak demand period due to behavioral changes, induced by social comparisons.	All residential
Irrigation Load Control	Switch-based control of irrigation pumps during peak demand period.	Irrigation customers
Capacity Bidding Program	Firm capacity commitment for load reduction during DR events; customers receive both a fixed capacity payment ($/kW) based on committed load reduction, plus an energy payment ($/kWh). Curtailment can be either manual or automated.	Large C&I, Extra-large C&I
Demand Bidding Program	Voluntary load reduction when DR events are called. There is no capacity commitment. Customers voluntary reduce load and receive energy payment ($/kWh) only based on performance. Curtailment can be either manual or automated.	Large C&I, Extra-large C&I
Emergency DR	Customers agree to reduce a fixed load when called during grid emergencies and receive both capacity ($/kW) payment and energy ($/kWh) payment. Curtailment can be either manual or automated.	Large C&I, Extra-large C&I
C&I Interruptible Rates	Customers are on an interruptible tariff for agreeing to reduce load when called.	Large C&I, Extra-large C&I
Time-Of-Use Rates	Rates that vary by block of hours during the day and by season.	Residential, All C&I, Irrigation
Critical Peak Pricing	Significantly higher price during certain critical hours of the year (high demand), superimposed on a time of use (TOU) rate; off-peak rate is lower than Otherwise Applicable Tariff.	Residential, All C&I, Irrigation
Peak Time Rebate	Discounted rate for reducing electricity use over baseline during DR events.	Residential, Small C&I

[6] The Direct Install approach can be considered for areas where smart thermostat saturation is not very high to make BYOT feasible; it can also focus on income-eligible customers where smart thermostat uptake may be relatively low. Additionally, utilities could consider transitioning legacy load control switch based DLC programs to a smart thermostat Direct Install program.
[7] This program would complement the smart thermostat BYOT program and target hard-to-reach segments such as residential income-eligible, and small/medium businesses (SMBs).

DR Options	Brief Description	Eligible Customers
Real Time Pricing	Dynamic rate with hourly variation in price.	Large C&I, Extra Large C&I
DR for Ancillary Services	Customer load reduction/shifting to provide ancillary services (spin, non-spin, regulation); typically requires automated fast response.	All customers
EV Load Control	Managed Charging of PHEV and EVs.	Customers with PHEV and EVs
Behind the Meter (BTM) battery	Dispatch of BTM batteries during DR events.	Customers with BTM batteries
Thermal Energy Storage	Load shifting to Thermal Energy Storage systems (either Ice Storage or Phase Change Materials) during DR events	All C&I customers with TES system
Voltage Optimization[8]	Energy and demand reduction using front of the meter voltage optimization technologies.	All

Source: Guidehouse

Guidehouse's process to identify the appropriate DR programs for Michiagn customers will include:

- In-depth interviews with MI utilities regarding histroical, current and potential future program offers and information from pilots conducted in the state
- Insights from primary research proposed in this study and past studies (e..g, customer surveys proposed in the this study, insights from customer surveys in past potential studies, market assessment study with MPSC-Guidehouse[9])
- Benchmarking of other utility programs
- In-depth interviews with DR program implementers and technology providers
- AMI deployment status and plan affecting rollout of certain programs

Guidehouse will specifically take into consideration suitable programs for income-eligible customers. For example, under residential DLC, a direct install approach where smart therostats are installed for free at customer premises may be more amenable for income-eligible customers than a BYOT approach. Simialrly, for time-varying rates, a default rate with opt-out will not apply to income-eligible customers. Also consideration of opt-in dynamic rates for income-eligible customers will be discussed with MI utilities and other stakeholders and accordingly included in the potential estimates for these customers. In additon, participation scenarios for market rate customers will be adjusted for income-eligible customers. The cost-effectiveness threshold for programs targeted toward income eligible customers (such as Smart Thermostat Direct Install) can be assumed to be lower than 1.0.

Develop Key Assumptions for Potential and Costs

The purpose of this task is to develop a set of assumptions that will ultimately drive the activity of modeling DR potential. We often refer to this process as developing the DR program design parameters. The two key parameters that are needed for potential estimation are participation rates and unit impact assumptions by DR option/program for applicable customer segments. Additional parameters for potential estimation include DR event participation rates, percentage of customers with enabling technology, and attrition rates of enrolled

[8] We typically don't include this in DR potential studies since it is a front of the meter resource. However, we saw that this was included in the 2017 MI statewide DR potential study and could include it at the MPSC's request.

[9] "Demand Response Market Assessment" for Michigan Public Service Commission; September 2017; available at https://www.michigan.gov/documents/mpsc/MI_Demand_Response_Market_Assessment_20170929_602432_7.pdf

customers. In addition, we will develop detailed bottom-up program cost assumptions that include items such as program development costs, equipment costs, marketing and program administration costs, product lifetimes, discount rate, etc.

Participation Assumptions

Customer surveys will include questions on customer awareness of and willingness to participate in DR programs. We will focus on segments that were identified in the 2017 Michigan Demand Response Potential Assessment as ones in which additional research might be helpful, such as multifamily customers and small / medium business customers.

In addition to customer surveys, we will consider several other information sources to develop programmatic assumptions:

- We will undertake a detailed market characterization and develop baseline count and demand projections by customer class, building type and end use. This segmentation allows us to develop unit impacts by end use and customer class, instead of aggregate unit impacts by customer class. Segmentation of customers by segment and characterizing count and peak demand at that level allows us to develop granular program participation assumptions, differentiated by segment. This segmentation approach also allows us to develop itemized bottom-up DR program and enabling technology cost assumptions.
- Second, we expect to draw upon the experience and insights gleaned from MI utilities DR activities and previous potential and existing evaluation studies. We plan to conduct in-depth interviews with utilities to glean insights on DR efforts to date and outlook for growing future DR programs. We routinely engage with stakeholders to provide valuable insights and perspectives on the results. In the program development process, we will rely extensively on inputs from MI utilities to help guide and shape the set of programs to be considered in the potential assessment.
- Third, the knowledge and experience from industry DR best practices plays a significant role in the program development process. We plan to conduct benchmarking with representative DR programs offered by other utilities, which might be most relevant for MI customers. We will select the appropriate programs for benchmarking in consultation with the MPSC. Benchmarking will involve in-depth interviews with program managers at the other utilities. In addition, we will review available information in publicly filed program evaluation reports and market assessment studies from other jurisdictions to assess participation and impact assumptions in similar DR programs offered by utilities and independent system operators / regional transmission operators (ISOs/RTOs). Additionally, we will draw on industry sources, such as program best practices presented at the Peak Load Management Alliance's (PLMA) conferences and webinars.[10]

[10] PLMA routinely presents awards to programs and gleaning insights from these programs could be helpful in developing key programmatic assumptions for the study.

Cost assumptions for DR programs fall into the following broad categories:

- **One Time Fixed Costs** (program development costs), specified in terms of $/DR option, which include program start-up costs, including for example, software and IT-infrastructure related costs, and associated labor time/costs (in terms of FTEs) incurred to set up the program.
- **One Time Variable Costs** include marketing and recruitment costs for new participants, and DR enabling technology costs associated with control and communications technologies. The enabling technology cost is specified either in terms of "$/new participant" on a per-site basis, or as "$/kW of enabled load reduction" on a participating load basis.[11]
- **Annual Fixed Costs,** specified in terms of $/year, primarily includes full-time equivalent (FTE) costs for annual program administration and ongoing IT related costs not included in the one-time fixed category above.
- **Annual Variable Costs,** primarily includes customer incentives, specified either as a fixed annual incentive amount per participant ($/participant/yr.), or in terms of load reduction ($/kW reduction plus $/kWh), depending on the program type. It also includes operating and maintenance costs that may be associated with servicing technology installed at customer premises. This category also includes program delivery costs based on pay-for-performance contracts with DR service providers ($/kW delivered).

In addition to these costs incurred by the DR program administrator, DR program participants may incur costs to participate in DR programs. For example, the smart thermostat purchase cost is included in a BYOT program. A C&I customer could incur costs for Auto-DR enablement. In addition to these equipment related costs, some jurisdictions provide guidelines to quantify customer intangible costs from DR program participation such as "loss of productivity" or "loss of comfort".[12] These hard-to-quantify participant costs are typically estimated as percentage of incentives provided to the customer for DR program participation.

Gas DR Options Characterization Approach

Guidehouse will draw on existing experience with gas DR program benchmarking research across the country and conduct additional benchmarking, as needed, to understand what program designs, technologies, and methods have been employed to date and what might be applicable for the MI utilities. Our research suggests three main types of gas DR programs:

1. Residential Thermostat Gas DR
    - Program offered by Southern California Gas Company (SoCalGas) and being piloted by National Grid in Massachusetts
2. C&I Automatic Fuel Switching (Gas to Fuel Oil)
    - Past National Grid programs (New York City, 2012-2017) achieved gas peak demand reduction for C&I customers by using automatic controls to switch applicable building loads from natural

[11] The enabling technology costs represents the incremental costs associated with controls and communications for making the device DR-enabled.

[12] "2016 Demand Response Cost Effectiveness Protocols", California Public Utilities Commission; available at https://www.cpuc.ca.gov/General.aspx?id=7023

gas to fuel oil

3. C&I Manual Fuel Switching Daily (Interruptible Natural Gas Rates)

    - Xcel Energy, Philadelphia Gas Works, and many other gas utilities offer discounted C&I gas rates if customers participate in a manual demand reduction program, often called Interruptible Natural Gas Rates

These programs highlight some of the challenges with historical gas DR opportunities. Historically, most programs required some form of backup energy source (e.g., fuel oil, steam, etc.) to offset the natural gas demand for key pieces of equipment. Few residential and commercial gas-fired loads have had connected controls with capabilities to communicate with the outside signals. Beyond the building technologies themselves, the metering and communication hardware (e.g., telephone telemetry) was expensive and complicated. Recent trends in end use and metering technologies have enabled more building segments and end-use loads to potentially participate in gas DR programs. Guidehouse will present findings from benchmarking research to the MPSC and discuss which gas DR programs and technologies are applicable for Michigan.

Gas DR Measure and Market Characterization

The next step will be to propose a list of gas DR options based on the benchmarking research, Guidehouse's existing experience, and discussions with the MPSC. Gas DR measures that could potentially be considered for the analysis include:

- **Smart Thermostat Gas DR** for residential and small/medium C&I customers that make slight adjustments to temperature settings to reduce overall space heating demand during peak hours for gas furnaces and boilers.
- **Water Heating Control** for residential and small/medium C&I customers using retrofit controller for gas storage water heaters that adjusts the temperature set point during peak events.
- **Space heating control vis Energy Management System (EMS)** for medium, large and extra-large C&I customers with EMS that can respond to DR signals and adjust space heating load based on pre-programmed user set preferences (similar to electric Auto-DR).
- **Process Load Controls** would apply to large and extra-large C&I customers with industrial process load that can be automatically shifted/reduced during peak events. This would be either manual or automated depending on customer preference and level of automation.

The characterization of gas DR options will follow the same approach as that for electric DR options. It will include specifying eligible customers based on end-use equipment, unit impacts (per customer/equipment load reduction and/or shifting during DR event periods), itemized program and technology costs, and assumptions around participation of eligible customers in gas DR options.

Our primary research (customer surveys) will include questions to assess customer eligibility and willingness to participate in gas DR programs. We will leverage our team's experience with gas DR, discuss program options with Michigan utilities and other stakeholders, and conduct additional benchmarking of utility programs to develop our assumptions.

Peak Definition. Guidehouse will work with Michigan utilities to identify gas peak demand needs and define peak demand periods for natural gas. For example, our ConEd gas DR work indicated that gas DR events would occur on any day where there would be a need to purchase or utilize peaking contracts. Con Edison expected this to happen on any winter day with an average daily temperature below 22°F, which typically is approximately 30 days per winter season. Based on the peak period definition and available peak load shape factors, Guidehouse will determine gas peak demand by end use and customer segment. The peak load shape factors can be sourced from publicly available load profile databases.[13]

1.3.2.3 EWR DR Integration under Measure Characterization

There are multiple areas in which EWR and DR interact and could be integrated in a potential study. Controls-based EWR measures (e.g., networked LEDs, smart thermostats, smart appliances, energy management control system) have DR capabilities. From a customer perspective, realization of both EWR and DR savings from these measures can potentially enhance their adoption. Characterization of such measures in a potential study needs to consider savings, costs, and benefits for both EWR and DR. Energy waste reduction measures impact the baseline load for DR. For example, methodologically, the lighting load shape after installing networked LEDs, which is an EWR measure, establishes the baseline load for calculating DR potential from the measure. Similarly, smart thermostats provide joint EWR and DR benefits. Smart thermostats help optimize heating, ventilation, and air-conditioning (HVAC) operation and derive EWR savings. Additionally, smart thermostats are used to realize active demand reduction during DR events and therefore need to be considered from a joint EWR-DR perspective.

Guidehouse's approach for EWR-DR integration under measure characterization will involve the following:

- Identify measures that provide joint EWR-DR benefits (e.g., smart thermostats, networked LEDs, smart water heaters, smart appliances, energy management control system, and others).[14]
- Characterize these measures from a joint EWR-DR perspective, which would entail:
    - Stacking of EWR and DR impacts for these measures, with EWR first and then DR. Using smart thermostats as an example, the baseline load for estimating DR impacts is the HVAC load profile post smart thermostat installation for EWR (installing the smart thermostat potentially provides energy savings during all or some operating hours and influences the load profile).
    - Cost-effectiveness assessment from a joint EWR-DR perspective, including both EWR and DR savings streams derived from the same technology instead of separately conducting cost-effectiveness tests under EWR and DR. For example, for smart thermostats, inclusion of both EWR and DR savings would enhance the cost-effectiveness of the technology instead of assessing cost-effectiveness from an EWR-only or a DR-only standpoint. However, this needs to consider additional DR programmatic costs (such as those associated with recruiting customers in the DR program and customer incentives for continuing program participation) and differences in measure lives for EWR and DR. Guidehouse's recommended approach will separate out EWR and DR potential, but will employ one measure cost for screening. The

[13] As described under the electric DR approach, we propose to use gas load profile data in the Open EI database that contains commercial and residential hourly load profiles for all TMY3 locations in the U.S. https://openei.org/datasets/files/961/pub/COMMERCIAL_LOAD_DATA_E_PLUS_OUTPUT/

[14] The market is seeing a proliferation of measures that provide both EWR and DR benefits with increasing number of end-use devices being equipped with sophisticated controls that enable grid-interactivity of the device.

MPSC will have opportunity to comment on the approach prior to Guidehouse finalizing it for this study.

Guidehouse and the MPSC will revisit this approach after approval of the final measure list and finalize approach based on discussions with MPSC staff and stakeholders.

1.3.3 Error! Reference source not found.Identifying and Characterizing Emerging Technologies

Guidehouse defines emerging technologies as known, existing technologies that have a reasonable chance of customer adoption in the frame of the study, and are experiencing rapidly changing costs or efficiencies through economies of scale or research and development (R&D). Guidehouse's approach to identifying and characterizing emerging technologies includes an industry-wide review of relevant literature, as well as discussions with internal experts, MPSC staff, and project stakeholders. This review identifies resources, including those discussed above, that will inform qualitative and quantitative identification of emerging technology trends. The project measure list will identify emerging technologies and relevant reference sources, and Guidehouse's recommendation whether to include in the 100 EWC measures receiving individual, bottom up measure characterization.

For each technology, the team will document key aspects of emerging technologies consistent with the approach used for conventional measures.

Recent examples of emerging technology measures include:

- Advanced LEDs
  - OLEDs, QLEDs
  - Networked LEDs
- Heat pump dryers
- Integrated heat pumps
- Optimized building controls
- Smart plugs
- Smart window coatings
- Solar hot water heaters
- Ultrathin building insulation

1.3.4 Estimate Current and Future Measure Saturations and Penetrations

For each segment of the market, the team will need to use a snapshot of saturation and age of energy-consuming equipment at a certain point in time, the time of the last baseline study covering each segment. Guidehouse will leverage the latest MI and/or regional baseline studies available to develop measure densities and efficient technology saturations.

Adjustments for changes in equipment saturations and new buildings in the future may also be accounted for. The saturation of various energy-using amenities changes over time and can be estimated using the last two baseline studies for each segment (or previous potential study baseline assumptions and data, along with the recent baseline studies) to derive trends. This goes beyond stock turnover to situations where the equipment stock is growing in size over time, which creates additional opportunities for programs. The most important and prevalent example of this occurs with residential cooling technologies being adopted in greater numbers in MI, but the same feature applies to other applications as well. At the same time, certain stocks of equipment may also be replaced faster than their natural lifetime-based turnover when new technologies compel people to get rid of their old equipment. This is likely most applicable in recent years to computer monitors, televisions, residential lighting, and oil to gas heating conversions. In some cases, such as LED lighting in residential

commercial applications, the market may have accelerated since the time of the last baseline or potential study. In this case, additional market intelligence may prove useful for estimating higher rates of uptake.

Baseline studies are not the only sources of data for measuring the stock turnover rate. Michigan offers a broad array of programs covering most existing measures. Evaluation activities have also in some cases provided attribution-related market research that might provide alternative estimates of the market size. In addition, the team will explore other sources of market data that have proven useful in other studies. If gaps in saturations and penetrations emerge from the review of secondary resources, the team may supplement primary data collection with targeted updates to these inputs.

1.3.5 Develop Market Acceptance and Adoption Parameters

Guidehouse will develop market acceptance and adoption forecasts primarily through surveying MI Utility customers. The decision maker survey, addressing both EWR and DR measures, will be fielded using customer contact information provided by utility companies. Guidehouse will field one residential and one C&I online survey and will develop a sample to achieve statistically significant results based on the survey design and stratification (e.g., Upper Peninsula, Lower Peninsula) that will be used in the model. Customers will be offered an incentive through Tango which allows customers to select an e-gift card from a participating retailer or restaurant (including Amazon.com, CVS or Dunkin' Donuts and more) or an online debit card (Visa® or MasterCard®). Table 6 includes details on the minimum number of completes and recommended customer incentive for each survey. Guidehouse will finalize sample design and customer outreach approach based on customer contact data received from utilities and the survey design.

Table 6: Decision Maker Survey Fielding Details

Customer Type	Minimum Number of Completes	Recommended Customer Incentive
Residential	500	$15
Commercial & Industrial	500	$25

Source: Guidehouse 2020

The primary objective of the surveys will be to collect information on customer awareness and willingness to pay for EWR and DR measures. The survey will be designed to understand the effect of coronavirus disease 2019 (COVID-19) on these customer perceptions to accurately forecast the likelihood of adoption under various program intervention and incentive scenarios to inform the achievable potential model.

Guidehouse will incorporate secondary objectives into the survey design including customer barriers to adopting EWR and DR measures, recent energy use decisions, and awareness of current EWR and DR program offerings. For technologies that provide joint EWR and DR benefits (e.g., smart thermostats, networked LEDs, smart water heaters), the primary research would include survey questions to assess customer willingness to adopt these technologies from a joint EWR-DR perspective since these technologies potentially provide dual benefits to the customer. The survey information will be used to inform the market adoption model parameters (discussed in section 1.4) for an integrated EWR-DR adoption model for these measures.

The types of additional information that may be collected through decision maker surveys include:

- Decision-maker awareness of major efficiency measures and current programs offered in the service

territory. In addition, the survey will assess decision maker awareness of DR programs for DR-enabling technologies (e.g., pool pump switch) and for measures that provide both EWR and DR benefits (e.g., smart thermostats).

- Major barriers to customers purchasing efficiency measures, by major measure type, as well as which barriers (e.g., building occupancy vs. ownership) are the primary barriers for each measure type. Data on customer barriers will be collected in a general way for all customer segments, except the large customers, where we will collect barriers by measure type data.
- Recent energy use decisions, including new additions or change-outs of energy-using appliances or installations of efficiency measures. Contributors to customers' evaluation of equipment purchasing decisions will be identified. This information will help to inform an increased energy and demand savings scenario, which is based on assuming measure saturation rates will be higher in the future.
- Home or business facility type, size, age, occupancy, usage patterns, demographics and firmographics.
- Specific to C&I customers: the percent of operating costs spent on energy.

The final design of the survey instruments will be determined by the final measure list, review of prior study information, and our assessment of the appropriate application of these types of surveys. Guidehouse recognizes the limitations on the type of information that can realistically be gathered from customer surveys and will be cognizant of those limitations in developing the research questions and survey instruments to be used in this primary research effort.

Results of existing MI baseline studies will be reviewed to inform any supplementary primary research needs to assess penetration / saturation information not included in the most recent MI baseline data collection. These additional penetration / saturation objectives will be considered on an as-needed basis to fill in critical gaps identified in the review of existing MI baseline data.

Guidehouse plans to provide a draft survey to the MPSC for review and feedback, including final sample design details and the customer outreach approach. The draft survey will also be provided to stakeholders, and presented at the second stakeholder meeting. The MPSC and stakeholder feedback will be incorporated into the final survey programmed survey instrument. The MPSC will also have the opportunity to review the programmed survey instrument prior to live fielding.

Prior to launching the survey, Guidehouse will set up a unique Guidehouse email account through which customers can reach out with questions and concerns related to the survey effort. If the customer question is something Guidehouse can address, we will directly resolve the issue with the customer; for example, sometimes customers need their link refreshed or have a question about incentive distribution. Guidehouse will forward customer emails with utility specific questions to a pre-defined point of contact at each utility for follow-up as needed and will work with the MPSC to establish these points of contacts prior to survey fielding.

Guidehouse will initially conduct a 'soft-launch' of the survey to a subset of customers. The soft launch will provide an opportunity for Guidehouse to review initial results and confirm the survey is meeting its data collection objectives.

1.4 Task 4: Develop and Run the Model

Guidehouse's suite of distributed energy resources (DER) market models will provide the MPSC with an integrated approach to assessing EWR-DR. The DER space is constantly evolving and resources are becoming more deeply intertwined with each other; this trend supports the **Error! Reference source not found.**more unified approach to modeling that we are adopting for this study to provide more accurate, dependable results.

1.4.1 Energy Waste Reduction

Guidehouse will use a custom-designed version of its DSM Potential tool, DSMSim™, to estimate technical, economic, and achievable EWR potential using best practice methods that have developed results that have been accepted in many other jurisdictions**Error! Reference source not found.**. DSMSim™ is a bottom-up technology diffusion and stock/flow tracking model implemented in a powerful, flexible, modeling platform that can readily deal with high degrees of dimensionality and the evolving needs of potential studies**Error! Reference source not found.**.

The DSMSim™ model has been widely used to forecast energy and demand potential across the United States and Canada, **Error! Reference source not found.**and adheres to all the current best practices in the evaluation industry. Key modeling features include:

- Ability to accommodate standard or customized cost test protocols, such as those outlined in national standard practice manuals[15]
- Handles any number of measures, programs, sectors, program periods and savings types (electric energy/demand, gas, water, emissions, etc.)
- Accounting for three measure replacement types (i.e., retrofit, ROB, and new construction measures) and the effects of similar technologies competing for market share
- Can easily switch between net and gross savings and cost-effectiveness results
- Provides cost-effectiveness metrics at the measure, program, sector, portfolio, end use or building type level, including combinations of these levels of granularity
- Powerful sensitivity and scenario analysis capability to identify key assumptions and largest leverage points
- Input data is imported from an Excel spreadsheet for portability, version control, and scenario analysis
- All summary results and intermediate calculations are immediately available in tabular or graphical form, in specified units, and can be exported to Excel and/or viewed through an online dashboard[16]

[15] E.g., the 2001 California Standard Practice Manual (CASPM); subsequent 2007 revision to the CASPM; 2017 National Standard Practice Manual (NSPM) by the National Efficiency Screening Project; etc.

[16] For an example of an Analytica Cloud Player Model Results Viewer which we developed for the 2019 CPUC Energy Efficiency Potential and Goals Study, see http://acp.analytica.com/acpbeta/shared/#dash/fca42209-b98d-4e83-852f-3d075f99ce9b. If this option for results viewing is preferable to the MPSC, we can develop and provide a tool user guidance document. Details of this option can be determined at a later date.

1.4.1.1 Technical Potential

Technical potential is defined as the energy savings that can be achieved assuming that all installed measures can immediately be replaced with the efficient measure/technology, wherever technically feasible, regardless of the cost, market acceptance, or whether a measure has failed and must be replaced.

Guidehouse's modeling approach considers an energy-efficient measure to be any change made to a building, piece of equipment, process, or behavior that could save energy. The savings can be defined in numerous ways, depending on which method is most appropriate for a given measure.

The calculation of technical potential in this study will differ depending on the assumed measure replacement type, since technical potential is calculated on a per-measure basis and includes estimates of savings per unit, measure density (e.g., quantity of measures per home), and total building stock.

The potential forecast will estimate the incremental annual and cumulative technical potential of energy and peak demand savings capable through EWR, without consideration of any non-engineering constraints, and include all possible efficient measures, disregarding economic feasibility and market acceptance. Technical potential will also consider how any anticipated future codes and standards will affect the baseline.

The DSMSim™ model accounts for three replacement types, where technical potential from retrofit and replace-on-burnout measures are calculated differently from technical potential for new construction measures. The formulae used to calculate technical potential by replacement type are discussed in the two subsections below.

Retrofit (RET) and Replace-On-Burnout (ROB) Measures

Retrofit (RET) measures, commonly referred to as advancement or early-retirement measures, are replacements of existing equipment before the equipment fails. RET measures can also be efficient processes that are not currently in place and that are not required for operational purposes. RET measures incur the full cost of implementation rather than incremental costs to some other baseline technology or process because the customer could choose not to replace the measure and would, therefore, incur no costs. In contrast, replace-on-burnout measures (ROB), sometimes referred to as lost-opportunity measures, are replacements of existing equipment that have failed and must be replaced, or existing processes that must be renewed. Because the failure of the existing measure requires a capital investment by the customer, the cost of implementing ROB measures is always incremental to the cost of a baseline (and less efficient) measure.

RET and ROB measures have a different meaning for technical potential compared with NEW measures. In any given year, the entire building stock is used for the calculation of technical potential. This method does not limit the calculated technical potential to any pre-assumed rate of adoption of retrofit measures. Existing building stock is reduced each year by the quantity of demolished building stock in that year and does not include new building stock that is added throughout the simulation. In cases where data is not available, Guidehouse will use similar data that we have already gathered from comparable studies.

For RET and ROB measures, annual potential is equal to total potential, thus offering an instantaneous view of technical potential. The equation used to calculate technical potential for retrofit measures is provided below.

$$\textit{Annual/Total Savings Potential} = \textit{Existing Building Stock}_{YEAR}\ \textit{(e.g., buildings[8])}$$
$$* \textit{Measure Density (e.g., widgets/building)}$$

$$* Savings_{YEAR} (e.g., sq.ft.^3/widget)$$

$$* Technical Suitability (dimensionless)$$

New Construction (NEW) Measures

Similar to replace-on-burnout measures, the cost of implementing new measures is incremental to the cost of a baseline (and less efficient) measure. However, new construction technical potential is driven by equipment installations in new building stock rather than by equipment in existing building stock. New building stock is added to keep up with forecasted growth in total building stock and to replace existing stock that is demolished each year. Demolished (sometimes called replacement) stock is calculated as a percentage of existing stock in each year and can be specified to market conditions. New building stock (the sum of growth in building stock and replacement of demolished stock) determines the incremental annual addition to technical potential, which is then added to totals from previous years to calculate the total potential in any given year.

The equations used to calculate technical potential for new construction measures are provided below.

$$\textbf{Annual Incremental Technical Potential (AITP):} AITP_{YEAR} = New\ Buildings_{YEAR}\ (e.g., buildings/year^{10})$$

$$X\ Measure\ Density\ (e.g., widgets/building)$$

$$X\ Savings_{YEAR}\ (e.g., sq.ft./widget)$$

$$X\ Technical\ Suitability\ (dimensionless)$$

Key aspects of the technical potential approach include:

- **Codes and Standards:** Technical potential will consider how any anticipated future codes and standards will affect the baseline.
- **Replacement Types:** The model accounts for three replacement types, where technical potential from retrofit and replace-on-burnout measures are calculated differently from technical potential for new construction measures, using the formulae presented above.
- **Competition Groups:** Guidehouse's modeling approach recognizes that some efficient technologies will compete against each other in the calculation of potential. The analysis only selects one measure per competition group to include in the summation of technical potential across measures (i.e., at the end use, customer segment, sector, service territory, or total level). The measure with the largest savings potential in a given competition group is used for calculating total technical potential of the competition group. This approach ensures that double counting is not present in the reported technical potential, though the technical potential for each individual measure is still calculated and reported.

Competition Groups

The study defines competition as efficient measures competing for the same installation as opposed to competing for the same savings (e.g., window A/C vs. split-system A/C) or for the same budget (e.g., lighting vs. water heating). For instance, a consumer may install a condensing water heater or a tankless water heater; both of which belong to the same competition group, as only one of these would be installed. General characteristics of competing technologies used to define the competition groups proposed for this study include:

- Competing efficient technologies share the same baseline technology characteristics, including baseline technology densities, costs, and consumption
- The total (baseline plus efficient) maximum densities of competing efficient technologies are the same
- Installation of competing technologies is mutually exclusive (i.e., installing one precludes installation of the others for that application)
- Competing technologies share the same replacement type (RET, ROB, or NEW)

To address the overlapping nature of measures within a competition group, Guidehouse's analysis only selects one measure per competition group to include in the summation of technical potential across measures (i.e., at the end use, customer segment, sector, service territory, or total level). The measure with the largest savings potential in a given competition group is used for calculating total technical potential of the competition group. This approach ensures that double counting is not present in the reported technical potential, though the technical potential for each individual measure is still calculated and reported.

1.4.1.2 Economic Potential

Economic potential is a subset of technical potential and uses the same assumptions regarding immediate replacement as in technical potential. However, this only includes those measures that have passed the benefit-cost (B/C) tests chosen for measure screening. A measure with a B/C ratio greater than or equal to 1.0 is a measure that provides monetary benefits greater than or equal to its costs. If a measure's B/C meets or exceeds the threshold, it is included in the economic potential.

DSMSim™ can calculate the five standard tests and use any of these tests for economic screening. It can also allow the economic potential threshold value to be adjusted (set at 1.0, or higher or lower). We will discuss with the MPSC how to define the B/C test and threshold (i.e., we recommend 1.0) to be used for economic screening. As part of our reporting on economic potential, we will provide details on any technologies in the segment/end use combinations that fail economic screen and perform robust quality assurance review to affirm that technical issues (e.g., negative incremental cost) are not forcing the measure to screen out. As with technical potential, Guidehouse recognizes codes and standards, replacement types, and competition groups in the development of economic potential.

Similar to technical potential, only one economic measure (meaning that its B/C ratio meets the threshold) from each competition group is included in the summation of economic potential across measures (e.g., at the end use, customer segment, sector, service territory or total level). If a competition group is composed of more than one measure that passes the Total Resource Cost (TRC) test, then the economic measure that provides the greatest savings potential is included in the summation of economic potential. This approach checks that double counting is not present in the reported economic potential, though economic potential for each individual measure is still calculated and reported.

Within DSMSim™, we will use MI-specific base avoided cost forecasts, and other financial (or societal cost of carbon) inputs to apply cost-benefit screens for all measures considered in the technical potential analysis.

The output of this task will be a base economic scenario, upon which we can perform sensitivity analysis (discussed below).

1.4.1.3 Achievable Potential

Achievable potential is a subset of economic potential, but further considers the likely rate of EWR acquisition, which is driven by a number of factors including the rate of equipment turnover (a function of measure's lifetime), simulated incentive levels, budget constraints, consumer willingness to adopt efficient technologies, and the likely rate at which marketing activities can facilitate technology adoption. This section provides a high-level summary of the approach to calculating achievable potential, which is fundamentally more complex than calculation of technical or economic potential.

The critical first step in the process of accurately estimating achievable potential is to simulate market adoption of EWR measures. Annual program participation is modeled through technology adoption and diffusion algorithms. The long-run equilibrium market share (i.e., how quickly a technology reaches final market saturation) is calculated by comparing a measure's payback period to a customer payback acceptance curve. Guidehouse's model employs an enhanced Bass Diffusion model to simulate the S-shaped growth toward equilibrium commonly seen for technology adoption. The Bass Diffusion model describes the process of the adoption of products as an interaction between users and potential users. In the model, achievable potential adopters "flow" to adopters by two primary mechanisms – adoption from external influences, such as marketing and advertising, and adoption from internal influences, such as word-of-mouth or peer-effects – with differences in stock turnover captured for replace-on-burnout measures relative to retrofit and new construction.

Guidehouse will use payback acceptance curves developed through primary research described in Section 1.3.5 to estimate equilibrium market share. Payback acceptance curves are developed by presenting decision makers with numerous choices between technologies with low upfront costs but high annual energy costs, and measures with higher upfront costs but lower annual energy costs. These curves represent the percentage of customers from different sectors willing to purchase a technology based on its payback time.

Since the payback time of a technology can change over time; as technology costs and/or energy costs change over time, the equilibrium market share can also change over time. The equilibrium market share is, therefore, recalculated for every time-step within the market simulation to make certain the dynamics of technology adoption considers this effect. As such, the term "equilibrium market share" is a bit of an oversimplification and a misnomer, as it can itself change over time and is, therefore, never truly in equilibrium; it is used nonetheless to facilitate understanding of the approach.

Another critical step in the process is the model calibration. We will calibrate the model's marketing effectiveness and word-of-mouth parameters at the sector and region (Upper Peninsula, Lower Peninsula) using data provided by MI utilities on historical program participation and program.

Calibration of a predictive model imposes unique challenges, as future data is not available to compare against model predictions. While engineering models, for example, can often be calibrated to a high degree of accuracy since simulated performance can be compared directly with performance of actual hardware, predictive models do not have this luxury. Demand-side management models, therefore, must rely on other techniques to provide both the developer and the recipient of model results with a level of comfort that simulated results are reasonable. We will take a number of steps to make sure that the initial, base year results used (such as 2019 or 2020) for the forecast model are reasonable and consider historic adoption, including:

- Comparing forecast values, by sector and end use, against historic achieved savings (e.g., from program savings for at least 2019). Although some studies indicate that demand-side management

potential models are calibrated to check first-year simulated savings precisely equal to prior-year reported savings, we have found that forcing such precise agreement has the potential to introduce errors into the modeling process by effectively masking the explanation for differences—particularly when the measures included may vary significantly. Additionally, there may be sound reasons for first-year simulated savings to differ from prior-year reported savings (e.g., savings estimates have changed). Thus, while we will endeavor to achieve agreement to a degree that is reasonable between past results and forecast first-year results, our approach does not force the model to do so.

- Identifying and ensuring an explanation existed for significant discrepancies between forecast savings and prior-year savings, recognizing that some ramp-up is expected, especially for new measures or archetype programs.
- Calculating $/first-year kWh costs by sector and comparing these with past results.
- Calculating the split (percentage) in spending between incentives and variable administrative costs predicted by the model to historic values.
- Calculating total program spending by sector and end use and comparing the resulting values to historical program spending.
- Calculating portfolio-level $/first-year kWh costs and comparing these with values Guidehouse researched through benchmarking of other jurisdictions.
- Cross checking that forecasted savings growth rates are reasonable given the average local economic conditions of the service territory.

The achievable potential analysis results will reflect the portfolio of passing measures under the desired B/C test. For the passing measures, we will determine the reasonably achievable peak demand (kW), annual electric consumption savings (kWh), and annual gas consumption savings (Dekatherm – Dth) for 2021 to 2040. Each achievable potential set of results shall, at a minimum, consider the market availability of each measure, customer awareness, the anticipated adoption rate at the specified incentive level, and any relevant market barriers.

For each scenario(s), DSMSim™ will generate detailed outputs from 2021 to 2040, including:

- Impact from utility programs as the achievable:
    - Peak demand (kW)
    - Annual electric consumption savings (kWh)
    - Annual gas consumption savings (Dth)
    - Avoided carbon emissions (tons)
    - Adoption rate each year (percent of customers)
- Resulting saturation levels of EWR options, as represented by three critical saturation metrics: the saturation of EWR relative to the baseline measures, other efficient measures in the competition group, and technical potential.
- Naturally occurring influence outside of MI utility programs
- Expected amount of remaining potential (technical, economic, achievable)

1.4.1.4 Sensitivity and Scenario Analysis

Sensitivity analysis means gauging a model output's response to a change in the input. Guidehouse's DSMSim™ model can calculate the sensitivity of key model outputs to many relevant inputs using parametric or custom (user defined) input ranges.

Guidehouse will work with the MPSC, MI utilities, and stakeholders to determine sensitivities for outputs of choice – any output available in DSMSim™ is capable of sensitivity analysis. For example, sensitivity tests can examine both savings and incremental costs, the split between savings and costs attributable to electric and natural gas, avoided costs, societal cost of carbon, retail rates, etc. We can perform sensitivity analysis on any input variable, and Guidehouse can be flexible to other needs and would work with the MPSC to determine the desired inputs and outputs.

We will present initial options for the sensitivity analyses and begin defining the scenarios during a meeting about technical and economic potential methodology. The final output will be a set of sensitivity scenarios as follows:

- **Avoided Costs:** Guidehouse will generate one to two scenarios for electric and natural gas avoided costs
- **Other Key Input Assumptions:** Guidehouse will perform sensitivity tests on up to seven economic or achievable assumptions for the Upper Peninsula and Lower Peninsula (for a total of 14 scenarios)

Guidehouse will also work with the MPSC, utilities and stakeholders to define three scenarios per territory for the achievable potential, for example:

- Standardized program rebate at 75% of incremental cost
- Maximum achievable scenario, with an assumption that programs will remove all barriers or optimize for all factors under its control (e.g., incentive approach, budget caps, marketing levels, etc.)
- Another scenario to be determined based on the results of the sensitivity tests

1.4.1.5 DSMSim™ Results Viewer

Guidehouse will provide the MPSC with the DSMSim™ Results Viewer generated by this study, including detailed outputs beyond what will be included in the report. This Excel-based tool can be used to sort, filter, and analyze study results across a variety aggregation levels and metrics. The standardized Results Viewer may be customized to add result views upon request. Guidehouse will provide the MPSC with a summary of standard Results Viewer outputs so that any additional requests may be identified before analysis completion.

1.4.2 Demand Response

Guidehouse has a well-established model that will serve as a starting point. DR potential is modeled using DRSim™ under the same platform as the EWR potential model. DRSim™ simulates the roll-out of DR technologies, their costs, and their interactions given user-defined deployment trajectories. The model is based on the Analytica platform and Guidehouse has used this for several prior DR potential studies. The model inputs and outputs will be presented in excel workbooks with comprehensive documentation for review and feedback by the MPSC and other stakeholders. The key DRSim™ inputs are:

- Baseline customer counts and peak demand projections by sector, customer class, segment/building type and end use (developed using the approach described previously in Step 1b)
- End-use equipment saturation to determine eligibility
- Per customer/equipment load reduction (unit impacts) by customer class and end use in DR programs (either as “kW reduction” or “% of end-use load”)
- Participation assumptions by customer class and end use in DR programs (represented as “% of eligible customers”), with program start year and ramp assumptions
- Event opt-out rates and customer attrition assumptions
- AMI deployment schedule
- Itemized programmatic and DR-enabling technology cost assumptions
- Avoided costs
- Program life
- Global parameters: discount rates, line losses, inflation rate

The key DRSim™ outputs are:

1. DR program potential estimates by customer class, segment, and end use/DR-enabling technology combinations
2. Amount of enrolled load/number of participants in DR programs
3. Annual itemized DR program costs
4. Levelized DR program costs and supply curves
5. DR program cost-effectiveness results with Net Present Value of benefits and costs and B/C ratio calculations by different cost tests
6. Potential results by scenarios with sensitivity analysis

Guidehouse will provide all model inputs and outputs in excel workbooks for review by the MPSC. The excel-based results dashboard will present different view of the results through a series of customized charts and tables.

The two levels of potential calculation for DR options are technical potential and achievable potential. Unlike EWR, which assesses economic potential at the level of individual measures, cost-effectiveness assessment for DR is meaningful at the program portfolio level (considering participation overlaps and program hierarchy) under achievable participation assumptions. DR options/programs that are not cost-effective at that stage are screened out. The potential calculations are further elaborated below.

Technical potential refers to the theoretical maximum potential that could be realized assuming 100% participation of eligible customers/load in DR options. Guidehouse calculates technical potential by multiplying the eligible load/customers by the unit impact for each DR option. An important caveat is that, by definition, technical potential calculation does not consider participation overlaps and program hierarchy. Accordingly, technical potential across the various DR options are not additive and should not be summed to obtain a “total” technical potential. The technical potential estimates for each DR option/program should be considered independently. The technical potential calculation is summarized through the following equation:

DR Technical Potential

$$Technical\ Potential_{DR}\ Option,End\ Use,Year$$

$$= 100\% * Eligible\ Load DR\ Option,Segment,End\ Use,Year$$

$$* Unit\ Impact DR\ Option,Segment,Year$$

Achievable potential is calculated by multiplying achievable participation assumptions (subject to program hierarchy and participation overlaps) by the technical potential estimates. Achievable potential also accounts for additional factors such as DR event opt-out rates. The achievable technical potential calculation is summarized through the following equation:

DR Achievable Potential

$$Achievable\ Potential$$

$$= Technical\ Potential DR\ Option,Segment,End\ Use,Year$$

$$* Achievable\ Participation\ Rate DR\ Option,Segment,Year$$

$$* (1 - Event\ Opt\ Out\ Rate) DR\ Option,Year$$

As mentioned previously, the economic screening of DR programs considers a portfolio of DR options with itemized program costs and benefits. DR options that pass the cost-effectiveness test under achievable participation assumptions are deemed economic and included in the DR program portfolio for further consideration. Achievable potential is estimated under different scenarios with variations in key model input parameters listed below under Step 5.

Our model develops different scenarios of achievable potential projections under varying input assumptions. Examples of key input variations are:

1. Different customer adoption scenarios of DR-enabling technologies such as smart thermostats (which can be tied with EWR-DR integration)
2. Different AMI deployment scenarios
3. Varying participation rate assumptions. For time-varying rates, these would be tied to AMI deployment scenarios.
4. Variations in program incentives and marketing costs influencing participation
5. Avoided cost scenarios

For gas DR, the potential and cost-effectiveness assessment will follow the same approach as for electric described above. Guidehouse will estimate the following levels of potential for gas DR:

- Technical standalone potential for all Gas DR options assuming 100 percent participation of eligible customers in DR options and without consideration of program hierarchy and participation overlaps.
- Achievable potential considering program hierarchy with participation overlaps and assuming achievable participation for the different program types. The cost-effectiveness of DR programs at this level helps determine which programs are economic and can be pursued.

1.4.3 EWR-DR Integration

Customer Adoption from an Integrated EWR-DR Perspective

An IDSM (integrated demand-side management) program offer bundles EWR and DR savings and incentives could be more attractive to the customer than independent EWR and DR offers.

For example, a customer's decision to purchase smart thermostats is not only influenced by energy savings attributable to EWR. The customer can choose to enroll the thermostat in a Bring Your Own Thermostat (BYOT) DR program and earn additional incentives from DR program participation, which in turn could enhance willingness to adopt smart thermostats. This could apply to other technologies with EWR and DR benefits (e.g., networked LEDs, smart water heaters, smart appliances, and energy management and control systems) where adoption of the technology would potentially provide both EWR and DR savings to the customer.

Guidehouse's market adoption framework with payback acceptance curves and Bass diffusion model in the proposed study is suited to capture EWR and DR benefits and costs to the customer for technologies that provide both EWR and DR benefits.

Table 70 illustrates the difference in customer costs and benefits from an EWR perspective only vis-à-vis combined EWR-DR perspective using smart thermostats as an example.

Table 7. Smart Thermostats Customer Costs and Benefits
(EWR-only Perspective vis-à-vis Integrated EWR-DR Perspective)

EWR-Only perspective	EWR-DR Integrated Perspective
Customer Costs • Smart thermostat purchase and installation costs	**Customer Costs** • Smart thermostat purchase and installation costs • Bill impacts, if any, due to higher energy use (from precooling and/or snapback after DR events) • DR program participation hassle cost
Customer Benefits • EWR rebate • Bill reduction due to energy savings from smart thermostat use • Non-energy benefits (comfort, convenience, better aesthetics)	**Customer Benefits** • EWR rebate • Bill reduction due to energy savings from smart thermostat use • Non-energy benefits (comfort, convenience, better aesthetics) • DR Program participation incentives (can include both upfront one-time enrollment incentive, plus ongoing incentives for program participation) • Bill impacts, if any, due to lower energy use during DR events

Source: Guidehouse 2020

In this example, the payback period to the customer for smart thermostat adoption from an EWR only standpoint will be different than from an integrated EWR-DR standpoint, leading to different levels of adoption in the two cases. Guidehouse will integrate the adoption forecasts of technologies with EWR and DR co-benefits in the DSMSim™ model (based on Bass diffusion and payback acceptance curves) with program eligibility and participation assumptions in the DRSim™ model to reflect the joint EWR-DR adoption perspective. This will help represent the achievable potential from market uptake of technologies with EWR and DR co-benefits under an IDSM program offer.

Cost-Effectiveness Assessment from an Integrated EWR-DR Perspective

Guidehouse proposes to approach cost-effectiveness of measures with joint EWR and DR benefits (co-benefits) from an integrated perspective. An IDSM program including such measures will have some shared

programmatic costs (e.g., one-time program set up costs, program administrative costs, marketing and outreach costs) while providing both EWR and DR savings. For example, an IDSM program with smart thermostats will incur common program costs while providing both EWR and DR benefits. This would enhance the cost-effectiveness of the technology, instead of assessing cost-effectiveness from an EWR-only or a DR-only standpoint.[17]

Guidehouse will work with the MPSC to develop IDSM program ideas and incorporate the EWR-DR integration elements discussed above in modeling impacts, customer adoption, and cost-effectiveness assessment.

1.5 Task 5: Draft Report

The project results will be detailed in two separate reports, one for DR and one for EWR. Both reports will include both electricity and natural gas potentials. Guidehouse will provide a draft of each report to the MPSC for review and comment in July 2021. Additionally, Guidehouse will facilitate a Technical Conference with stakeholders to present and receive feedback on the draft results. We understand the draft reports may result in questions and requests for further explanations from the MPSC and stakeholders, which could lead to rerunning the models. Table 8 provides an outline of our proposed draft reports with approximate expected page length for each section.

Table 8. Initial Draft Report Outline for both EWR and DR Reports

Report Outline (approximate number of pages)
Executive Summary (20 pages)
Introduction (5 pages)
Study Methodology (15 pages)
Technical Potential Results (5 pages)
Economic Potential Results (EWR only, 5 pages)
Achievable Potential Results (25 pages)
Program Design Guidance and Conclusions (5 pages)
Appendix • Achievable Potential Detailed Results (Excel Results Viewer) • Supporting documentation (as required with all requested documentation, including electronic files)

Source: Guidehouse

The Achievable Potential Results section of the Draft Report will include key results such as potential by customer segment and end use as well as top measures and sensitivities. The Achievable Potential Detailed Results appendix will be in the form of the DSMSim™ Excel-based Results Viewer including detailed outputs beyond what will be included in the report. This Excel-based tool can be used to sort, filter, and analyze study results across a variety aggregation levels and metrics. The standardized Results Viewer may be customized

[17] This will help represent the IDSM program offers that MI utilities have already considered. For example, Consumers Energy announced recently that it is going to provide smart thermostats to residential customers, in exchange for which customers agree to enroll in a smart thermostat DR program. The utility provides a rebate for smart thermostats and additional incentives for DR program enrollment and participation.

to add result views upon request. The Draft Report will also include program design guidance informed by the analysis of the quantitative results. This guidance will be aligned with MI utility's current program offerings and regulatory environment.

1.6 Task 6: Final Report

Guidehouse will submit both final reports to the MPSC by the end of August 2021 for review and approval, along with supporting documentation. The final reports will be updated, based on feedback received from MPSC staff on the draft reports. Additionally, feedback from the stakeholder Technical Conference will be included.

2. Stakeholder Collaboration

Guidehouse recognizes the results of a potential study such as this can have wide impacts on utility planning and demand-side program targets and implementation designs. As such, a successful study should include opportunities to share the processes and approach undertaken to develop the results. This section provides and overview of planned stakeholder engagement throughout the potential study. Three stakeholder meetings are planned, as illustrated in Table 9.

The MPSC will identify relevant stakeholders to include in meetings and / or electronic communication of project status. Guidehouse recommends including representatives of affected utilities in stakeholder outreach.

No in-person stakeholder meetings are planned at this time, due to ongoing COVID-19 health and safety guidelines. Meetings will use the Teams platform, and will include video and screen share presentations.

Table 9. Stakeholder Meeting Summary

Meeting	Topic	Timeframe
Initial Stakeholder Meeting	Project overview, stakeholder feedback of EWR Measure and DR Option lists	Week of November 30, 2021
Second Stakeholder Meeting	Project update, stakeholder feedback of Market Characterization results and customer survey questions	Late January 2021
Third Stakeholder Meeting (Technical Conference)	Review Draft Report results	Late July 2021

Source: Guidehouse

2.1 Initial Stakeholder Meeting

The initial stakeholder meeting will provide an overview of the potential study approach and provide a summary of project status. Additionally, the meeting will solicit stakeholder feedback on the EWR Measure and DR Option lists (planned for MPSC approval 11/20/2020).

Guidehouse will schedule the meeting and invite relevant stakeholders as identified by the MPSC. We recommend this meeting occur the first week of December (week of 11/30/2020), to offer stakeholders a timely opportunity to provide feedback on the approved EWR Measure and DR Option lists. Guidehouse will provide materials to stakeholders on 11/23/2020, including the approved EWR Measure and DR Option lists.

2.2 Second Stakeholder Meeting

The second stakeholder meeting will provide a general project update. The late January 2021 meeting will be scheduled to provide a presentation of, and solicit feedback to, the market characterization results, and an overview of the customer survey questions.

Guidehouse will schedule the meeting based on the Initial Stakeholder Meeting invitation, and any additional stakeholders identified by the MPSC. We recommend this meeting occur the third week of January (week of 1/18/2021), to offer stakeholders a timely opportunity to provide feedback on the approved measure characterization, survey instrument before programming is complete.

Guidehouse will schedule the meeting based on the Second Stakeholder Meeting invitation, and any additional stakeholders identified by the MPSC. Guidehouse will provide stakeholder materials the week of 1/11/2021, including a summary of market characterization and the approved customer survey.

2.3 Third Stakeholder Meeting (Technical Conference)

The final stakeholder meeting will be the Technical Conference, expected in late July 2021 and timed after the draft report has been submitted to the MPSC for review. The Technical Conference will include a presentation of the EWR and DR achievable potential study results, and provide stakeholders an opportunity to provide feedback and request clarifications on the analysis and results. Questions and clarifications from the Technical Conference will be addressed in the final report. The Technical Conference is tentatively scheduled for July 21, 2021.

2.4 MPSC Stakeholder Coordination

In addition to the three stakeholder meetings, Guidehouse understands the MPSC will also keep stakeholders updated on the study's progress through the following communications:

- **Data Request**: Identify single point of contact at each utility for Guidehouse data request, and request utility support to fulfill the data request.
- **Draft Customer Survey**: Distribute draft customer survey to stakeholders.
- **Draft Report**: Distribute draft report to stakeholders.

Guidehouse will consider stakeholder feedback when finalizing documents. When incorporating stakeholder edits or comments into the final report, Guidehouse will determine relevance based on alignment with project scope and goals, and professional judgment.

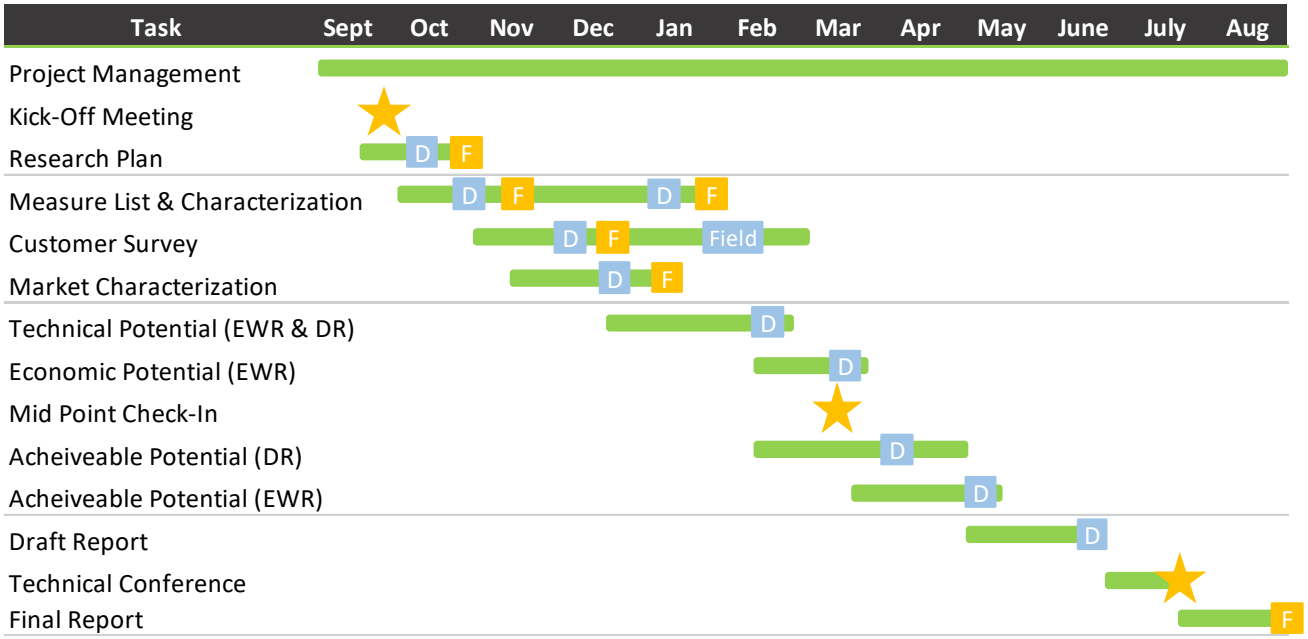
3. Project Management

This section details the overall project schedule, communications and project management expectations, and project milestones.

3.1 Project Schedule

A high-level project schedule is presented in Figure 1, summarizing the project schedule for completing each of the tasks, including key deliverables. We are committed to achieving the delivery dates required by the MPSC, assuming that the MPSC will be able to provide support, inputs, and document review as requested to achieve this schedule. The team selected for this engagement has the availability to do work over the period September 2020 through August 2021 and to meet the required schedule. Detailed project schedules including deliverable review times are presented in Figure 2 and Figure 3.

Figure 1. High-Level Project Schedule



Source: Guidehouse

Figure 2. October 2020 – March 2021 Detailed Project Schedule

Activity	Date		Oct				Nov				Dec				Jan				Feb				March			
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Bi Weekly Meetings	Ongoing																									
Monthly Summary	10th of each month																									
Draft Research Plan: MPSC Review	10/14/2020	10/27/2020																								
Update and Finalize Research Plan	10/28/2020	11/2/2020																								
Data Request and Collection	10/15/2020	12/9/2020																								
Draft EWR Measure List and DR Options: MPSC Review	11/2/2020	11/13/2020																								
Update and Finalize EWR Measure List and DR Options	11/16/2020	11/20/2020																								
Preliminary EWR Measure Characterization	11/2/2020	11/20/2020																								
EWR Measure Characterization (with ongoing review)	11/20/2020	3/5/2021																								
Market Characterization	11/16/2020	12/23/2020																								
Market Characterization Review: MPSC Review	12/23/2020	1/13/2021																								
Draft Survey and Survey Instrument	11/16/2020	2/8/2021																								
Survey: MPSC Review	12/21/2020	1/8/2021																								
Survey Instrument: MPSC Review	2/8/2021	2/12/2021																								
Survey Fielding	2/15/2021	3/5/2021																								
Survey Results	3/5/2021	3/26/2021																								
EWR and DR Technical Potential Modeling	1/21/2021	3/29/2021																								
Initial Stakeholder Meeting	11/30/2020	12/4/2020																								
Second Stakeholder Meeting	1/18/2021	1/22/2021																								
Mid-Point MPSC Project Check In	3/29/2021	3/31/2021																								

Source: Guidehouse

Figure 3. October 2020 – March 2021 Detailed Project Schedule

Activity	Date		April				May				June				July				August				September			
			1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Bi Weekly Meetings	Ongoing																									
Monthly Summary	10th of each month																									
EWR and DR Technical Potential: MPSC Review	4/5/2021	4/9/2021																								
EWR Economic Potential Modeling	3/29/2021	4/30/2021																								
EWR Economic Potential: MPSC Review	5/3/2021	5/7/2021																								
DR Achievable Potential Modeling	4/5/2021	4/26/2021																								
DR Achievable Potential: MPSC Review	4/27/2021	5/10/2021																								
EWR Achievable Potential Modeling	5/3/2021	6/18/2021																								
EWR Achievable Potential: MPSC Review	6/21/2021	6/25/2021																								
Draft Reporting	5/10/2021	7/9/2021																								
Stakeholder Technical Conference	7/21/2021	7/21/2021																								
Finalize Report	7/22/2021	8/18/2021																								
Final Report MPSC Review and Iteration	8/19/2021	8/31/2021																								

Source: Guidehouse

3.2 Communication

This section provides an overview of project communications protocols. Table 10 provides a summary of Guidehouse's approach to project management and communication for this project.

Table 10. Overview of Guidehouse Project Management Activities and Frequencies

Area	Activity	Frequency
Project Management and Communications 	• MPSC - Guidehouse status meetings. • Guidehouse will provide meeting agendas, facilitation, notes, and action items.	Biweekly, starting 10/21/2020
	• Monthly project status update. • Brief snapshot of previous month's achievements and next month's tasks, including an assessment of possible risks and remediation activities (if needed).	Monthly, by the 10th of the following month
	• Prepare detailed work plans for each significant task.	As needed, prior to start of each task
	• Prepare data collection instruments and sampling plans for MPSC review and feedback.	Prior to data collection activities
	• Maintain a running log of all documents and key correspondence either provided to or from the MPSC.	As needed
	• Present interim results and ad hoc memos throughout the project to provide timely feedback.	As needed
	• Conduct meetings to brainstorm, discuss issues, present methods or findings.	As needed
Budget Management 	• The Project Management Team will evaluate the balance of the projected budget with actual expenditures allocated to each task and communicate regularly with the MPSC.	Monthly
Work Product Quality 	• Senior Advisors will review survey and interview instruments for relevance to needed information, completeness, appropriate word choice, appropriate length.	Prior to submitting draft instruments for client review
	• The Project Management team and Senior Advisors will review all sample designs for representativeness, compliance with required confidence intervals, and reasonableness of assumptions.	As needed
	• The Project Management team and Senior Advisors will review data collection protocols and analysis plans and compare them to data collection tools to ensure all necessary data is being collected.	As needed
	• The Project Management Team and Senior Advisors will ensure clarity of writing and data presentation in all deliverables.	Prior to submittal of DRAFT and FINAL Reports
	• The Project Management Team, Senior Advisors, and editing resources will ensure formatting of the final work product is consistent and in-line with required style guides and templates.	Prior to submittal of DRAFT and FINAL Reports
	• The Project Management Team will submit draft deliverables for review and comment before issuing final deliverables.	According to Timeline
	• Task/Activity Leads, the Project Management Team and the Senior Advisors will review final work products for clarity, incorporate stakeholder feedback and maintain a record of communication and actions undertaken showing how the Guidehouse team has responded to that feedback.	Between DRAFT and FINAL Reports

Final Project Team Meeting 	• Conduct a final project meeting to include turning over MPSC owned intellectual property, surviving agreement provisions, final invoicing and preparing a schedule to close out the activities for this agreement.	Within several weeks of the approval of the final set of deliverables approved under this contract

Source: Guidehouse

3.3 MPSC Document Review and Feedback

Guidehouse will provide draft documents for MPSC staff review and feedback. Guidehouse expects to incorporate feedback to deliver final project documents that meet the MPSC's needs in alignment with the project goals and objectives. Guidehouse requests feedback from MPSC stakeholders be combined as much as possible, such that Guidehouse and the MPSC can collaborate to identify and rectify any potentially conflicting feedback.

3.4 Project Milestones

Project Milestones are summarized in Table 11.

Table 11. Project Milestones

	Milestone	Anticipated Date	Approximate Elapsed Months
1	• Kick Off Meeting, Kick Off Deck, Meeting Notes • Draft Work Plan	10/30/2020	2
2	• Final EWR Measure List • Draft EWR Measure Characterizations • Final DR Option List • Draft DR Option Characterizations • Draft EWR Market Characterization	1/29/2021	3
3	• Completed EWR & DR Surveys; Results Summary • Draft EWR Tech Potential Results • Draft DR Tech Potential Results	2/26/2021	1
4	• Draft EWR Economic Potential Results • Draft DR Economic Potential Results • Mid-Point Check In Presentation and Meeting Notes	3/31/2021	1
5	• Draft EWR Achievable Potential Results	5/31/2021	2
6	• Draft Report	6/30/2021	1
7	• Technical Conference Presentation and Meeting Notes • Final Report	8/31/2021	2
	Total		**12**

Source: Guidehouse

3.5 Deliverables and Assumptions

3.5.1 Deliverables Summary

Guidehouse's project approach is encapsulated by the individual project tasks and their resulting deliverables. Table 12 provides an overview of all project tasks, objectives, and deliverables.

In addition to task-specific deliverables, Guidehouse will provide project management deliverables relating to check-in meeting facilitation, regular project and budget updates, stakeholder collaboration, etc. Project Management deliverables will include:

- Check-in meeting agenda's, meeting facilitation, and meeting notes
- Monthly project status updates
- Ad hoc meetings and communications to provide updates and clarifications on ongoing tasks
- Stakeholder collaboration, as described in Section 1.7: Guidehouse will provide meeting agendas, presentations, facilitation and meeting notes from three stakeholder meetings.

Table 12. Project Tasks Summary

Task	Objective	Deliverables
Task 1 **Conduct Project Initiation Meeting**	To ensure the proposed scope of work meets the MPSC's expectations.	• Draft Project Initiation Meeting agenda provided five business days in advance for the MPSC's review and feedback • Conduct Project Initiation Meeting – review scope of work, project schedule and key milestone dates, discuss key issues, data requirements, project management and communications protocols, and next steps • Project Initiation Meeting notes
Task 2 **Develop Research Plan**	To develop the Research Plan providing a detailed description of all required activities.	• Draft Research Plan with key milestones and deliverables dates • Detailed data requests to the MPSC and utilities

Task 3
Conduct Research
	To implement the Research Plan, including developing EWR and DR measures	• Draft Measure and DR Options lists
		• Final Measure and DR Options lists
		  ○ Updated incorporating MPSC feedback 11/20/2020
		  ○ Updated incorporating Stakeholder feedback 12/11/2020
		• Draft Measure and DR Option characterizations
		• Final Measure and DR Option characterizations incorporating MPSC feedback
		• Draft customer survey guide
		• Final customer survey guide incorporating MPSC feedback
		• Draft survey instrument
		• Final survey instrument incorporating MPSC and stakeholder feedback
		• Summary of survey findings

Task 4
Develop and Run Models
	To conduct and support the models' savings analysis scenarios results.	• Market characterization summary
		• Draft EWR and DR Technical Potential results
		• Draft EWR Economic Potential results
		  ○ Incorporating MPSC EWR Technical Potential results feedback
		• Draft EWR and DR Achievable Potential results[18]
		  ○ Incorporating MPSC EWR Economic Potential results feedback
		  ○ Incorporating MPSC DR Technical Potential results feedback
		• Detailed presentation of the models before final results are completed

[18] Guidehouse has budgeted to provide up to three Achievable Potential scenarios

Task 5
Summarize Results in Draft Report
	To provide a draft report following the outline developed in Task 2.	• Draft Report for MPSC's review and feedback
		• Updated EWR and DR Achievable Potential results[19]
		  ○ Incorporating MPSC draft EWR Achievable Potential results feedback
		  ○ Incorporating MPSC draft DR Achievable Potential results feedback

Task 6
Produce Final Report
	To provide a final report addressing MPSC and stakeholder feedback.	• Final Report
		  ○ Incorporating MPSC and stakeholder Technical Conference feedback
		  ○ For MPSC review and approval, by August 18, 2021
		• Copies of all work papers, survey forms, and electronic spreadsheets used to conduct the study in an electronic format with formulas and calculations intact

Source: Guidehouse

[19] Guidehouse has budgeted to provide up to three Achievable Potential scenarios

3.5.2 Assumptions and Clarifications

Guidehouse has made several key assumptions underlying the scope of work for the final report to be completed by August 30, 2021. We are assuming that:

- The MPSC will appoint one part-time project point of contact to work with Guidehouse to facilitate and schedule access to internal and external stakeholders, obtain access to pertinent data and documents that are needed for the analysis and executing this assignment.
- Relevant MPSC staff, subcontractors, and project stakeholders will be available to provide input and guidance, answer questions, and provide timely access to required data and information for the analysis to proceed on schedule.
- The MPSC will review and comment on the draft deliverables, final deliverable, and final presentation documents in a timely manner (within 10 business days of submission) so that the project schedule can be maintained.
- We will analyze up to 100 EWR measures, focusing on those measures estimated to achieve 90% or more of the incremental achievable savings.

  For DR, we will consider all DR options offered in utility programs in MI and in other states. In addition, we will add emerging new measures such as managed charging of EVs, BTM battery and thermal storage for dispatch during DR events, and other emerging DR-enabling technologies.
- Guidehouse will submit a written project status update on a monthly basis; adjustments in frequency may be jointly agreed upon.
- Guidehouse will prepare draft and final reports for this project. The final report will incorporate draft report comments received from the MPSC. The MPSC will coordinate comments from reviewers so that one document contains all comments. If additional report drafts are desired by the MPSC, the exact scope and budget for these additional drafts will be agreed upon by Guidehouse and the MPSC.
- On-site meetings are not included in the project.

Appendix A: Preliminary Measure List

Guidehouse will provide a draft EWR Measure and DR Option List on November 2, 2020. The MPSC will review the draft lists and provide feedback by November 13, 2020. Guidehouse will incorporate MPSC's comments to finalize the list by November 20, 2020. The final EWR Measure and DR Option Lists will be provided to external stakeholders the week of November 23, in advance of an initial stakeholder meeting the week of November 30, 2020.

The draft EWR Measure and DR Option Lists will be in Excel format and contain the following fields:

- Measure name
- Market segment (Residential, Commercial, Industrial)
- Fuel type (Electricity, Natural Gas)
- Replacement type (Replace on Burnout, New Construction, Retrofit)
- Preliminary Baseline (as available at the early draft stage)

Appendix B: Data Request

Data Request Details

Please see *Appendix B Tab* in accompanying "MI EWR and DR Potential Study Data Request_2020 10 14.xlsx" Excel workbook.

Data Request Overview

Guidehouse will facilitate data requests directly with MI utilities[20] to obtain the following data necessary to populate baseline conditions and calibrate adoption rates in EWR potential models; details are provided in Appendix B Excel workbook.

The MPSC will provide contact information for each utility for Guidehouse to request:

- **Customer information**: this information includes number of customers, sales, and peak demands by market segment, delivery pathway, or sector (residential, commercial and industrial), recent customer survey results, available load research information, summaries of energy audit results, customer contact information and other related customer information.
- **Electric and gas forecast information**: results, information, data, and forecast model structures for each of MI utility's most recent electric and gas forecasts, by sector, pathway, and segment, as available.
- **EWR and DR Program tracking data, Annual Reports and Evaluation Studies**: Program and measure savings, costs, load shapes, and measure lives, including data contained in MI utility's residential and non-residential program tracking databases, annual reports, and evaluation studies, including not yet published draft reports, and published studies.
- **Avoided costs of electricity and natural gas** by subcategory, as appropriate (e.g., annual energy, energy by costing period, peak demand, etc.).
- **Discount rates and other economic parameters**: MI's weighted average cost of capital, electricity and gas rates, and other information needed to support cost-effectiveness analysis, customer payback and decision-making, non-energy impacts, etc. This will be consistent with what is used by MI in its EWR benefit-cost models.
- **Supporting Studies (as appropriate):** The MI Energy Measures Database (MEMD) will be the primary source for measure information, supplemented by the following studies:
    - Any available data from ongoing 2020 MI Housing Baseline Study, conducted by Cadmus
    - 2016 Commercial & Industrial Baseline Study, conducted for DTE Energy by Guidehouse

[20] The MPSC will provide the specific utilities to include in the study.

- 2016 Residential Baseline Study, conducted for DTE Energy by Guidehouse
- 2014 Consumers Energy Residential Appliance Saturation and Home Characteristics Study, conducted by Cadmus
- 2016 Non-Residential Energy Efficiency Baseline Study, conducted for Consumers Energy by EMI Consulting, Inc.
- 2011 MI Residential Baseline Study, conducted by the MPSC
- 2015 Residential Energy Consumption Survey (RECS), conducted by EIA
- 2014 Manufacturing Energy Consumption Survey (MECS), conducted by EIA
- 2012 Commercial Building Energy Consumption Survey (CBECS), conducted by EIA
- 2017 American Housing Survey, conducted by the U.S. Census Bureau
- If available, any potential study data currently being analyzed by MI utilities

Data Request Communication

Guidehouse will request utility specific data directly from the utilities identified by the MPSC. Guidehouse expects to make an initial email request to each utility, followed up by subsequent correspondence to individual utilities as needed in response to questions and clarifications.

Proposed initial utility email data request language:

To: Utility contacts identified by the MPSC

From: Guidehouse Project Manager (Neil Curtis)

CC: MPSC Project Manager (Lynn Beck)

Subject: MI Potential Study Utility Data Request

Greetings,

Guidehouse (formerly Navigant) is conducting a study of Michigan's technical, economic, and achievable energy waste reduction (EWR) and demand response (DR) potential. The study is being conducted for the Michigan Public Service Commission (MPSC). The study period is 2021-2040.

This is a request for utilities identified by the MPSC to provide supporting data for the study. The attached spreadsheet details the specific data requested from each utility (MI EWR and DR Potential Study Data Request_2020 10 14.xlsx).

Please provide the requested data within two weeks (by X/XX/XXX) to Guidehouse's secure FTP site, here: http://share.navigant.com, addressed to neil.curtis@guidehouse.com. FTP site instructions are attached (Guidehouse FTP instructions.docx).

Please include utility name in the subject line for all correspondence.

Next Steps: Project research is underway. Guidehouse expects to collaborate with the MPSC to provide several opportunities for stakeholder feedback and project updates during the project. The opportunities will include both virtual meetings, document review, and a July 2021 Technical Conference to present draft results. The project is expected to be completed by August 30, 2021.

Please don't hesitate to reach out to me with any questions about the data request.

Thank you for your consideration.

Appendix C: Acronyms List

A/C	Air Conditioner
AITP	Annual Incremental Technical Potential
AMI	Automated Metering Infrastructure
B/C	Benefit / Cost
BTM	Behind the Meter
BYOT	Bring Your Own Thermostat
CASPM	California Standard Practice Manual
C&I	Commercial and Industrial
CBECS	Commercial Building Energy Consumption Survey
COVID-19	Coronavirus Disease 2019
CPUC	California Public Service Commission
DER	Distributed Energy Resources
DLC	Direct Load Control
DOE	Department of Energy
DR	Demand Response
DSM	Demand-side Management
Dth	Dekatherm
EE	Energy Efficiency
e.g.	For Example
EI	Energy Information
EIA	Energy Information Administration
EMS	Energy Management System
ETC	Etcetera
EV	Electric Vehicle
EWR	Energy Waste Reduction
FTE	Full-time Equivalent
HVAC	Heating, Ventilation, and Air-conditioning
IDSM	Integrated Demand-side Management
i.e.	In Other Words
ISO	Independent System Operator
IT	Information Technology
kW	Kilowatt
kWh	Kilowatt-hour
LARA	Licensing and Regulatory Affairs
LED	Light-emitting Diode
MECS	Manufacturing Energy Consumption Survey
MEMD	Michigan Energy Measures Database
MI	Michigan
MPSC	Michigan Public Service Commission
NC	New Construction
NSPM	National Standard Practice Manual

NTG	Net-to-Gross
NTGR	Net-to-Gross Ratio
OLED	Organic Light-emitting Diode
PHEV	Plug-in Hybrid Electric Vehicle
PLMA	Peak Load Management Alliance
QLED	Quantum Light-emitting Diode
RECS	Residential Energy Consumption Survey
RET	Retrofit
RTO	Regional Transmission Operator
ROB	Replace on Burnout
R&D	Research and Development
SIC	Standard Industrial Classification
SMB	Small, Medium Business
SoCalGas	Southern California Gas
sq. ft.	Square Feet
TOU	Time of Use
TRC	Total Resource Cost
TRM	Technical Reference Manual
U.S.	United States
YR	Year
°F	Degrees Fahrenheit