VOL. 2

Appendix 2

Potential Study Appendix

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

Contents

SECTION 2A

Detailed Methodology

Detailed Methodology

This appendix provides additional detail about the methodology used to develop the results of the New York Commercial Potential Study. This appendix covers the following topics:

- Energy forecasts
- Measure characterization
- Top down approach
- Use of Baseline data
- Scenario analysis
- Avoided costs
- Economic potential analysis
- Adoption curves

Energy Forecasts

BASELINE ENERGY SALES FORECASTS

The Study Team developed baseline sales forecasts and disaggregated loads for electricity, natural gas, fuel oil, and propane. Energy consumption was derived from the census of buildings examined in the baseline study. Thus, the team did not include in the baseline sales forecast any building types that were not part of the baseline study. Table 1 shows the building types studied[1] For electric energy, the study used consumption data provided by the participating New York investor-owned utilities as part of the baseline study. For the other fuels, the team combined baseline data about the number of square feet, by building type, and primary heating fuel, with data on energy use per square foot from the Energy Information Administration's (EIA) Commercial Building Energy Consumption Survey (CBECS) for the corresponding building types. CBECS data was also used to further disaggregate energy use by end use. The Study Team also further disaggregated sales data for new construction and renovated spaces and those for existing facilities. The Study Team used EIA's projection of new square feet, by year, for new-construction activity in the Mid-Atlantic region.[2]

Table 1 | Building Types Examined in the Potential Study

Segment	Share of Businesses	Share of Electric Use
Office/Government	35%	35%
Retail	26%	13%
Food Service	11%	9%
Health Services/Hospitals	9%	10%
Warehouse	7%	9%
Education	5%	12%
Grocery/Convenience	4%	7%
Lodging/Hospitality	3%	4%
TOTAL	**100%**	**100%**

[1]Note that the total sales for only the commercial segments studied account for only about 60% of the entire commercial electric sales. It is likely that efficiency potential opportunities for the remainder are proportional in terms of percent of sales.
[2]EIA. Annual Energy Outlook [2019]. https://www.eia.gov/outlooks/aeo/.

The procedure yields energy consumption in Year 1 of the potential study, disaggregated into building type and end use. For electric energy, the Study Team used the 2019 Gold Book from the New York grid operator, NYISO,[3] to project baseline energy use in later years of the study. Since the NYISO forecast was only used to project the load growth in later years, and year one load was derived directly from the baseline data, there was no need to adjust the NYISO forecast to look at load at meter or to adjust for the proportion of total commercial load addressed in this study.

As part of its forecast, NYISO estimates the impact of expected levels of efficiency and codes and standards. Since future energy efficiency programs will affect the total potential, the Study Team has added these values back into the forecast. Because NYISO does not publish separate estimates for the impacts of codes and standards versus efficiency, the Study Team added back the full combined value published by NYISO. Decreases in savings from expected future codes and standards are reflected in the analysis in the baseline efficiency level assumed for the measure characterization. The study does not assume any increased stringency of energy code over time beyond those that are currently known. Note that there is current uncertainty around whether a standard effectively mandating LEDs for all general service lamps will be implemented as planned. The Study Team assumes that the standard will go into place – if this does not happen, there will be additional savings opportunities for this application that are not included in the study.

Once the Study Team adjusted for expected changes to federal standards, the forecast was then divided into existing and new-construction load, taking into consideration the ratio of current square footage to expected new square footage from EIA's 2018 Annual Energy Outlook (AEO).[4]

For fuels other than electricity, the growth rate is derived directly from the sales forecast in the 2018 Annual Energy Outlook. The team has not assumed or adjusted for any embedded efficiency in the AEO forecasts, nor made assumptions about how fuel switching may be reflected in EIA's underlying assumptions. The team simply accepted the EIA forecasts as the best available published estimates of future loads—absent any concerted market interventions such as those from utility efficiency programs.

Measure Characterization

The Study Team initially created a measure list for the study from several sources—notably, the New York Technical Reference Manual[5] (TRM) and previous potential studies conducted by Optimal Energy. The team characterized each measure, specifying the costs, savings, effective useful life, existing market saturation, and other impacts or quantitative variables of the measure. To characterize the measures for this study, the team used data from the baseline study wherever applicable and practical. The analysis then supplemented this information with that from other sources, particularly the New York TRM, other regional TRMs, and the Study Team's existing measure characterization database.

[3] New York Independent System Operator, Inc., 2019. Load & Capacity Data Report—Gold Book. Rensselaer, NY: New York ISO. https://www.nyiso.com/documents/20142/2226333/2019-Gold-Book-Final-Public.pdf/

[4] U.S. Energy Information Administration, 2018. Annual Energy Outlook 2018, with Projections to 2050. Report AEO2018. Washington, DC: U.S. EIA. https://www.eia.gov/outlooks/aeo/pdf/AEO2018.pdf/

[5] New York State Department of Public Service, 2019. The New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs—Residential, Multi-Family, and Commercial / Industrial. Albany, NY: DPS. http://www3.dps.ny.gov/W/PSCWeb.nsf/All/72C23DECFF52920A85257F1100671BDD.

The Study Team examined 141 measures, characterizing them for up to four applicable markets (market driven, new construction, major renovation, and retrofit):

> **Market-driven, or "lost opportunity" measures**. These occur when the market is driving a purchase or sale of a new piece of equipment. This might involve regular planned lighting change-outs, or when an existing air conditioning (AC) unit fails. For such measures, the applicable baseline is a new code-compliant unit, and not the existing conditions. The Study Team thus defined the incremental cost as the difference between the efficient unit cost and the cost of a new code-compliant unit, with savings calculated against code requirements (often more stringent than they were when the original equipment was first installed).

> **New construction measures (in new construction projects) and major renovation measures.** These measures are a type of market-driven measures, since market forces pertain to and drive new construction activity. However, the team separated these measures since there are several whole-building measures (for example, integrated building design and commissioning) that apply only to new construction or major renovations. Further, the Study Team's model forecast separates out the energy use from new construction versus that of existing buildings.

> **Retrofit measures.** A retrofit measure ocurs when there is no driving market force mandating the purchase of new equipment—for example, when a business adds controls to an existing boiler, or when a customer retires an inefficient chiller before the end of its useful life. For retrofit measures, since the counterfactual option is no action, the initial cost is the full installed cost of the measure and the savings are calculated from the existing equipment. In the counterfactual case, there is a future moment when the existing equipment would have failed and needed replacement. At that time, it is assumed there is a cost that would have been incurred, but which was avoided because of the retrofit. At the same time, the analysis considered a shift in savings because they would be calculated against the new code-compliant unit instead of the old existing unit.

These market characterizations are important because the costs and savings of a given measure can vary by applicable market, as can the timing and magnitude of the different efficiency opportunities. Regarding the costs and savings, a retrofit, or early retirement of operating (but inefficient) equipment, involves covering the costs of entirely new equipment. Those costs also involve the labor to install it and dispose of the old equipment. The retrofit can be done at any time because it is not tied to any particular market event. For new construction or other market-driven opportunities, installing new, high-efficiency equipment might involve only the incremental cost difference between the standard efficiency of a piece of equipment and the cost of a high efficiency one; the same labor and capital costs would be incurred in either case. In addition, these interventions can be effective only at the time of some natural market event such as construction of a new building, upon equipment failure, or during remodeling. On the savings side, retrofit measures can initially save more when compared to older existing equipment, but savings are reduced at the time when the baseline equipment would have failed and needed natural replacement. Market-driven measures, by contrast, only achieve the incremental savings over current standard efficiency purchases from year one.

For each measure, in addition to separately characterizing them by market, the Study Team separately analyzed the measure / market combination for the building market segments (e.g., office, retail space, food services, etc.). Together, the team modeled 5,476 distinct measure/market/segment/fuel permutations for each year of the analysis.

In general, measure characterizations involve defining the following for each combination of measure, market, and segment:

- Measure lifetime—both baseline and high-efficiency options, if different
- Measure savings, relative to baseline equipment
- Measure cost, whether incremental or fully installed, depending on the market
- Operations and maintenance (O&M) impacts, relative to baseline equipment (where significant and feasible to quantify)
- Water use impacts, relative to baseline equipment (where applicable)

ENERGY SAVINGS

For each technology, the Study Team has based the energy use of baseline and high-efficiency measures primarily on engineering analysis or related research. The team has relied heavily on the statewide baseline data collected as part of this study, the New York TRM and TRMs from other jurisdictions, and the Study Team's own database of measure characteristics. For more complex measures not addressed by the TRM engineering calculations, the team has used inputs from the baseline data and available information on the performance of high-efficiency equipment or practices.

COSTS

The analysis drew measure costs from the Study Team's measure characterization database when no specific New York costs were available. The Study Team has developed these costs over time, continually updating them with the latest information from local and regional jurisdictions. The current database now contains updates for studies in New Orleans and Minnesota, for example. Major sources are the Mid-Atlantic TRMs, the Minnesota TRM, incremental-cost studies, direct research into incremental costs, and other analyses and databases that are publicly available.

LIFETIMES

As with measure costs, the Study Team drew measure lifetime information from its own measure characterization database. This long-standing and routinely updated information was revised for this study, using data from the New York TRM.

OPERATIONS AND MAINTENANCE IMPACTS

O&M impacts are those not relating to energy costs of operations. They represent, for example, replacement lamp purchases for new, high-efficiency fixtures; or changes in labor for servicing high-efficiency vs. standard-efficiency measures. High-efficiency equipment can often reduce O&M costs because high-quality components require less-frequent servicing. On the other hand, some high-efficiency technologies require enhanced servicing, or have expensive components that need to be replaced prior to the end of the measure's lifetimes. For most measures, O&M impacts are very minimal, because many efficient and baseline technologies have the same O&M costs over time. Where these impacts are significant, the team has based its estimation of those impacts on proprietary engineering and cost analyses, the New York TRM, and other available data. These estimates are applicable mainly to lighting measures, which have replacement costs that are easy to define and quantify.

Top-Down Approach

The general top-down approach to this study begins with the baseline forecasted sales for each building segment, which the Study Team has then broken down into loads attributable to individual building equipment. The top-down approach looks at the energy sales forecast and disaggregation data, and determines the percentage of the applicable end use energy that can be offset by the installation of a given efficiency measure in each year. This contrasts with a “bottom-up” approach, in which a specific number of measures are assumed to be installed each year.

The Study Team has applied measure-specific factors to the forecasted building type and end use sales, by year, to derive the annual potential for each measure in the 10-year analysis period, using the following central equation:

$$\text{Measure savings} = \text{Segment / end-use / year kWh sales} \times \text{Applicability factor} \times \text{Feasibility factor} \times \text{Turnover factor (replacement only)} \times \text{Not complete factor (retrofit only)} \times \text{Savings fraction} \times \text{Penetration rate}$$

The Study Team has defined the equation terms and their related factors as follows:

- **APPLICABILITY FACTOR** is the fraction of the end-use energy sales (from the sales disaggregation) for each building type and year that is attributable to equipment that could be replaced by the high-efficiency measure. For example, for replacing office interior linear fluorescent lighting with a higher efficiency LED technology, the Study Team uses the portion of total office building interior lighting electrical load consumed by linear fluorescent lighting.
- **FEASIBILITY FACTOR** is the fraction of applicable end use sales for which it is technically feasible to install the efficiency measure. Numbers below 100% reflect engineering or other technical barriers that are likely to preclude the adoption of the measure. The Study Team did not reduce feasibility for economic or behavioral barriers that would affect penetration estimates. Rather, it reflects technical or physical constraints that would make measure adoption impossible or ill-advised, e.g., efficient lighting technology that cannot be used in certain low-temperature applications.
- **TURNOVER FACTOR** is the percentage of existing equipment that will be naturally replaced each year due to failure, remodeling, or renovation. This applies to the lost opportunity (planned or replaced when the equipment fails) and renovation markets only. It is generally assumed that turnover factors are to be one divided by the baseline equipment measure life (for example, the Study Team assumes that 5% or 1 / 20th of the existing stock of equipment is replaced each year for a measure with a 20 year estimated life).
- **NOT COMPLETE FACTOR** is the percentage of existing equipment that already represents the high-efficiency option. This applies only to retrofit markets. For example, if 30% of current buildings already have connected thermostats, then the not-complete factor for connected thermostats would be 70% (100% - 30%), reflecting that only 70% of the total potential from thermostats remains.

- **SAVINGS FRACTION** represents the percent savings (compared to either existing stock for retrofit markets, or new baseline equipment for non-retrofit markets) of the high efficiency technology. The Study Team bases savings fractions on individual measure data and assumptions about existing stock efficiency, standard practice for new purchases, and high-efficiency options.
    - *Baseline adjustments* refer to savings fractions' downward adjustments in future years for early retirement retrofit measures. This accounts for the fact that newer, standard equipment efficiencies are higher than older, existing stock efficiencies. The Study Team assumes average existing equipment being replaced for a retrofit measure is at 60% of its estimated useful life. The baseline adjustment also comes with a cost credit to reflect the value of deferring investment in standard equipment that the participant would have had to install to replace the failed unit.
- **ANNUAL PENETRATIONS** are the difference between the base case measure penetrations and the assumed measure penetrations for an economic potential scenario. For the economic potential, the Study Team assumes that 100% penetration of cost-effective measures is captured for all markets, with retrofit measures generally being phased in to reflect resource constraints such as contractor availability. For the achievable scenarios, the Study Team base penetrations in part on the baseline data survey questions about "awareness" and "willingness to adopt."

Use of Baseline Data

This study benefited from a rich set of primary data from the baseline study on the types, sizes, efficiencies, and features of energy-using equipment currently in place in New York State. The data allowed the Study Team to obtain an accurate picture of how much opportunity remains statewide for each measure, and to refine the savings estimates during the measure characterization process. The researchers used baseline data in four main ways:

- **NOT COMPLETE:** The baseline data showed information such as the percent of existing technology certified as ENERGY STAR®, or the portion of existing units in each efficiency bin. This information made it possible to derive not-complete factors that are directly based on current, real-world conditions.
- **MEASURE CHARACTERIZATIONS:** The baseline data allowed refinement of measure characterizations, especially the percent savings, in several ways. For example, in many measures the percent savings varies by the capacity of the unit (since code and/or efficient unit requirements vary). In these cases, the Study Team could base a weighted average on the actual portion of the equipment in each size bin. The primary data also helped set the baseline for retrofit measures. For example, if an air conditioning retrofit is applicable to measures with a seasonal energy efficiency ratio (SEER) of 11 or under, the primary data can help determine the SEER of existing measures with ratios of lower than 11.
- **APPLICABILITY FACTORS:** The primary data also significantly informed the applicability factors. For example, for lighting measures, the baseline data show the number of linear fixtures per business. When the study combined these data with the average power draw per linear fixture in a building, and made similar calculations for each lighting type, the team could derive the portion of total lighting energy use for each specific lighting type. For measures such as boilers and furnaces fueled by gas, oil, or propane, the baseline data also helped determine the portion of space and water heating loads from each fuel type.

- **YEAR 1 ENERGY USE AND SALES DISAGGREGATION:** The team similarly used primary data to derive the Year 1 energy use and sales disaggregation by building type. For electric energy, energy use by building type and region came directly from the primary baseline data. For gas, oil, and propane, the primary data showed the number of square feet using each fuel as a primary heat source. The Study Team combined this data with the building-specific energy use intensity, in MMBtu per square foot, from the U.S. Energy Information Administration's (EIA's) Commercial Building Consumption Survey, to derive total energy use by building type.

Scenario Analysis

The primary scenario for the study was the economic potential, which reflects all cost-effective energy efficiency without regard to market barriers or businesses' willingness to adopt. The Study Team also estimated technical potential, as well as maximum and constrained achievable potential.

COST-EFFECTIVENESS TESTS

Assessing the cost-effectiveness of efficiency measures means comparing the costs of investing in the measure with the economic benefits realized from that investment. The cost-effectiveness test used for this study follow the New York State Benefit Cost Analysis Framework. These tests consider the energy-related costs and benefits of efficiency measures from the perspective of the New York economy and ratepayers as a whole, including the benefits associated with avoided carbon dioxide (CO_2) emissions.

Efficiency measure costs represent the incremental cost of the efficient measure compared to code compliant or industry standard technology. Measure benefits are driven primarily by energy savings over the measure lifetime. The energy impacts may include multiple fuels and end uses, which are all accounted for in the estimation of the measure costs and benefits over its lifetime. Because the NYISO and utilities need to ensure adequate capacity to meet system peak demand, even if that peak is only reached a few hours or days each year, substantial economic benefits can accrue from reducing the system peak demand; this is accounted for in the cost-effectiveness analysis for electricity and natural gas.

The team evaluated the following scenarios:

- **ECONOMIC POTENTIAL (BASE CASE):** This scenario aligns with the values the utility uses for screening their efficiency programs and guidance from the New York Department of Public Service for developing avoided gas and electric costs. This scenario also contains a value for the social cost of carbon, to value avoided CO_2 emissions. For study regions that cover multiple utilities, the Study Team used weighted average values for each region.

- **TECHNICAL POTENTIAL:** This scenario is similar to the Economic Base Case scenario, but it does not eliminate savings from measures that are not cost-effective.

- **MAXIMUM ACHIEVABLE POTENTIAL:** For this scenario, the Study Team looked at the subset of economic potential that might be reasonably achievable if financial barriers are completely eliminated through well-designed and implemented interventions (i.e., modeled as incentives at 100% of incremental cost for each measure), with no budget constraints. The team has derived likely adoption curves over time under the achievable potential scenarios, using survey data, other program experience, assumptions about awareness and barriers, and professional judgment. Avoided costs and discount rate are the same as in the core economic scenario. The study does not include program administrative costs for the scenario.

- **CONSTRAINED ACHIEVABLE POTENTIAL:** This scenario uses the same assumptions as the Maximum Achievable scenario, but the customer is still responsible for 50% of the incremental cost of the measure, resulting in lower adoption.

DISCOUNTING THE FUTURE VALUE OF MONEY

The team has discounted the future costs and benefits to the present, using a real discount rate based on the New York investor-owned utilities' weighted average cost of capital (WACC). This approach aligns with direction from the New York Department of Public Service. For discounting, the team has assumed that initial measure costs occur at the beginning of the year, whereas annual energy savings accrue halfway through the year.

Avoided Costs

These are the benefits applied to the analysis:

- **AVOIDED ELECTRIC ENERGY COSTS:** These represent the societal costs associated with producing the marginal unit of electricity. For this study, the team used forecasts of locational marginal prices (LMPs) based on NYISO's 2018 Congestion Assessment and Resource Integration Studies (CARIS 2) model. The team simplified thousands of data points into average costs during six energy periods: on-peak (weekdays between 12 AM and 8 PM) and off-peak hours for "winter" months (December through February), "summer" months (June through August), and "shoulder" months (March through May, and September through November). For Year 1 (2020) avoided electric energy costs ranged from $24.78 / MWh in shoulder off-peak hours in the Upstate region, to $52.37 / MWh for winter on-peak hours in the Downstate region.

- **AVOIDED ELECTRIC GENERATION CAPACITY COSTS:** This is the societal cost of new generation equipment to meet an incremental increase in system peak load. For this study, the team has used NYISO's projections of prices for its installed capacity (ICAP) market.

- **AVOIDED ELECTRIC TRANSMISSION AND DISTRIBUTION CAPACITY COSTS:** This represents the societal cost of a marginal increase in system peak demand related to capital investments and maintenance costs of the utilities' transmission and distribution systems. This study uses the specific avoided costs that each utility filed in 2016 in the New York Companies Benefit-Cost Analysis Handbook (BCA Handbook).

- **AVOIDED ANNUAL GAS COSTS:** These are based on the 2018 CARIS 2 model (unburdened $ / MMBtu).

- **AVOIDED GAS TRANSMISSION AND DISTRIBUTION (T&D) COSTS:** These are based on the latest utility filings showing their marginal cost of service (MCOS) values and on Con Edison's BCA input assumptions for its 2019 efficiency portfolio.

- **AVOIDED OIL AND PROPANE COSTS**: These are the societal costs associated with meeting a marginal increase in oil or propane consumption. The team has based them on average retail rates from 2016 through 2019. Because these fuels are not regulated, retail rates reflect the marginal societal costs.

- **AVOIDED NON-ENERGY COSTS:** Some measures produce quantifiable non-energy benefits, such as O&M savings and water savings. These have been included when significant and quantifiable.

- **AVOIDED CO2 EMISSIONS:** This analysis uses the Environmental Protection Agency (EPA) Social Cost of Carbon (SCC) at the 3% discount rate and marginal emissions factors consistent with NYS standard practice. For electricity, the value is net of the projected Regional Greenhouse Gas Initiative (RGGI) compliance costs included in the 2018 CARIS 2 Base Case model.

The Study Team then multiplied avoided costs for each type, period, and year by each measure's energy and capacity savings for each fuel and for each year the measure persists, as appropriate. This approach resulted in a calculation of the avoided-cost benefits. A measure is considered cost effective if all quantified benefits exceed the measure's net incremental cost.

ELECTRIC LOAD SHAPES

The team used electric energy load shapes for each measure, to distribute the annual efficiency measure energy savings into the appropriate energy costing periods of the avoided costs, and to estimate the coincident peak demand impacts of each measure. This study relied on hourly (8,760 hours/year) load shapes specific to each building type and end use. The team developed the data from existing models of prototypical buildings under the climate zones corresponding to the specified New York regions.[6]

Economic Potential Analysis

This analysis, along with all the data inputs, produces measure-level potential, with the economic potential being limited to installation of cost-effective measures. However, the total economic potential is less than the sum of each separate measure potential. This is because of interactions between measures and competition between measures, i.e., interactions result from installation of multiple measures in the same facility. For example, if a business insulates their building, the heating load is reduced. As a result, if a business then installs a high-efficiency furnace, savings from the furnace will be lower because the overall heating needs of the building have been lowered. As a result, interactions between measures must be taken into account to avoid overestimating savings potential. Because the economic potential assumes all possible cost-effective measures are adopted, interactions assume every building does all applicable measures.

[6] The Study Team purchased EShapes from Itron.

The Study Team also made adjustments for competing measures. These are two or more efficiency measures that can be applied together for a given use, but only one can be chosen. An example is choosing between installing a boiler or a furnace, but not both. In this case, the total penetration for all competing measures is 100%, with priority given to the measures ranked from offering the highest savings to the lowest savings. If the first measure is applicable in all situations, it would have 100% penetration, and all other competing measures would show no potential. If, on the other hand, the first measure could be installed in only 50% of opportunities, then the second measure would capture the remaining opportunities.

The Study Team evenly spread out the implementation of retrofit measures across the 10-year study period. The retrofit penetration rates are assumed to be 10% of the market for each of the 10 study years, with the exception of technologies with a measure life under 10 years. For example, since retro-commissioning has a measure life shorter than the analysis period, the same building might become eligible for a second retro-commissioning, once the first one has expired. For shell measures with effective lives longer than 10 years, for example, the penetration is evenly spread across the study years until it achieves 100% of eligible participation.

Adoption Curves

The Economic Base Case scenario estimates a good upper bound on the amount of cost-effective potential available given current energy-related and measure costs. However, in a practical sense, the potential is limited through several non-financial market barriers, even if an efficiency program or market intervention eliminates all financial barriers. Further, it will take time for a market to achieve its maximum adoption. From an analytical perspective, the Study Team made assumptions about the rate at which customers will adopt efficiency measures if an energy efficiency program promotes them through financial incentives, financing, reductions in transaction costs, marketing, and education of customers and contractors.

An achievable efficiency scenario therefore assumes some level of incentive or market intervention and attempts to model customer response.

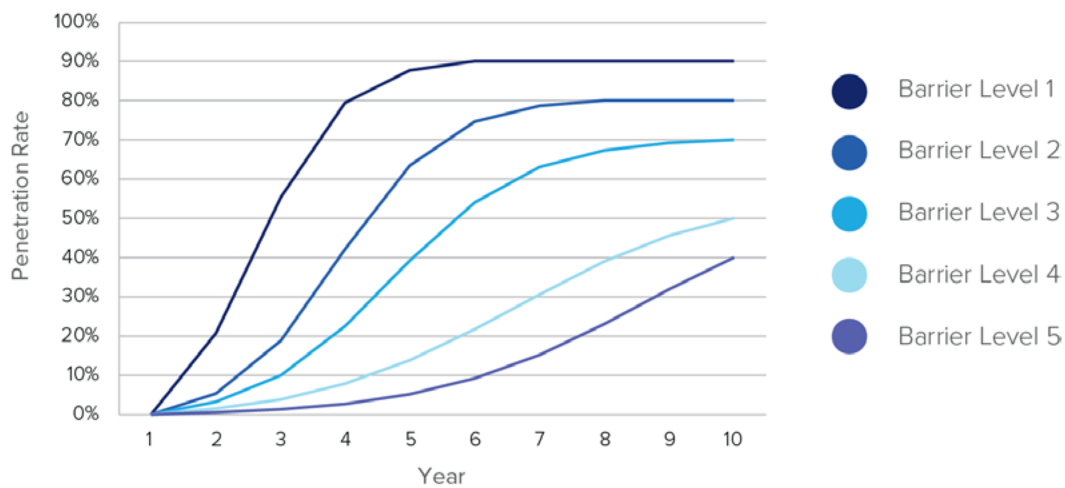
MAXIMUM ACHIEVABLE POTENTIAL

To estimate the maximum achievable potential, the Study Team estimated the maximum achievable penetration (that is, the adoption rate) for each measure and market. For the “lost opportunity” market—involving natural replacement, new construction, and renovation—the penetration is the portion of the turnover or construction / renovation rate in a given year. For the retrofit market, the maximum penetration is the percent of the total market available to install the energy efficiency measure. The results of top-performing programs informed maximum penetration rates, as did methods for estimating the maximum achievable potential reported in the literature.

Energy efficiency measures are assumed to be adopted in a standard S curve (sigmoid curve), where the adoption rate increases slowly in the initial program years from early adopters, then steepens significantly in the mid-years of mass adoption, and then levels out in later years, when latecomers adopt the measure. The initial and final rates of adoption vary according to the level of market barriers associated with each measure. This pattern pertains too to the number of years it takes to reach maximum adoption.

The Study Team assigned a barrier level (on a scale of 1 to 5) to each measure. Barrier Level 1 reflected inexpensive, straightforward, one-for-one replacements, such as LED lighting. Barrier Level 5 represented expensive, complicated measures that might require some active participation from the customer, such as deep energy retrofits. Each barrier level had its own associated sigmoid penetration curve, with different maximum penetrations and different ramp-up rates. In some cases, the team used custom curves, such as when there were multiple, mutually exclusive measures. Figure 1 shows the default curves for each barrier level, for market-driven measures. The curves for retrofit measures look the same, but have a lower scale, as the percentage applies to the whole census of existing equipment, rather than just the portion that is naturally turning over in a given year. Most measures start with some existing penetration. In this case, the curves will be shifted over to the left until the Year 1 value matches the estimated existing penetration.

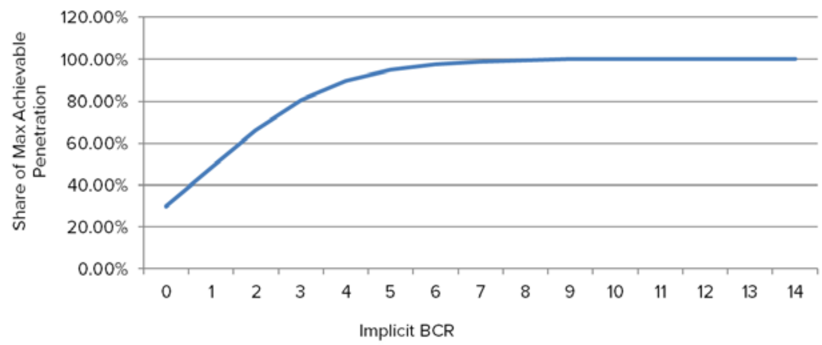
Figure 1 | Default adoption curves for market-driven measures, by barrier level



CONSTRAINED ACHIEVABLE POTENTIAL

The incentive-constrained achievable potential scenario assumes that the customer remains responsible for, on average, 50% of the measure incremental costs. In this scenario, penetration will be lower than for the maximum achievable value, since not everyone who is willing to install the measure at cost parity (e.g., with an incentive that covers full incremental costs) is still willing to install if the incentives are only at 50% of incremental cost. To adjust the maximum achievable penetration, the team looked at the participant benefit-cost ratio (BCR). The participant BCR compares the benefits of the efficiency measure (cost savings across the measure life) to the incremental cost of the measure from the perspective of the program participant. This test discounts the stream of benefits at the same rate as used in the test to determine societal cost-effectiveness. As the participant BCR increases, the penetration of the measure will approach the maximum achievable penetration, as defined above. The curve in Figure 2 defines how the maximum adoption is affected by the participant BCR in the Constrained Achievable scenario.

Figure 2 | Effects of maximum adoption by the participant's benefit-cost ratio.



The y-value of the curve acts as a multiplier to the maximum adoption level in the Maximum Achievable scenario. For example, assume a measure with Barrier Level 1 has a participant BCR of about 2, with incentives covering 50% of the incremental cost. In the Maximum Achievable scenario, the maximum adoption would reach about 90%. In the Constrained Achievable scenario, the maximum adoption is: 90% x 60% = 54%. Once the participant BCR rises over 5, the Constrained Achievable potential starts to approach the Maximum Achievable potential.

Finally, the baseline study data collection effort asked certain questions about measure adoption. Table 2 shows the most pertinent question for adoption curves. The survey asked respondents how likely they were to implement an efficiency measure with the given incentive amounts, represented in terms of share of the measure's incremental measure cost (IMC). Table 2 shows the portion of respondents giving a 6 or 7 on a scale of 1 (not at all likely) to 7 (very likely).

Table 2 | Impact of Financial Incentives on Likelihood to Purchase Energy Efficient Equipment to Replace Failed Equipment (Share of Respondents Providing Likelihood Rating of 6 or Higher on 1 to 7 Scale)

	Statewaide					
	Incentive covering 0% IMC?		Incentive covering 50% IMC?		Incentive covering 100% IMC?	
Segment	Share	n	Share	n	Share	n
Office / Government	27%	476	56%	477	87%	479
Retail	25%	510	60%	512	85%	510
Food service	22%	398	51%	391	84%	389
Grocery / Convenience Store	26%	152	55%	149	86%	149
Health Services	25%	251	57%	250	85%	251
Education	25%	211	60%	210	90%	211
Lodging/Hospitality	25%	118	58%	115	89%	116
TOTAL	**25%**	**2,265**	**56%**	**2,254**	**86%**	**2,253**

Table 2 shows that 86% of respondents said they would be likely or very likely to install the measure with incentives covering the full incremental cost of the measure. This response corresponds well to the default maximum achievable adoption curves, falling right in between the maximum adoption for measures with Barrier Level 1 and measures with Barrier Level 2.

SECTION 2B

Other Appendices

Other Appendices

Additional appendices for this report include the detailed inputs used in the potential model. Due to their dimensions, the Study Team provided these as separate Microsoft Excel spreadsheets. The other appendices are:

Appendix 2B: Baseline Energy Sales Forecasts
Appendix 2C: Energy Sales Disaggregation by Building Type and End Use
Appendix 2D: Measure Results
Appendix 2E: Measure Characterizations