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prepared for

INDIANA MICHIGAN POWER COMPANY

INDIANA MICHIGAN POWER
An AEP Company

2021 POTENTIAL STUDY

EXECUTIVE SUMMARY

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prepared by
GDS ASSOCIATES INC
BRIGHTLINE GROUP

1 EXECUTIVE SUMMARY

1.1 BACKGROUND & STUDY SCOPE

As part of their larger 2021 Integrated Resource Plan (IRP), Indiana-Michigan Power ("I&M") commissioned GDS Associates ("GDS") and Brightline Group, collectively "the GDS Team", to assess energy savings potential in both the Indiana and Michigan jurisdictions of the I&M service area to help inform future planning efforts. Separate estimates of electric energy efficiency, demand response, and distributed energy resource (DER) potential were developed.

In addition, I&M also requested that GDS conduct limited primary market research to help inform key inputs in the market potential analysis. The final research plan focused on 1) collecting updated equipment penetration, saturation, and efficiency characteristics, 2) site conditions related to distributed energy resources, and 3) customer willingness to participate (WTP) in program offerings across select end-uses/measures.

This report focuses on the presentation of the overall combined potential savings for the entire I&M service area across both Indiana and Michigan. Separate reports present the findings for the I&M Indiana and I&M Michigan service areas.

1.2 MARKET RESEARCH

The initial step in the assessment of future potential is to develop a clear understanding of the current market segments, as well as a clear understanding of the market research data available in the I&M service area. In late 2020 I&M requested the GDS team to conduct market research that would inform critical elements of the market potential study. The research objectives were developed in coordination with I&M and the potential study team. Primary market research activities were focused on collecting updated equipment penetration, saturation, and efficiency characteristics; and customer willingness to participate (WTP) in program offerings across select end-uses/measures.

The resulting data was used to develop updated estimates of baseline and efficient equipment saturation estimates in the market potential study and develop expected long-term adoption rates for energy efficiency, demand response, and DERs over the study horizon. The GDS Team conducted surveys of business and residential customers during January and February of 2021 with the objectives of gathering primary data on the following topics:

- Willingness to participate in a variety of energy efficiency, demand response and distributed energy resource (DER) program scenarios
- Baseline / Saturation of energy-using equipment
- Program awareness
- Barriers

Survey results served as inputs for the market potential model, enabling the market potential analysis to take into consideration the specific market conditions that exist in I&M's service territory. Figure 1-1 presents a summary of the specific technologies and Demand Side Management (DSM) topic areas addressed within the business and residential surveys.

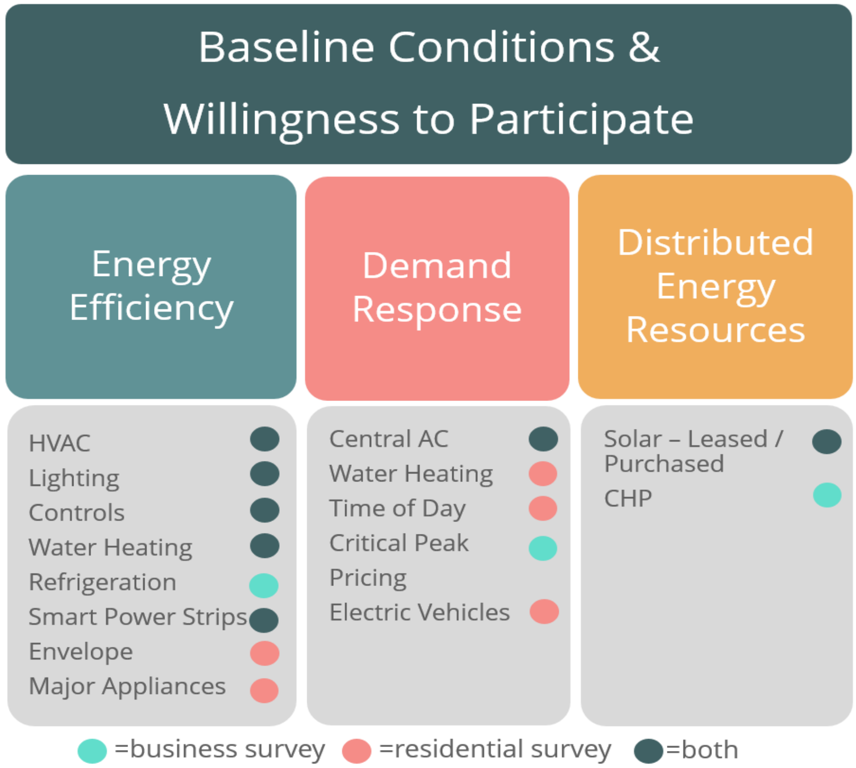


FIGURE 1-1 SURVEY SCOPE

Data collection results across the entire I&M service area are provided below.

1.2.1 Primary Data Collection

The following subsections provide an overview of the primary data collection activities conducted by the GDS team to support the market potential analysis of energy efficiency, demand response, and DER potential. The GDS team conducted survey research in the residential and nonresidential sectors.

1.2.1.1 Survey Administration

Surveys were administered in an online format, with email recruitment followed by two reminder emails sent at approximately one-week increments. VuPoint Research administered the business and residential online surveys and conducted telephone follow up to businesses who had initiated but not completed the survey after the initial email recruitment period. BrightLine Group administered the online multifamily property owner and manager survey and conducted both email and telephone follow up recruitment.

Respondents who completed the survey were entered into a drawing to win an electronic gift card. $100 gift cards were awarded to ten randomly selected business survey respondents and five randomly selected residential survey respondents. All four multifamily property owner / manager respondents received a $100 gift card.

1.2.1.2 Sampling Approach

The team developed a sampling approach with an objective of achieving industry-standard statistical significance (90% confidence, 10% relative precision, or 90/10) at the strata level for all questions, taking into consideration there would be variation in the WTP modules included in each survey to keep survey length manageable for respondents. The sample design assumed a coefficient of variation (CV) of 0.5 for the residential sample, and 0.7 for the business sample, assuming there would likely be greater variation among business responses.

Overall, the response outcomes were positive, and the survey effort produced a robust set of primary data. The team set aggressive sampling targets, with a goal of having high levels of statistical significance for detailed sub-groups within the population. The response fell short on some of those targets, but the team gathered a strong data set that meets the needs of the analysis. Table 1-1 sampling targets and response outcomes.

The business survey achieved 90/10 at the strata level for the baseline questions, and at the state level for other questions (i.e., 189 business respondents started the survey and completed the baseline questions but did not complete the survey in its entirety).[1] The residential survey achieved 90/10 for all strata except multifamily (see Table 1-2).[2]

TABLE 1-1 SURVEY SAMPLING TARGETS AND RESPONSE SUMMARY

State	Target Completes	Completes (Entire Survey)	Completes (Baseline Questions)
Nonresidential Customer Survey *Stratification: state, small /large*			
Indiana	**530**	**375**	504
Michigan	522	158	218
Total	**1,052**	533	722
Residential Customer Survey *Stratification: state, single / multifamily, and income-qualified / market rate*			
Indiana	**544**	820	1,085
Michigan	544	829	1,114
Total	1,088	1,649	2,199

1.2.1.3 Residential Online Survey

The residential customer research targeted homeowners and tenants in the following key segments: income-eligible and market-rate customers, and customers occupying single family and multifamily homes. Income-eligible was defined by household size as 200% of the federal poverty threshold.

A residential online customer survey collected home characteristics, equipment penetration for key end-uses – such as heating, cooling, water heating, insulation, smart power strips, thermostats, major appliances, solar PV systems, pool pumps, and electric vehicles – and information on barriers and willingness to adopt a range of energy efficient measures at varying incentive levels. Table 1-2 provides the targeted and completed residential online surveys in both the Indiana and Michigan territories.

TABLE 1-2 TARGETED AND COMPLETED RESIDENTIAL SECTOR ONLINE SURVEYS

Strata	State	Target Sample Size	Total Completed
Single Family – Market Rate	**Indiana**	**136**	**289**
Multifamily – Market Rate	**Indiana**	**136**	**6**
Single Family - IQ	**Indiana**	**136**	**441**

[1] The response to business baseline questions would meet 90/10 for IN assuming a CV of 0.7, and for MI assuming a CV of 0.6.
[2] The residential survey achieved 90/10 at the strata level for Indiana multifamily – income qualified, but not for other multifamily strata.

Strata	State	Target Sample Size	Total Completed
Multifamily - IQ	Indiana	136	84
Single Family – Market Rate	Michigan	136	515
Multifamily – Market Rate	Michigan	136	10
Single Family - IQ	Michigan	136	270
Multifamily - IQ	Michigan	136	34

1.2.1.4 Business Sector Online Survey

Primary data collection was also conducted in the nonresidential sector via an online survey with business customers. The survey collected business and facility characteristics, as well as equipment penetrations for key end-uses, such as lighting, heating, cooling, water heating, refrigeration, thermostats, and on-site generation (including solar PV systems). The nonresidential online survey also collected information on barriers to energy efficiency and willingness-to-adopt energy efficient measures under various incentive offerings. In total, GDS collected survey data from 722 commercial customers, with 504 in the I&M Indiana service area and 218 from the I&M Michigan service area. GDS examined the annual energy consumption data from the survey participants and developed a weighting adjustment based on the sample's consumption by building type relative to the I&M population in both the Indiana and Michigan service area.

The state-specific reports provide additional detail on the residential and business market research data as well as the adoption curve data for both sectors.

1.3 BASELINE FORECAST

The load forecast is a critical input into I&M's 2021 DSM Market Potential Study, having various uses in estimation of residential and business sector potential. Therefore, the GDS team carefully reviewed I&M's most recently completed load forecast models and documentation to produce the various forecast components necessary as inputs into this analysis. The chapter describes the various ways in which the forecast is used for this study, presents the baseline and disaggregated forecasts, and describes the methodology and data sources used by GDS for the purposes of generating the load forecasts that were used in the potential analysis.

1.3.1 I&M Load Forecasting System

I&M employs a sophisticated load forecasting system that uses econometric and Statistically Adjusted End-Use ("SAE") models to project number of consumers, average consumption per consumer, and total energy sales by class. Residential, Commercial, and Industrial consumers are projected using traditional econometric techniques. Residential average usage and commercial energy sales are projected using SAE model specifications. Industrial energy sales are projected using econometric techniques.

A residential SAE model specification takes end-use data drawn from utility, regional, and even national sources and develops monthly end-use indices designed to predict average household consumption. The end-use data includes market share of key electric consuming appliances, average device efficiency trends, average building shell efficiency trends, price elasticity of demand, income elasticity of demand, and elasticity associated with the average number of people per household. A cooling index is developed to represent space cooling load and is further modified by Cooling Degree Days to incorporate summer weather into the model. Likewise, a heating index representing space heating is modified by Heating Degree Days. Finally, a base index is developed to represent consumption of all other end-uses in the home.

A commercial SAE model specification is very similar to a residential specification, with end-use energy intensity indices developed based on area employment in various industry codes. National and regional commercial data is used to estimate end-use consumption for various industries (for example, restaurants will have higher cooking usage shares than offices).

I&M also projects the impacts of DSM programs it has run in the past. The DSM impacts included in the load forecast are inputs derived from the previous IRP study conducted by I&M in 2018 and 2019.

1.3.2 Adjustments to the I&M Load Forecast

Before assessing the future potential for energy efficiency, demand response, or distributed energy resources in the I&M service area, a few modifications to the 2020-vintage I&M forecast were necessary to create an adjusted baseline forecast. These modifications are addressed in more detail below.

1.3.2.1 Code Frozen Efficiency Adjustments

The base case forecast I&M developed uses the appliance efficiency forecast published in the Energy Information Administration's (EIA) Annual Energy Outlook (AEO) as inputs for the various end-use indices contained within the SAE models. While this is the best practice for developing a base case forecast, to determine potential impacts of DSM/EE programs it is helpful to understand how energy sales would be impacted if appliance efficiencies were held constant at the prevailing U.S. code level. If the base case efficiency level is below code in a given year, the base case forecasted energy sales will be adjusted downward in said year, and if the base case efficiency level is above code in a given year, forecasted energy sales will be adjusted upward. The process for the code frozen efficiency adjustments follows, using residential cooling load as an example.

The forecasted number of consumers is multiplied by the cooling end-use market share saturation to determine the number of cooling end-use appliances in the service territory, as well as the year over year change in the number of appliances. The change in the number of appliances from year to year is then multiplied by the prevailing U.S code efficiency level in that year, while the number of existing appliances is multiplied by the base year efficiency level. The result is a weighted average of existing and new stock appliances and their efficiencies, creating the code frozen efficiency level for the I&M service territory. Next, the percent difference between the base case efficiency level and the code frozen efficiency level is multiplied by the base case energy consumption for cooling load, resulting in the adjustment that should be applied to the base case forecast for cooling load. The results of the code frozen efficiency adjustments can be seen below in Figure 1-2 and Figure 1-3 for Indiana and Figure 1-4 and Figure 1-5 for Michigan.

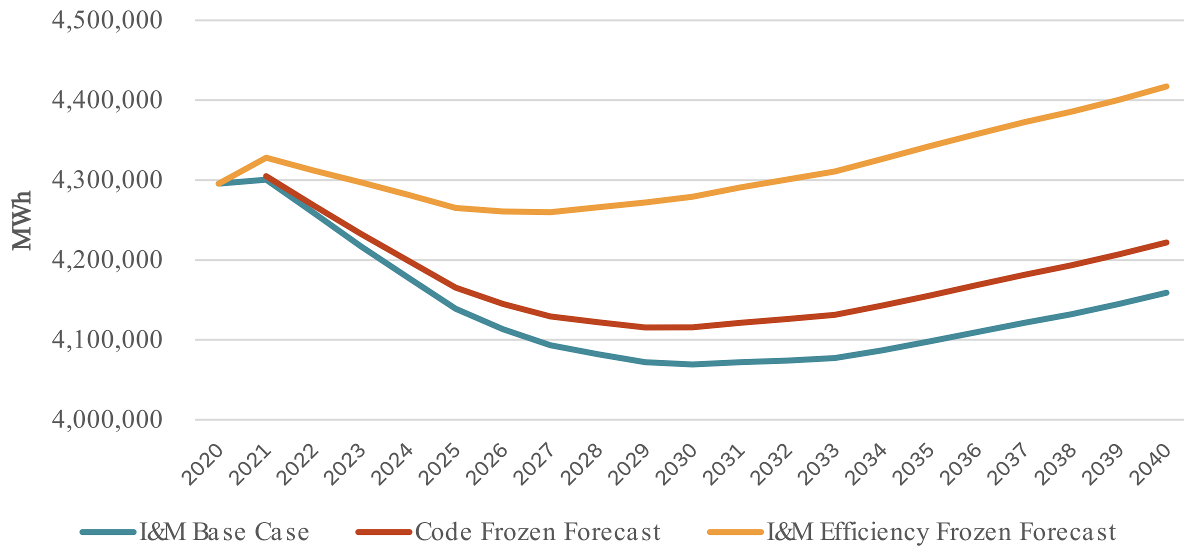


FIGURE 1-2. INDIANA RESIDENTIAL SECTOR FORECAST TRENDS

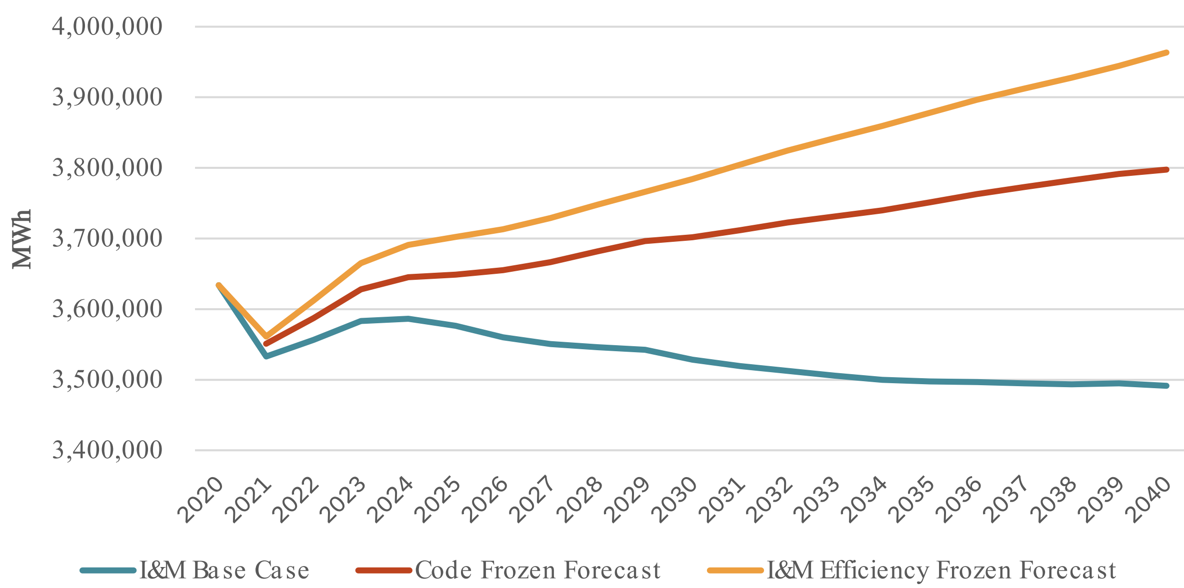


FIGURE 1-3. INDIANA COMMERCIAL SECTOR FORECAST TRENDS

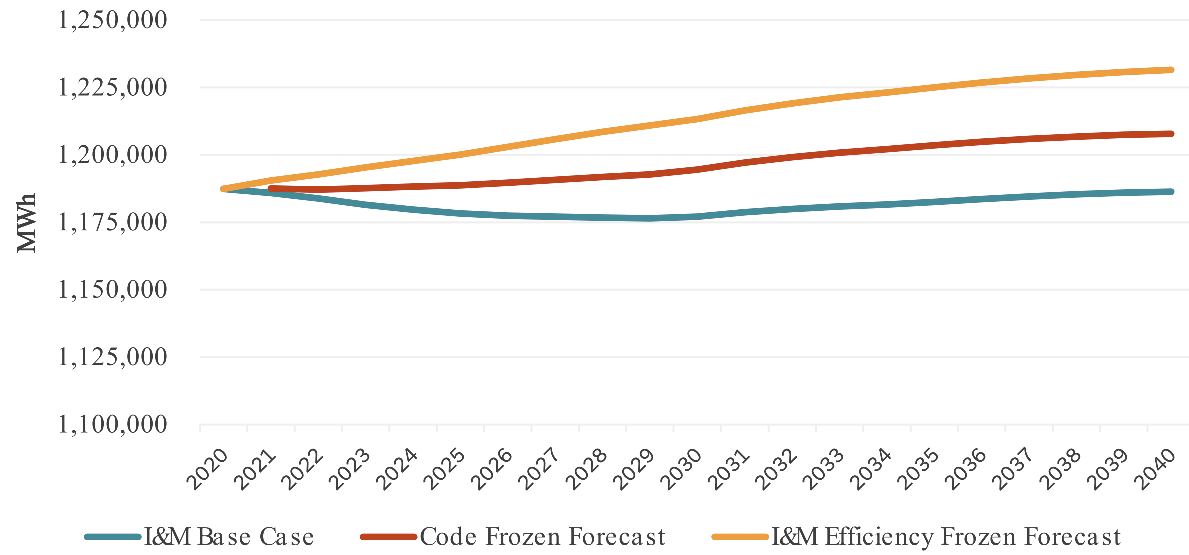


FIGURE 1-4. MICHIGAN RESIDENTIAL SECTOR FORECAST TRENDS

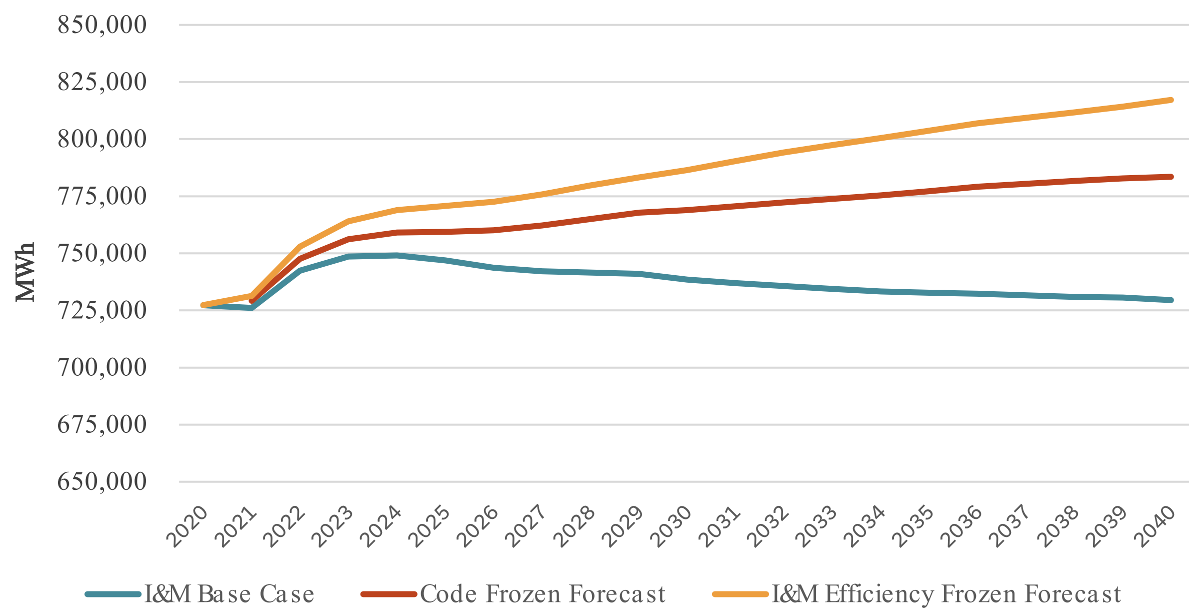


FIGURE 1-5. MICHIGAN COMMERCIAL SECTOR FORECAST TRENDS

1.3.3 Adjustment for Large C&I Opt-Out Customers

The 2019 I&M Indiana business sector customer database containing all C&I customers and whether the customer had opted-out of DSM/EE programs was utilized to determine how to adjust for opt-out customers. The number of customers and total energy was calculated both including and excluding opt-out customers. The load forecast for the C&I sectors was adjusted down by the percent of load attributed to opt-out customers from the customer database, in effect excluding any load of opt-out customers. The opt-out adjustment was held constant for all years of the load forecast. Approximately 9% of commercial energy sales and 50% of industrial energy sales were removed due to customer opt-outs.

I&M Michigan jurisdiction regulations do not contain a provision for any large C&I customer opt-out of DSM/EE programs, so no adjustments were necessary to exclude such load for the I&M Michigan specific load shape analysis.

1.3.4 Reclassification of Load

Last, the 2019 I&M business sector customer database designated commercial and industrial rate codes based on current tariff definition. When only using the account type/tariff definition to classify customers as either commercial or industrial, there were several manufacturing type premises classified as commercial, as well as several typically commercial customers classified as industrial, (i.e. a retail service building coded as an industrial account).

Conversely, the dataset also identified each business by Standard Industry Code (SIC). The GDS team mapped these industry codes to a specified building type and classified the building type as either commercial or industrial. Customers with a building type classified as "Industrial Manufacturing" were coded as Industrial customers, while all other building types were coded as Commercial. In Indiana, the result of this reclassification was a shift of approximately 0.5% of industrial sector sales, or 32,925 MWh, to the commercial sector. In Michigan, the result of this reclassification was a shift of approximately 0.3% of industrial sector sales, or 2,430 MWh, to the commercial sector. The 0.5% shift for Indiana and 0.3% shift for Michigan were then applied to the I&M base case forecasted sales for the commercial and industrial classes. Although specific accounts were reclassified from both commercial and industrial to the opposing class, only the overall magnitude of the shift of energy sales from this analysis was used as an input for the potential analysis.

1.4 TYPES OF POTENTIAL ANALYZED

This potential study provides a roadmap for both I&M and policy makers to develop strategies and programs for energy efficiency (EE), demand response (DR), and distributed energy resources (DERs) in the I&M service territories. In addition to technical and economic potential estimates, the development of achievable and program potential estimates for a range of feasible measures is useful for program planning and modification purposes. Unlike achievable and program potential estimates, technical and economic potential estimates do not include customer acceptance considerations for measures, which are often among the most important factors when estimating the likely customer response to new programs. For this study, the GDS Team produced the following estimates of demand side management potential:

- Technical potential
- Economic potential
- Achievable potential
    - Maximum achievable potential ("MAP")
    - Realistically achievable potential ('RAP")
- Program potential
    - Based off RAP

This executive summary provides overall energy efficiency technical, economic, and achievable potential as well as demand response and distributed energy resource achievable potential. The state-specific reports each have chapters describing program potential.

1.5 APPROACH SUMMARY

The purpose of this market potential study is to provide a foundation for the continuation of utility-administered energy efficiency and demand response programs in the I&M service territories and to determine the remaining opportunities for cost-effective energy savings, demand savings, and distributed energy resources for the I&M service territories. This study examined a full array of technologies, programs, and energy efficient building practices that are technically achievable.

1.5.1 Energy Efficiency

For the residential sector, GDS utilized a bottom-up approach to the modeling of energy efficiency potential, whereby measure-level estimates of costs, savings, and useful lives were used as the basis for developing the technical, economic, and achievable potential estimates. The measure data was used to build-up the technical potential, by applying the data to each relevant market segment. The measure data allowed for benefit-cost screening to assess economic potential, which was in turn used as the basis for achievable potential, taking into consideration incentives and estimates of annual adoption rates. For the C&I sector, GDS employed a bottom-up modeling approach to first estimate measure-level savings, costs, and cost-effectiveness, and then applied measure savings to all applicable shares of energy load.

1.5.1.1 Market Characterization

The initial step in the analysis was to gather a clear understanding of the current market segments in the I&M service area. The GDS team coordinated with I&M to gather utility sales and customer data and existing market research to define appropriate market sectors, market segments, vintages, saturation data and end uses. This information served as the basis for completing a forecast disaggregation and market characterization of both the residential and nonresidential sectors.

1.5.1.2 Measure Characterization

The study's sector-level energy efficiency measure lists were informed by a range of sources including the MEMD, the Illinois and Indiana TRMs, current I&M program offerings, and commercially viable emerging technologies, among others. Measure list development was a collaborative effort in which GDS developed draft lists that were shared with I&M and stakeholders. The final measure lists ultimately included in the study reflected the informed comments and considerations from the parties that participated in the measure list review process.

In total, GDS analyzed 353 measure types for I&M. Many measures were included in the study as multiple permutations to account for different specific market segments, such as different building types, efficiency levels, and replacement options. GDS developed a total of 2,106 measure permutations for this study. Each permutation was, screened for cost-effectiveness according to the UCT.

TABLE 1-3: NUMBER OF ELECTRIC MEASURES EVALUATED

	# of Measures	Total # of Measure Permutations
I&M		
Residential	168	673
Commercial	157	1,405
Industrial/Ag	28	28
Total	***353***	***2,106***

1.5.1.3 Types of Potential

The first two types of potential, technical and economic, provide a theoretical upper bound for energy savings from energy efficiency measures. Still, even the best-designed portfolio of programs is unlikely to capture 100% of the technical or economic potential. Therefore, achievable potential attempts to estimate what savings may realistically be achieved through market interventions, when it can be captured, and how much it would cost to do so. Figure 1-6 illustrates the types of energy efficiency potential considered in this analysis.

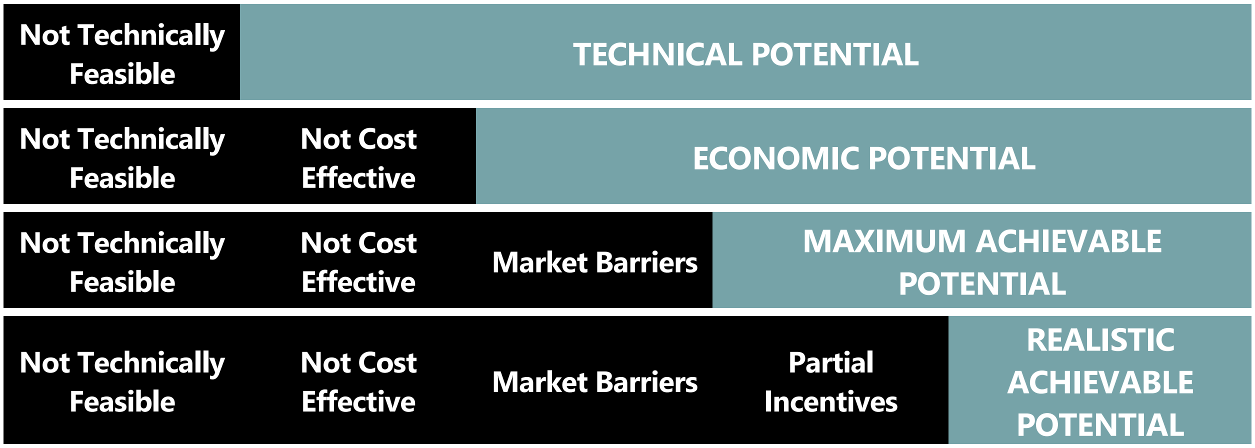


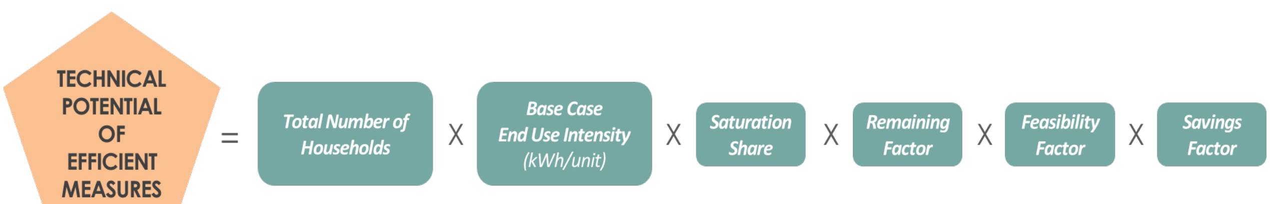
FIGURE 1-6 TYPE OF ENERGY EFFICIENCY POTENTIAL[3]

1.5.1.4 Technical Potential

Technical potential is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end users to adopt the efficiency measures. Technical potential is only constrained by factors such as technical feasibility and applicability of measures. Under technical potential, GDS assumed that 100% of new construction and market opportunity measures are adopted as those opportunities become available (e.g., as new buildings are constructed, they immediately adopt efficiency measures, or as existing measures reach the end of their useful life). For retrofit measures, implementation was assumed to be resource constrained and that it was not possible to install all retrofit measures all at once. Rather, retrofit opportunities were assumed to be replaced incrementally until 100% of stock was converted to the efficient measure over a period of no more than 15 years.

The core equation used in the residential sector energy efficiency technical potential analysis for each individual efficiency measure is shown in Equation 1-1 below. The C&I sector employs a similar analytical approach.

EQUATION 1-1 CORE EQUATION FOR RESIDENTIAL SECTOR TECHNICAL POTENTIAL



Where…

Base Case Equipment End-Use Intensity = the electricity used per customer per year by each base-case technology in each market segment. In other words, the base case equipment end-use intensity is the consumption of the electrical energy using equipment that the efficient technology replaces or affects.

Saturation Share = the fraction of the end-use electrical energy that is applicable for the efficient technology in a given market segment. For example, for residential water heating, the saturation share would be the fraction of all residential electric customers that have electric water heating in their household.

3 Reproduced from "Guide to Resource Planning with Energy Efficiency." November 2007. US Environmental Protection Agency (EPA). Figure 2-1. Modified to depict the additional levels of achievable and program potential included in this study.

Remaining Factor = the fraction of equipment that is not considered to already be energy efficient. To extend the example above, the fraction of electric water heaters that is not already energy efficient.

Feasibility Factor = (also functions as the applicability factor) the fraction of the applicable units that is technically feasible for conversion to the most efficient available technology from an engineering perspective (e.g., it may not be possible to install heat pump water heaters in all homes because of space limitations).

Savings Factor = the percentage reduction in electricity consumption resulting from the application of the efficient technology.

1.5.1.5 Economic Potential

Economic potential refers to the subset of the technical potential that is economically cost-effective (based on screening with the UCT) as compared to conventional supply-side energy resources. Refer to the state-specific reports for additional details on how measures were evaluated for cost-effectiveness.

1.5.1.6 Achievable Potential

Achievable potential is the amount of energy that can realistically be saved given various market barriers. Achievable potential considers real-world barriers to encouraging end users to adopt efficiency measures; the non-measure costs of delivering programs (for administration, marketing, analysis, and EM&V); and the capability of programs and administrators to boost program activity over time. Barriers include financial, customer awareness and WTP in programs, technical constraints, and other barriers the "program intervention" is modeled to overcome. Additional considerations include political and/or regulatory constraints. The potential study evaluated two achievable potential scenarios:

- ***MAP*** estimates achievable potential on paying incentives up to 100% of measure incremental costs and aggressive adoption rates.[4]
- ***RAP*** estimates achievable potential with I&M paying incentive levels (as a percent of incremental measure costs) closely calibrated to historical levels but is not constrained by any previously determined spending levels.

1.5.2 Demand Response

According to the Federal Energy Regulatory Commission (FERC), demand response is defined as changes in electric usage by demand-side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.

PJM defines a demand response program as providing end-use customers with the ability to manage their electricity use in response to conditions in the wholesale market. In short, resources must be dispatchable and measurable. Demand response rate options such as TOU rates do not meet these requirements. However, these rates can provide value for I&M by lowering their peak demand requirements.

This study uses the broader FERC definition of demand response so that all potential DR, including rate options, are identified. I&M's integrated resource planning team will analyze and adjust as necessary the identified DR potential for what can be counted in the PJM market and/or how DR potential will be used to construct alternative resource plans.

1.5.2.1 Demand Response Program Options

Table 1-4 provides a brief description of the demand response (DR) program options that were considered as part of the base analysis and identifies the eligible customer segment for each demand response program to

[4] The GDS team lowered MAP incentives to less than 100% of measure incremental cost in some cases if 100% incentives would preclude the measure from being cost-effective. MAP incentives were lowered to either 75% or 50% of the incremental measure cost if either of those incentive levels would allow for a measure to remain cost-effective.

be considered in this study. The list of DR options was determined based on a review of the I&M's current and/or planned offerings, offerings of other peer utilities, and market research into emerging DR technologies. The base case analysis includes direct load control (DLC), rate design, and aggregator options.

TABLE 1-4 DEMAND RESPONSE BASE CASE PROGRAM OPTIONS AND ELIGIBLE MARKETS

DR Program Option	Program Description	Eligible Markets
Central AC DLC	The compressor of the air conditioner is remotely shut off (cycled) by the system operator for periods that may range from 7 ½ to 15 minutes during every 30-minute period (i.e., 25%-50% duty cycle).	Residential Low-Income Customers
Connected Thermostat	The system operator can remotely raise the AC's thermostat set point during peak load conditions, lowering AC and/or heating load.	Residential and C&I Customers
Smart Water Heater	The system operator can remotely change the water heater's set point or shut off the water heater during peak load conditions.	Residential and C&I Customers
DHW DLC	The water heater is remotely shut off by the system operator for periods normally ranging from 2 to 8 hours.	C&I Customers
Room AC DLC	The compressor of the air conditioner is remotely shut off (cycled) by the system operator for periods that may range from 7 ½ to 15 minutes during every 30-minute period (i.e., 25%-50% duty cycle)	Residential Customers
Smart Appliance	Direct utility control of smart appliances.	Residential Customers
Electric Vehicle Charging Control	Direct utility control of electric vehicle charging stations.	Residential and C&I Customers
DLC Lighting	A portion of the lighting load is remotely shut off by the system operator for periods normally ranging from 2 to 4 hours.	C&I Customers
Connected Energy Management System	The system operating can remotely shut off or setback a portion of a building's loads controlled through the connected energy management system.	C&I Customers
Thermal Storage	The use of a cold storage medium such as ice, chilled water, or other liquids. Off-peak energy is used to produce chilled water or ice for use in cooling during peak hours. The cool storage process is limited to off-peak periods.	Residential and C&I Customers
Battery Storage	The system operator remotely calls for energy stored in batteries to be discharged to the grid during peak conditions.	Residential and C&I Customers
Behavioral	The system operator uses electronic messaging, like text messaging or email, to alert participating customers to an upcoming peak event. Customers receive incentives for reducing their usage during the peak window but are not penalized for lack of participation.	Residential Customers
Electric Vehicle Off-Peak Charging Rate	Special rate service for electric vehicles that charge off-peak.	Residential and C&I Customers
Time-of-use (TOU) Rate	A retail rate with different prices for usage during different blocks of time. Daily pricing blocks could include on-peak, mid-peak, and off-peak periods. Pricing is pre-defined, and once established, does not vary with actual cost conditions.	Residential and C&I Customers

DR Program Option	Program Description	Eligible Markets
Critical peak pricing (CPP) Rate	A retail rate in which an extra-high price for electricity is provided during a limited number of critical periods of the year. Market-based prices are typically provided on a day-ahead basis, or an hour ahead basis.	Residential and C&I Customers
Peak Time Rebates (PTR) Rate	A program where customers are rewarded if they reduce electricity consumption during peak times with monetary rebates.	Residential and C&I Customers
Capacity Bidding Programs (Large C&I Aggregator)	CBP is a flexible bidding program offering qualified businesses payments for agreeing to reduce when a CBP event is called. Businesses make monthly nominations and receive capacity payments based on the amount of capacity reduction nominated each month, plus energy payments based on your actual kilowatt-hour (kWh) energy reduction when an event is called. Penalties occur if load nominations are not met.	C&I Customers
Demand Bidding Programs (Small C&I Aggregator)	DBP is a year-round, flexible, Internet-based bidding program that offers business customers credits for voluntarily reducing power when a DBP event is called.	C&I Customers
Curtailable Rate	A discounted rate is offered to the customer for agreeing to interrupt or curtail load during peak period. The interruption is mandatory.	C&I Customers
Real Time Pricing (RTP) Rate	A retail rate with hourly energy prices closely matched to either the underlying wholesale electricity market or the utility's cost of production.	C&I Customers

Double-counting savings from demand response programs that affect the same end uses is a common issue that must be addressed when calculating the demand response savings potential. For example, a direct load control (DLC) program of air conditioning and a rate program both assume load reduction of the customers' air conditioners. For this reason, it is typically assumed that customers cannot participate in programs that affect the same end uses.

1.5.2.2 Demand Response Potential Assessment Approach Overview

The analysis of DR, where possible, closely follows the approach outlined for energy efficiency. The framework for assessing the cost-effectiveness of demand response programs is based on *A Framework for Evaluating the Cost-Effectiveness of Demand Response*, *prepared for the National Forum on the National Action Plan (NAPA) on Demand Response*.[5] Additionally, the GDS Team reviewed the May 2017 National Standard Practice Manual published by the National Efficiency Screening Project.[6] The GDS Team utilized this guide to define avoided ancillary services and energy and/or capacity price suppression benefits.

The demand response program potential for I&M was analyzed using a spreadsheet-based tool incorporating segment forecasts, program performance and economic definitions, and measure applicability estimates. The DR model determines the estimated savings for each demand response program by performing a review of all benefits and cost associated with each program. The GDS Team developed the model such that the value of future programs could be determined and will help facilitate demand response program planning strategies. The model contains approximately 50 required inputs for each program including: expected life, coincident peak ("CP") kW load reductions, proposed rebate levels, program related expenses such as vendor service fees, marketing and evaluation cost and on-going O&M expenses.

[5] Study was prepared by Synapse Energy Economics and the Regulatory Assistance Project, February 2013.
[6] National Standard Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources, May 18, 2017, Prepared by The National Efficiency Screening Project

The UCT Test was used to determine the cost-effectiveness of each demand response program. Benefits are based on avoided generation capacity, energy (including load shifting) and T&D infrastructure costs. Costs include incentive costs, increased supply costs, fixed program capital costs (such as the cost of a central controller), program administrative, marketing and evaluation costs.

The demand response analysis includes estimates of technical, economic, achievable, and program potential. Achievable potential is broken into maximum and realistic potential in this study:

- ***MAP*** represents an estimate of the maximum cost-effective demand response potential that can be achieved over the study period. For this study, this will be defined as customer participation in demand response program options that reflect a "best practice" estimate of what could eventually be achieved. MAP assumes no barriers to effective delivery of programs.
- ***RAP*** represents an estimate of the amount of demand response potential that can be realistically achieved over the study period. For this study, this will be defined as achieving customer participation in demand response program options that reflect a realistic estimate of what could eventually be achieved assuming typical or "average" industry experience. RAP is a discounted MAP, by considering program barriers that limit participation, therefore reducing savings that could be achieved. Both MAP and RAP include the impact of energy efficiency gains realized in the Energy Efficiency Potential study. These gains include the changes that occur when old equipment is replaced with high efficiency equipment. Yearly impacts were developed for the space cooling end use and for whole building impacts, applied for rate programs that affect multiple measures.

1.5.3 Distributed Energy Resources

As part of the overall potential modeling exercise, the GDS Team considered distributed energy resources (DER) as sources of behind-the-meter customer-sited generation. The DER potential study followed the same method as the energy efficiency potential study in that the DER analysis reviewed the opportunity for technical, economic, and achievable potential. We used the same forecast data as used in the energy efficiency study to assess DER potential. The analysis limited resources for this potential study to technologies that are behind-the-meter and owned by the customer and did not consider market potential for supply-side resources. Specifically, this market potential assessment for DER focused on solar photovoltaic (PV) and combined heat and power (CHP) systems.

1.5.3.1 Technical Potential – Solar Photovoltaic

Photovoltaic systems utilize solar panels, a packaged collection of photovoltaic cells, to convert sunlight into electricity. A system is constructed with multiple solar panels, a DC/AC inverter(s), a racking system to hold the panels, and electrical system interconnections. These systems are often roof-mounted and face south-west, south, and/or, south-east.

The study analyzed the potential associated with roof-mounted systems installed on residential and non-residential sector buildings. For the non-residential sector, the analysis also estimated potential for ground mounted (or covered parking) systems for a few specific business types. The analysis included battery storage as an additional configuration with each solar PV system type; however, due to the uncertainty associated with battery dispatch schedules, potential battery generation is excluded from this analysis. As noted above, this study did not explore the market potential associated utility-scale solar PV installations.

The approach to estimating technical potential required calculating the total square footage of suitable rooftop area within the I&M's territory and calculating solar PV system generation based on building and regional characteristics. Technical potential is computed using Equation 1-2.

EQUATION 1-2 SOLAR PV TECHNICAL POTENTIAL CALCULATION

$$\boldsymbol{PV\ Technical\ Potential} = \boldsymbol{\Sigma}(\boldsymbol{Suitable\ Rooftop\ Square\ Footage}\ \times \boldsymbol{PV\ System\ Generation\ per\ Sq.Ft.})$$

The two key parameters in Equation 1-2 were estimated based on multiple data sources relevant to each state's region in the I&M territory. Methods for defining these parameters are discussed below.

The GDS Team estimated total rooftop square footage using the forecast disaggregation analysis to characterize the residential and non-residential building stocks. The building stocks were characterized based on relevant parameters such as number of facilities, average number of floors, average premise consumption, and premise EUI. The GDS Team used these parameters to estimate the total rooftop square footage.

To estimate the fraction of the total roof area that is suitable for rooftop solar PV, the GDS Team relied on research completed by the National Renewable Energy Laboratory (NREL). NREL has developed estimates of the portion of total rooftops across the country that are suitable for solar PV based on analysis of LIDAR data. NREL criteria for suitable roof area include:

- **Contiguous rooftop area size:** Rooftops with fewer than 10 square meters of contiguous roof area excluded.
- **Rooftop orientation (tilt and azimuth):** Northeast through northwest orientation and roof pitches greater than 60 degrees excluded.
- **Shading:** Roof areas that had a minimum solar exposure of less than 80% relative to an unshaded roof were excluded.

Based on NREL's data, the GDS Team was able to apply unique suitability factors to estimate the total square footage of suitable rooftop for residential and non-residential buildings across I&M's territory.

The second key parameter – PV system generation – was estimated by developing standardized solar PV system configurations. These included system sizes for residential premises ranging from 3 to 20 kW (DC) and 10 to 2,000 kW (DC) for non-residential premises. Additionally, the GDS Team selected battery system sizes for each solar PV system size to dispatch energy for 2-4 hours.

The Team relied on NREL's PVWatts[7] (Version 6.1.4) and System Advisor Model (SAM)8 tools to estimate system generation for both residential and non-residential sited systems. These tools model PV power density based on site specific data from NREL's LIDAR-based NSRDB to estimate total solar irradiance in conjunction with PV system specifications. The PV system simulations were generated based on Fort Wayne, IN and Niles, MI. The GDS Team based assumptions for PV system azimuth on rooftop orientation data sourced from Google's Project Sunroof also based on Fort Wayne, IN and Niles, MI. The analysis assumptions are summarized in Table 1-5.

TABLE 1-5 KEY ASSUMPTIONS IN SOLAR PV ANALYSIS

Parameter	Assumptions
Residential System Sizes (Nominal DC Capacity)	3 kW, 5 kW, 7.5 kW, 10 kW, 15 kW, 20 kW
Non-Residential System Sizes (Nominal DC Capacity)	10 kW, 15 kW, 20 kW, 25 kW, 50 kW, 100 kW, 250 kW, 500 kW, 1,000 kW, 2,000 kW
System losses	14.1%

7 PVWatts estimates solar PV energy production and costs. Developed by the National Renewable Energy Laboratory. (NREL) http://pvwatts.nrel.gov/

8 SAM estimates hourly solar PV energy production and costs with more detailed inputs and outputs than PVwatts. Developed by the National Renewable Energy Laboratory. (NREL) http:// https://sam.nrel.gov/

Parameter	Assumptions
Tilt	By region
Azimuth:	By region
DC to AC size ratio	1.2
Inverter efficiency	96% (micro-inverter)
Battery Round-Trip Efficiency	85%

Based on the simulations and resulting capacity factors for residential and non-residential buildings for the Indiana and Michigan regions, we applied the state-specific capacity factor to the system size to estimate annual electricity generation. These system generation values were used to calculate total energy generation per square foot of rooftop and extrapolated based on the total suitable rooftop square footage to estimate overall all technical potential. As a final step, the GDS Team removed from the technical potential for any generation occurring from existing systems. Data on existing systems was provided directly by I&M.

1.5.3.2 Technical Potential – Combined Heat and Power

CHP systems generate electric power and useful thermal energy in a single integrated system. Heat that is normally wasted in conventional power generation is recovered as useful thermal energy. Due to the integration of both power and thermal generation, CHP systems are more efficient than separate sources for electric power generation and thermal energy production.

In most CHP applications, a heat engine creates shaft power that drives an electrical generator (fuel cells can produce electrical power directly from electrochemical reactions). The waste heat from the engine is then recovered to provide steam or hot water to meet on-site needs. By combining the thermal and electrical energy generation in one process, the total efficiency of a CHP application far exceeds that of a separate plant and boiler system. Overall, the efficiency of CHP technologies can reach 80% or more, while simple-cycle electricity generation reaches only 30% and combined cycle generation typically achieves 50%. When considering both thermal and electric energy generation, CHP requires 40% less energy input to achieve the same energy output as a separate plant and boiler system. Figure 1-7 illustrates this point.

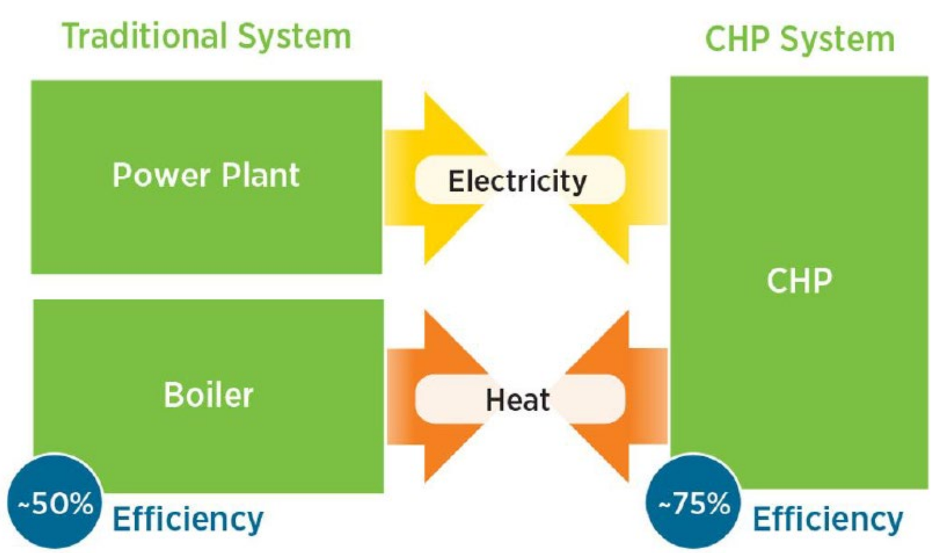


Figure courtesy of US DOE Energy Efficiency & Renewable Energy

FIGURE 1-7 CHP ENERGY FLOW DIAGRAM

Common technologies used in CHP applications and explored in this study include:

- Steam turbines
- Gas turbines
- Micro turbines
- Fuel Cells
- Reciprocating engines

Applications with steady demand for electricity and thermal energy are potentially good economic targets for CHP deployment. Industrial applications, particularly in industries with continuous processing and high steam requirements, are very economic and represent a large share of existing CHP capacity today. Commercial applications such as hospitals, nursing homes, laundries, and hotels with large hot water needs are well suited for CHP. Institutional applications such as colleges and schools, prisons, and residential and recreational facilities are also excellent prospects for CHP.

Selecting a specific CHP technology depends on several factors, which include but are not limited to power requirements, the duty cycle, space constraints, thermal energy needs, emission regulations, fuel availability, utility prices, and interconnection issues. Table 1-6 summarizes the CHP technologies evaluated in this study and their assumed operating parameters.

TABLE 1-6 CHP TECHNOLOGY COMPARISON[9]

Parameter	Reciprocating Engine	Gas Turbine	Steam Turbine	Micro-Turbine	Fuel Cell
Size (kW)	50-5,000	500-50,000	10-100,000	30-250	200-2,000
Electric Efficiency	28-39%	25-40% (simple) 40-60% (combined)	5-15%	25-28%	36-42%
Overall Efficiency	73-79%	64-72%	~80%	67-72%	62%-67%
Fuels	Natural gas, biogas, propane, liquid fuels	Natural gas, biogas, propane, distillate oil	All	Natural gas, biogas, propane, distillate oil	Hydrogen, natural gas, propane
NO_x Emissions (lb/MWh)	0.15-2.17	0.55-0.68	Function of boiler emissions	0.14-0.17	0.01-0.04
Uses for Heat Recovery	Hot water, low pressure steam, district heating	Direct heat, hot water-, low- or high-pressure steam, district heating	Low- or high-pressure steam, district heating	Direct heat, hot water, low pressure steam	Hot water-, low- or high-pressure steam
Thermal Output (Btu/kWh)	3,000-6,100	3,200-5,000	n/a	4,800-6,300	1,500-3,000
Useable Temp (°F)	200-500	500-1,100	n/a	400-650	140-700

To estimate technical potential for CHP, the GDS Team first developed a screening process based on the DOE's national technical potential study of CHP resources[10] to identify probable CHP candidate premises. First,

[9] Combined Heat and Power Market Assessment. ICF International for the California Energy Commission, April 2010.
[10] U.S. Department of Energy. Combined Heat and Power (CHP) Technical Potential in the United States, March 2016.

customers with less than 50,000 kWh annual consumption were removed from eligibility as a CHP candidate. Second, we considered customer loads to assess if and what CHP system type and size may be a potential match to a customer. To effectively utilize CHP, a facility must have coincident electric and thermal energy requirements for a large load factor of the year. A continuous process industry with nearly constant steam or hot water demand electric load is an excellent target, such as a chemicals manufacturer or a hospital. Facilities with intermittent electric and thermal loads are progressively less attractive as the number of hours of coincident load diminishes. We therefore screened for eligible customers based on the customer's annual kWh usage and an approximate sized CHP system based on a thermal factor.

The Team calculated and applied a thermal factor to potential candidate customer loads to reflect thermal load considerations in CHP sizing. In most cases, on-site thermal energy demand is smaller than electrical demand. Thus, CHP size is usually dictated by the thermal load to achieve proper efficiencies and adequate returns on investment. The Team used power to heat ratios[11] for both the CHP technology as well as different market segments to calculate the thermal factor as shown in following equation.

EQUATION 1-3 THERMAL FACTOR CALCULATION

$$\textit{Thermal Factor} = \frac{P/H\ (CHP\ System)}{P/H\ (Customer\ Segment)}$$

A thermal factor of one (1.0) would result in the CHP system capacity being equal to the electric demand of the facility. A thermal factor of less than one would indicate that the application is thermally limited, and the resulting CHP system size would be below the electric demand of the facility. A thermal factor greater than one indicates that a CHP system sized to the thermal load would produce more electricity than can be used on-site, resulting in excess power that could be exported to the grid. Following the method applied in the DOE national technical potential study, the thermal factor was multiplied by each customer's annual consumption to estimate the appropriate CHP system size. The Team screened and removed any CHP technology that did not fall within +/- 15% generation of the customer's annual kWh consumption. A summary of the power to heat ratios by segment is listed in Table 1-7, as sourced from the DOE EPA CHP potential study.

TABLE 1-7 POWER TO HEAT RATIO BY SEGMENT

Industrial Segment	Heat to Power Ratio	Commercial Segment	Heat to Power Ratio
Utilities	1.29	Education	0.50
Smelting	0.26	Healthcare	0.75
Food Manufacturing	1.10	Institutions	0.94
Transportation Manufacturing	0.33	Grocery	0.62
Paper Manufacturing	2.37	Lodging	0.62
Plastics Manufacturing	0.31	Office	0.20
Misc. Manufacturing	1.34	Retail	0.84
Agriculture	0.25	Warehouse	0.68
Construction	0.25	Misc.	0.68
Metal Manufacturing	3.83		

[11] Power to heat ratios were sourced from a combination of the following sources:
•U.S. Environmental Protection Agency Combined Heat and Power Partnership. Catalog of CHP Technologies, September 2017.
•U.S. Environmental Protection Agency Combined Heat and Power Partnership. Spark Spread Estimator Version 1.2
•U.S. Department of Energy. Combined Heat and Power (CHP) Technical Potential in the United States, March 2016.

After applying the screening method, we reviewed which CHP systems were eligible matches for given customer sites. In cases where multiple CHP technologies were viable for a single customer site, an applicability factor was assigned for each eligible CHP technology. After assigning applicability factors, the Team summed the total CHP generation across the population. The GDS Team removed from the technical potential any generation occurring from existing systems. Data on existing systems was provided directly by I&M.

1.5.3.3 Economic Potential

Economic potential represents the DER generation possible given full adoption of all cost-effective DER measures. For the cost effectiveness analysis on solar PV and CHP, the GDS Team used a Total Resource Cost (TRC) hurdle of 1.0. To assess the TRC, the GDS Team relied on the same avoided energy and capacity costs used in the energy efficiency analysis. These avoided costs serve as the benefits while the costs are represented as the installation and O&M costs of the modeled solar PV and CHP measures. The study did not find any economic or achievable DER potential. Refer to the state-specific reports for additional detail on the DER economic potential analysis.

1.6 POTENTIAL SAVINGS OVERVIEW

The following several sub-sections provide an overview of the energy efficiency potential as well as summary demand response potential and distributed energy resource potential. The state-specific reports provide additional summary data and methodological considerations and descriptions.

1.6.1 Energy Efficiency Potential for Residential Customers

Figure 1-8 provides the I&M system-level residential technical, economic, MAP and RAP savings estimates by 2025, 2028, and 2040. The 2025 technical potential is 12.7% of forecasted sales, and the economic potential is 10.2% of forecasted sales. The 2025 MAP is 4.4% and the RAP is 4.0%, as a percentage of forecasted sales. By 2040 the technical and economic potential rise to 38% and 32% of forecasted sales, respectively. This indicates that a large portion of the technical potential is cost-effective. The MAP and RAP rise respectively to 18% and 14% of forecasted sales by 2040. The gap between economic potential and MAP/RAP represents market barriers to prospective program participants, both financial and non-financial, to achieving the full amount of economic potential.

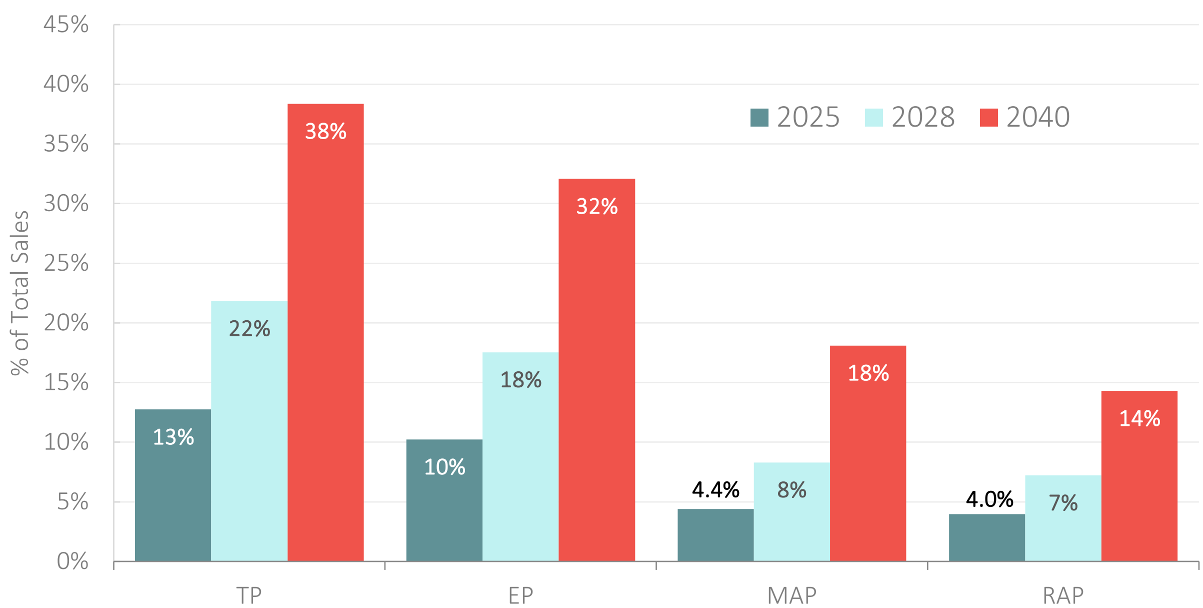


FIGURE 1-8: OVERVIEW OF I&M SYSTEM-LEVEL RESIDENTIAL ENERGY EFFICIENCY POTENTIAL

Table 1-8 provides I&M system-level residential incremental annual energy and demand savings for MAP and RAP across the next six years as well as the potential by 2040. Incremental RAP energy savings range from 71,870 MWh in 2023 to 109,238 MWh by 2040, and cumulative RAP energy savings rise to 807,284 MWh by 2040.[12]

TABLE 1-8 I&M SYSTEM-LEVEL RESIDENTIAL MAP & RAP POTENTIAL

	2023	2024	2025	2026	2027	2032	2040
Incremental Annual Energy (MWh)							
MAP	76,858	87,930	97,328	103,872	109,462	114,177	123,563
RAP	71,870	80,315	86,505	90,420	93,807	96,797	109,238
Incremental Annual Energy (MW)							
MAP	18.0	20.5	22.6	24.1	25.4	26.3	27.6
RAP	16.1	17.6	18.7	19.5	20.2	20.8	23.0
Cumulative Annual Energy (MWh)							
MAP	92,827	166,091	239,548	312,099	385,492	454,505	1,022,305
RAP	86,441	152,415	216,435	278,301	339,472	394,754	807,284
Cumulative Annual Energy (MW)							
MAP	22.3	40.9	60.0	78.3	96.3	112.7	230.4
RAP	19.8	35.6	51.0	65.5	79.4	91.6	176.3

1.6.2 Energy Efficiency Potential for Commercial Customers

Figure 1-9 provides the I&M system-level commercial technical, economic, MAP and RAP savings estimates by 2025, 2028, and 2040. The 2025 technical potential is 11.5% of forecasted sales, and the economic potential is 11.4% of forecasted sales. The 2025 MAP is 6.9% and the RAP is 5.0%, as a percentage of forecasted sales. By 2040 the technical and economic potential rise to 36% of forecasted sales. This indicates that essentially all the technical potential is cost-effective. The MAP and RAP rise respectively to 19% and 15% of forecasted sales by 2040. The gap between economic potential and MAP/RAP represents market barriers to prospective program participants, both financial and non-financial, to achieving the full amount of economic potential.

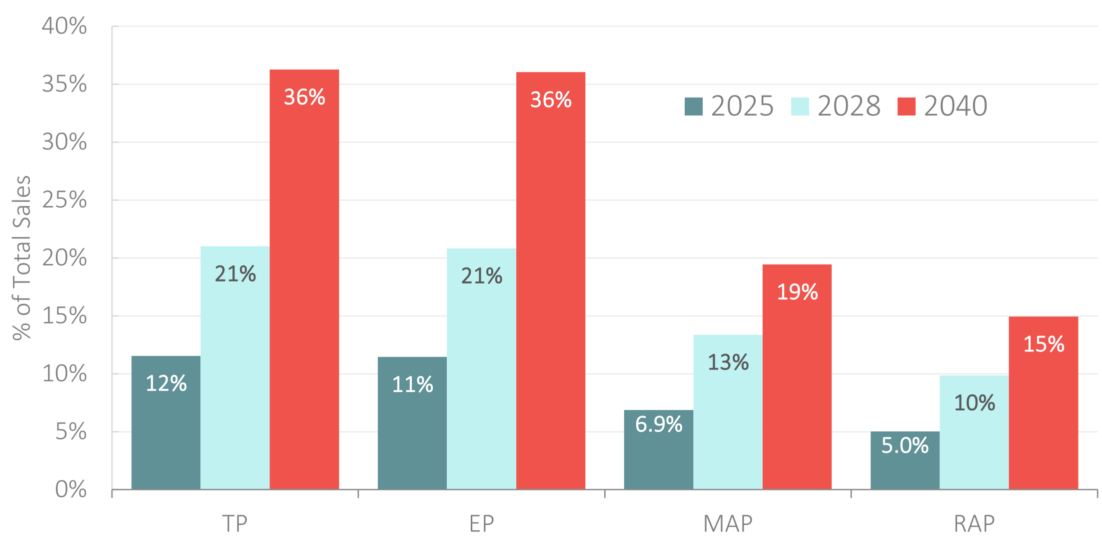


FIGURE 1-9: OVERVIEW OF I&M SYSTEM-LEVEL COMMERCIAL ENERGY EFFICIENCY POTENTIAL

[12] Cumulative annual potential in 2023 is greater than the incremental annual potential because the study timeframe for I&M Michigan begins in 2022. This is the case for all sectors.

Table 1-9 provides I&M system-level commercial incremental and cumulative annual energy and demand savings for MAP and RAP across the next six years as well as the potential by 2040. Incremental RAP energy savings range from 71,143 MWh in 2023 to 90,931 MWh by 2040, and cumulative RAP energy savings rise to 703,768 MWh by 2040.

TABLE 1-9 I&M SYSTEM-LEVEL COMMCERCIAL MAP & RAP POTENTIAL

	2023	2024	2025	2026	2027	2032	2040
Incremental Annual Energy (MWh)							
MAP	97,484	92,092	89,467	90,942	91,633	94,480	111,780
RAP	71,143	66,859	65,858	68,130	69,255	73,191	90,931
Incremental Annual Energy (MW)							
MAP	15.2	14.7	14.8	15.6	16.1	16.5	20.4
RAP	10.7	10.3	10.6	11.5	11.9	12.5	15.7
Cumulative Annual Energy (MWh)							
MAP	116,196	207,636	295,128	379,096	455,737	528,967	917,027
RAP	84,991	151,194	215,134	277,089	333,742	388,951	703,768
Cumulative Annual Energy (MW)							
MAP	18.2	32.9	47.6	62.2	76.1	89.9	191.6
RAP	12.8	23.1	33.6	44.1	54.4	64.8	143.4

1.6.3 Energy Efficiency Potential for Industrial Customers

Figure 1-10 provides the I&M system-level industrial technical, economic, MAP and RAP savings estimates by 2025, 2028, and 2040. The 2025 technical potential is 6.1% of forecasted sales, and the economic potential is also 6.1% of forecasted sales. The 2025 MAP is 3.8% and the RAP is 2.8%, as a percentage of forecasted sales. By 2040 the technical and economic potential rise to 21% of forecasted sales. This indicates that essentially all the technical potential is cost-effective. The MAP and RAP rise respectively to 14% and 10% of forecasted sales by 2040. The gap between economic potential and MAP/RAP represents market barriers to prospective program participants, both financial and non-financial, to achieving the full amount of economic potential.

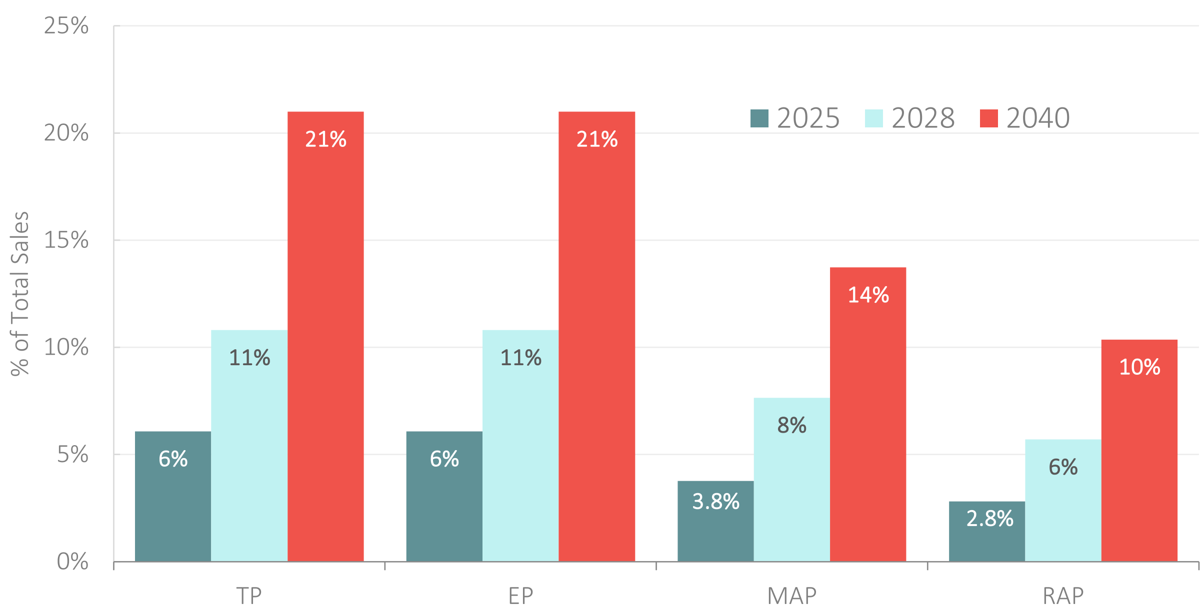


FIGURE 1-10: OVERVIEW OF I&M SYSTEM-LEVEL INDUSTRIAL ENERGY EFFICIENCY POTENTIAL

Table 1-10 provides I&M system-level industrial incremental and cumulative annual energy and demand savings for MAP and RAP across the next six years as well as the potential by 2040. Incremental RAP energy savings range from 37,876 MWh in 2023 to 53,389 MWh by 2040, and cumulative RAP energy savings rise to 454,863 MWh by 2040.

TABLE 1-10 I&M SYSTEM-LEVEL INDUSTRIAL MAP & RAP POTENTIAL

	2023	2024	2025	2026	2027	2032	2040
Incremental Annual Energy (MWh)							
MAP	50,976	50,011	50,573	57,090	55,030	55,301	69,526
RAP	37,876	37,164	37,716	42,721	41,198	41,641	53,389
Incremental Annual Energy (MW)							
MAP	8.8	8.7	8.7	9.8	9.7	9.2	11.9
RAP	6.5	6.4	6.5	7.4	7.3	6.9	9.1
Cumulative Annual Energy (MWh)							
MAP	60,606	110,618	159,376	206,596	251,304	294,393	602,574
RAP	45,361	82,525	118,799	153,983	187,274	219,478	454,863
Cumulative Annual Energy (MW)							
MAP	10.5	19.2	27.6	35.7	43.5	50.9	103.8
RAP	7.8	14.3	20.5	26.6	32.3	37.9	78.2

1.6.4 Demand Response Potential for All Customers

1.6.4.1 Residential Potential

Figure 1-11 shows the 2040 I&M system-level residential market rate and income-eligible MAP and RAP demand response potential for I&M. These demand reduction values are presented at the customer meter level.

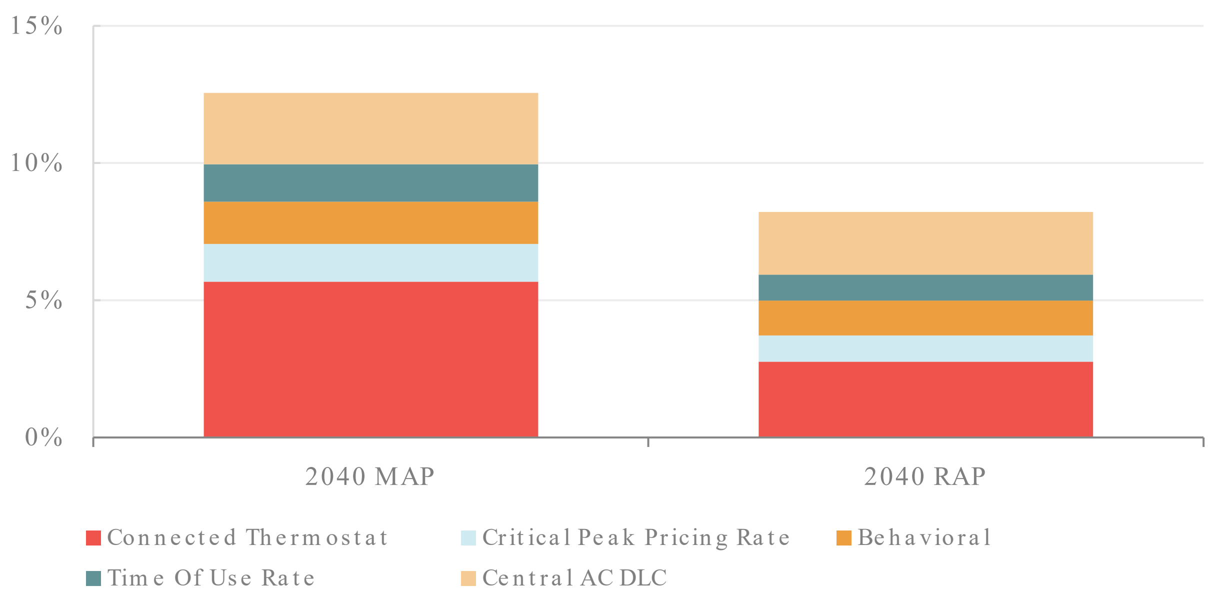


FIGURE 1-11: I&M SYSTEM-LEVEL SUMMER PEAK MW RESIDENTIAL SECTOR BASE CASE RESULTS AS % OF 2040 RESIDENTIAL CLASS LOAD

1.6.4.2 C&I Sector Potential

Figure 1-12 shows the 2040 I&M system-level C&I sector MAP and RAP demand response potential for I&M. These demand reduction values are presented at the customer meter level.

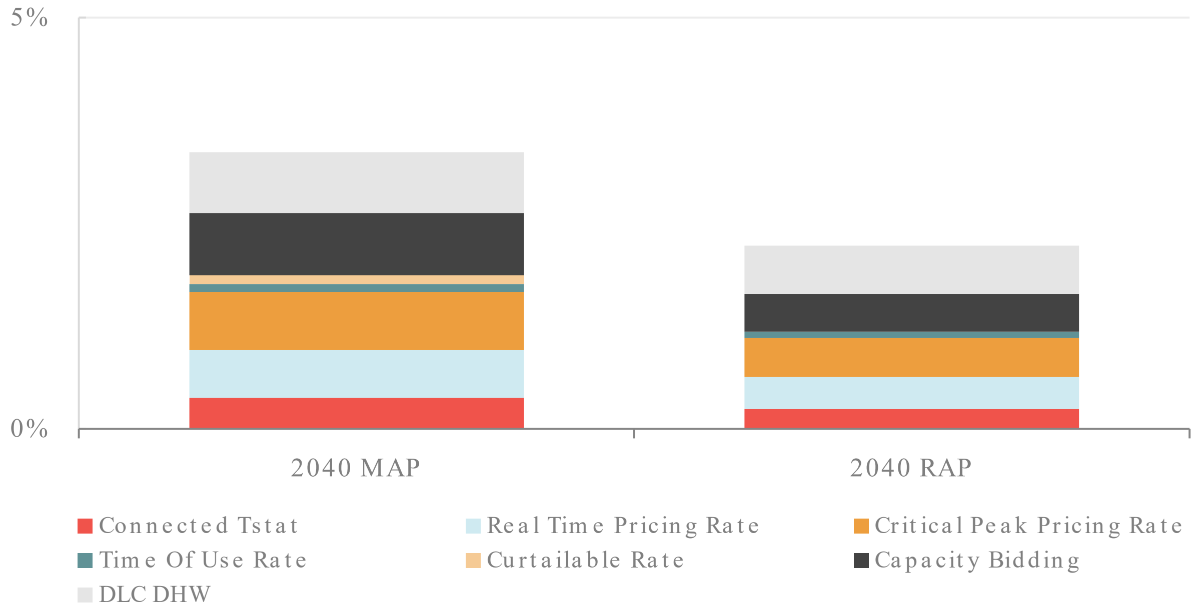


FIGURE 1-12 I&M SYSTEM-LEVEL SUMMER PEAK MW C&I SECTOR BASE CASE RESULTS AS % OF 2040 C&I CLASS LOAD

Figure 1-13 shows the I&M system-level annual demand response RAP potential for the Base Case by sector for I&M. These demand reduction values are present at the customer meter level.

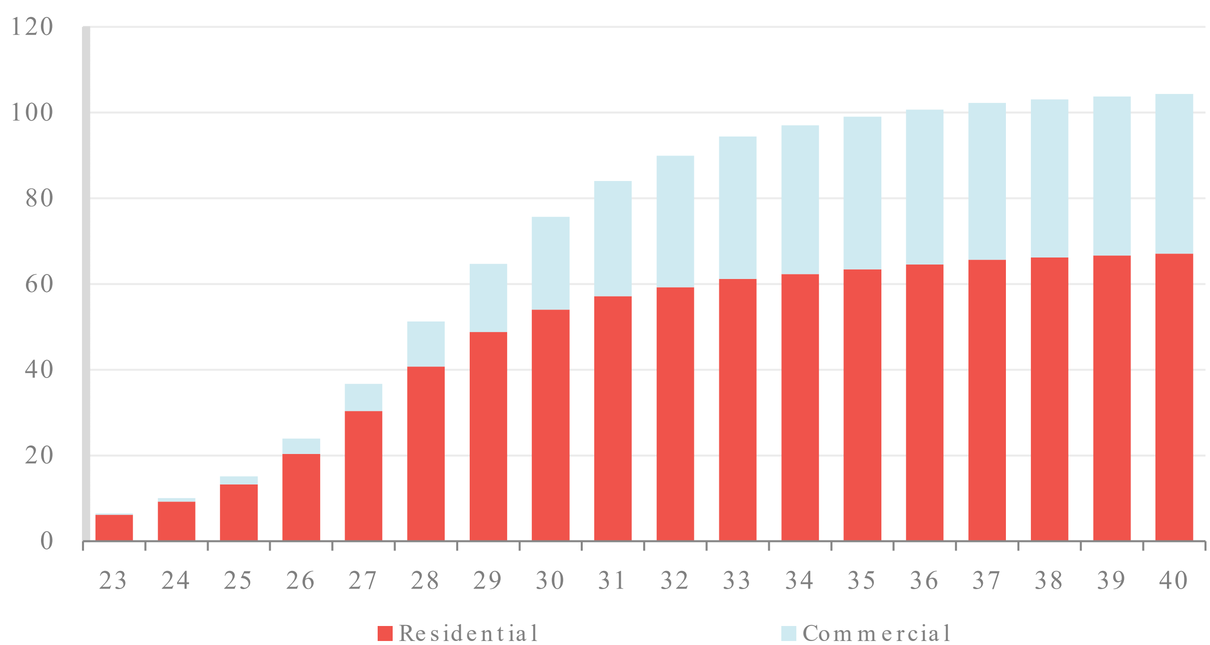


FIGURE 1-13: I&M SYSTEM-LEVEL CUMULATIVE ANNUAL BASE CASE SUMMER PEAK MW RAP POTENTIAL BY SECTOR

1.6.5 Distributed Energy Resource Potential for All Customers

1.6.5.1 Solar Photovoltaics

Table 1-11 summarizes the I&M system-level solar PV cumulative annual potential estimates for electric demand and Table 1-12 for electric energy within I&M's territory. The 2040 technical potential for solar PV is more than 8.3 million MWh.

TABLE 1-11: SUMMARY OF I&M SYSTEM-LEVEL SOLAR PV ELECTRIC DEMAND MARKET POTENTIAL

Year	Technical DC Capacity (MW)	Technical Peak Capacity (MW)	Economic (MW)	MAP (MW)	RAP (MW)
2025	1,054	329	0	0	0
2028	3,126	976	0	0	0
2040	7,824	2,440	0	0	0

TABLE 1-12: SUMMARY OF I&M SYSTEM-LEVEL SOLAR ELECTRIC ENERGY MARKET POTENTIAL

Year	Technical (MWh)	Economic (MWh)	MAP (MWh)	RAP (MWh)
2025	1,117,122	0	0	0
2028	3,306,381	0	0	0
2040	8,249,617	0	0	0

1.6.5.2 Combined Heat and Power

Table 1-13 summarizes the I&M system-level CHP cumulative annual potential estimates for electric demand and Table 1-14 for electric energy within I&M's service territories. The 2040 technical potential for CHP is more than 2 million MWh.

TABLE 1-13: SUMMARY OF I&M SYSTEM-LEVEL CHP ELECTRIC DEMAND MARKET POTENTIAL

Year	Technical DC Capacity (MW)	Technical Peak Capacity (MW)	Economic (MW)	MAP (MW)	RAP (MW)
2025	41	29	0	0	0
2028	125	89	0	0	0
2040	336	239	0	0	0

TABLE 1-14: SUMMARY OF I&M SYSTEM-LEVEL CHP ELECTRIC ENERGY MARKET POTENTIAL

Year	Technical (MWh)	Economic (MWh)	MAP (MWh)	RAP (MWh)
2025	252,376	0	0	0
2028	771,121	0	0	0
2040	2,079,016	0	0	0

1.7 STUDY LIMITATIONS AND CAVEATS

As with any assessment of potential, this study necessarily builds on various assumptions and data sources, including the following:

- Energy efficiency measure lives, savings, and costs (total measure costs, incremental costs, and incentive costs)
- Projected penetration rates for energy efficiency measures
- Projections of energy avoided costs
- Future known changes to codes and standards
- End-use saturations and fuel shares

While the GDS Team has sought to use the best and most current available data (including the use of new primary market research in key market subsegments of interest based on stakeholder feedback) there are often reasonable alternative assumptions which would yield slightly different results. For instance, the analysis assumes that many existing measures, regardless of their current efficiency levels, can be eligible for future installation and savings opportunities. Other studies may select a narrower viewpoint, limiting the amount of potential from equipment that is already considered to be energy efficient. Additionally, the models used in this analysis must make several assumptions regarding program delivery and the timing of equipment replacement that may ultimately occur more rapidly (or more slowly) than currently forecasted.

Furthermore, while the lists of energy efficiency measures examined in this study analysis represent technologies available on the market today as well as a limited number of emerging technologies not currently offered by I&M, these measure lists may not be exhaustive. The GDS Team acknowledges that new efficient technologies may become available over the course of the 20-year study timeframe that could produce efficiency gains and costs at different levels than those currently assumed.

Last, where possible, the GDS Team and I&M collaborated to ensure consistency with assumptions and methodological considerations that are expected to be employed by during the program planning process. However, final program designs and implementation strategies may need additional flexibility to target specific or underserved markets, address equity concerns, or react to changing customer preferences.

GDS Associates, Inc.
ENGINEERS & CONSULTANTS

INDIANA MICHIGAN POWER
An AEP Company

2021 POTENTIAL STUDY

EXECUTIVE SUMMARY

September
2021

prepared by
GDS ASSOCIATES INC
BRIGHTLINE GROUP