



Xcel Energy Colorado Stakeholder Meeting

November 12, 2020



On the call today



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Agenda

01 | Project Plan

02 | Modeling Methodology

03 | Improvements &
Additional Considerations

04 | Measure
Characterization

05 | Next Steps

Project Plan



Project Plan

- Guidehouse is in the process of estimating the DSM technical, economical, and achievable potential for Xcel Energy's Colorado territory. Our study covers both electric and gas potential.
- Project Timeline



Modeling Methodology



DSM Potential Model Architecture

Model Inputs



Equipment Saturation



Building Stock Characteristics



Historic Consumption



Load Forecasts



Measure Costs, Other Chars



Customer Willingness to Pay



Demand Side Management Simulator

Key Input

Net or Gross:

Potential to Evaluate:

Screening Cost Test:

Considered Cost Tests:

Apply CO2 Price:

Emerging Tech Overlay:



Measure Filters

Key Output

Cumulative Potential % of Sales: mid

Potential by Sector and Utility: mid

Top Measures by Utility: mid

Measure B/C Ratio: mid

Benefits and Costs Summary: mid

Budget Breakdown: mid

Key Modules



Advanced Interface



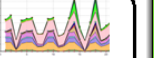
Model Details



All Potential



Other Input

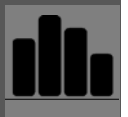


Other Output

Source: Guidehouse

Model Outputs

Technical, Economic, Achievable Potential



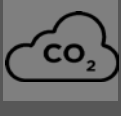
Achievable Potential Sensitivities



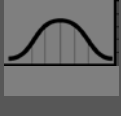
DSM Supply Curves



Carbon Emissions Reduction



Market Saturation

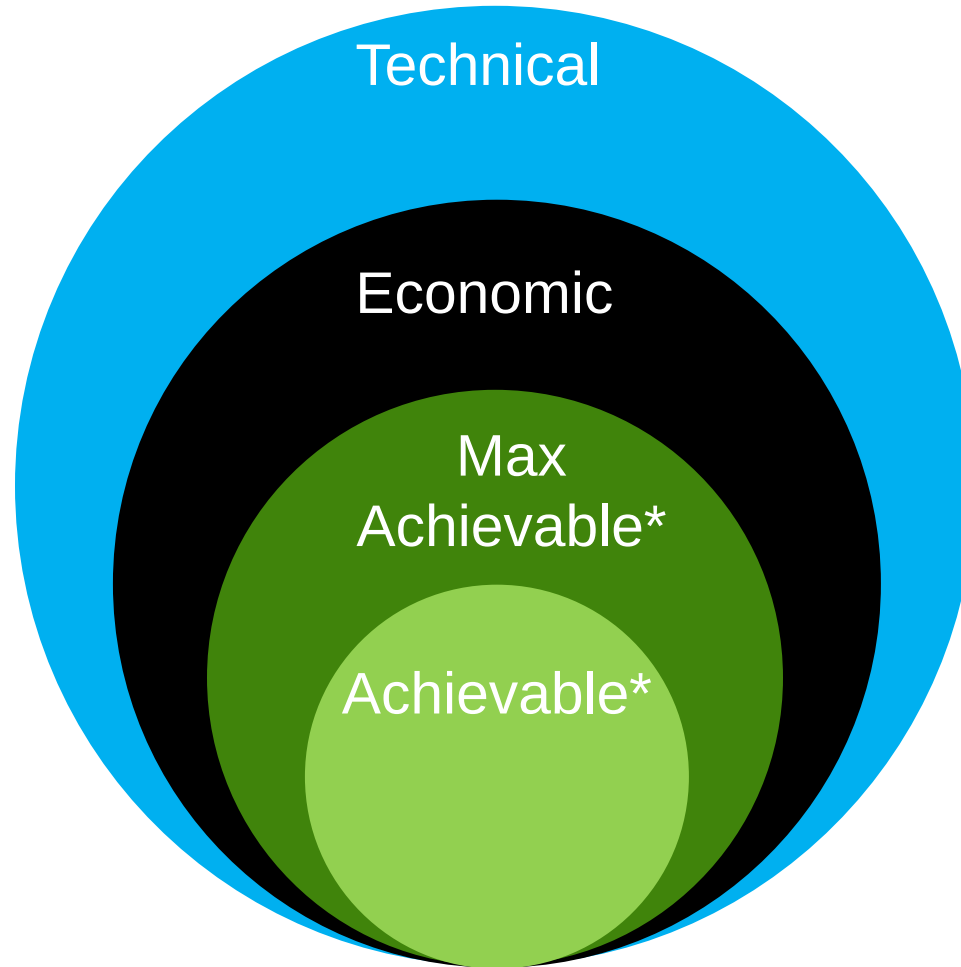


Resource Acquisition Cost



DSM Potential Definitions

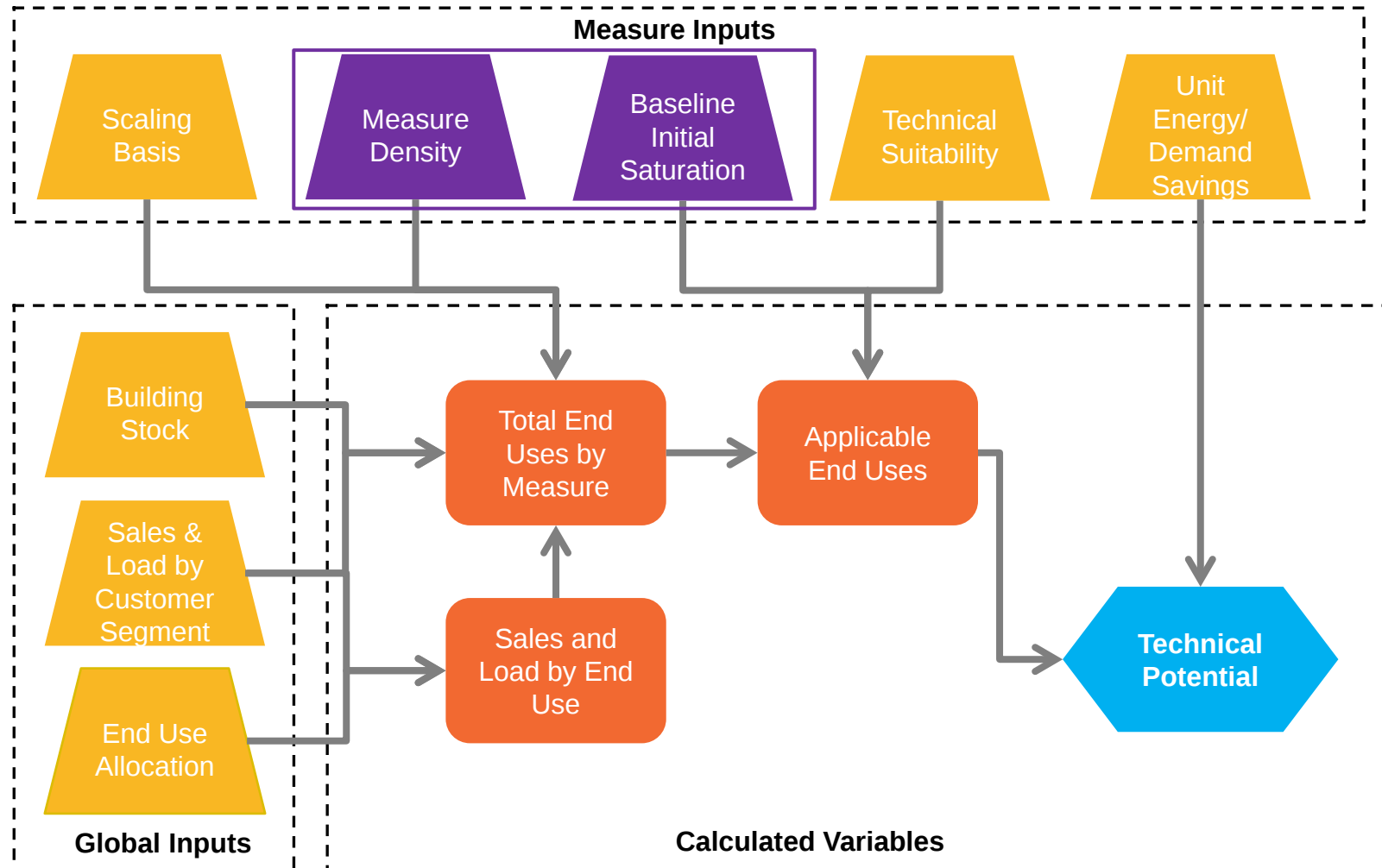
Each level of potential has defining characteristics



Achievable potentials are **not a true exclusive subset of the higher levels*

Technical Potential

Upper limit of potential savings set by selected energy efficient measures

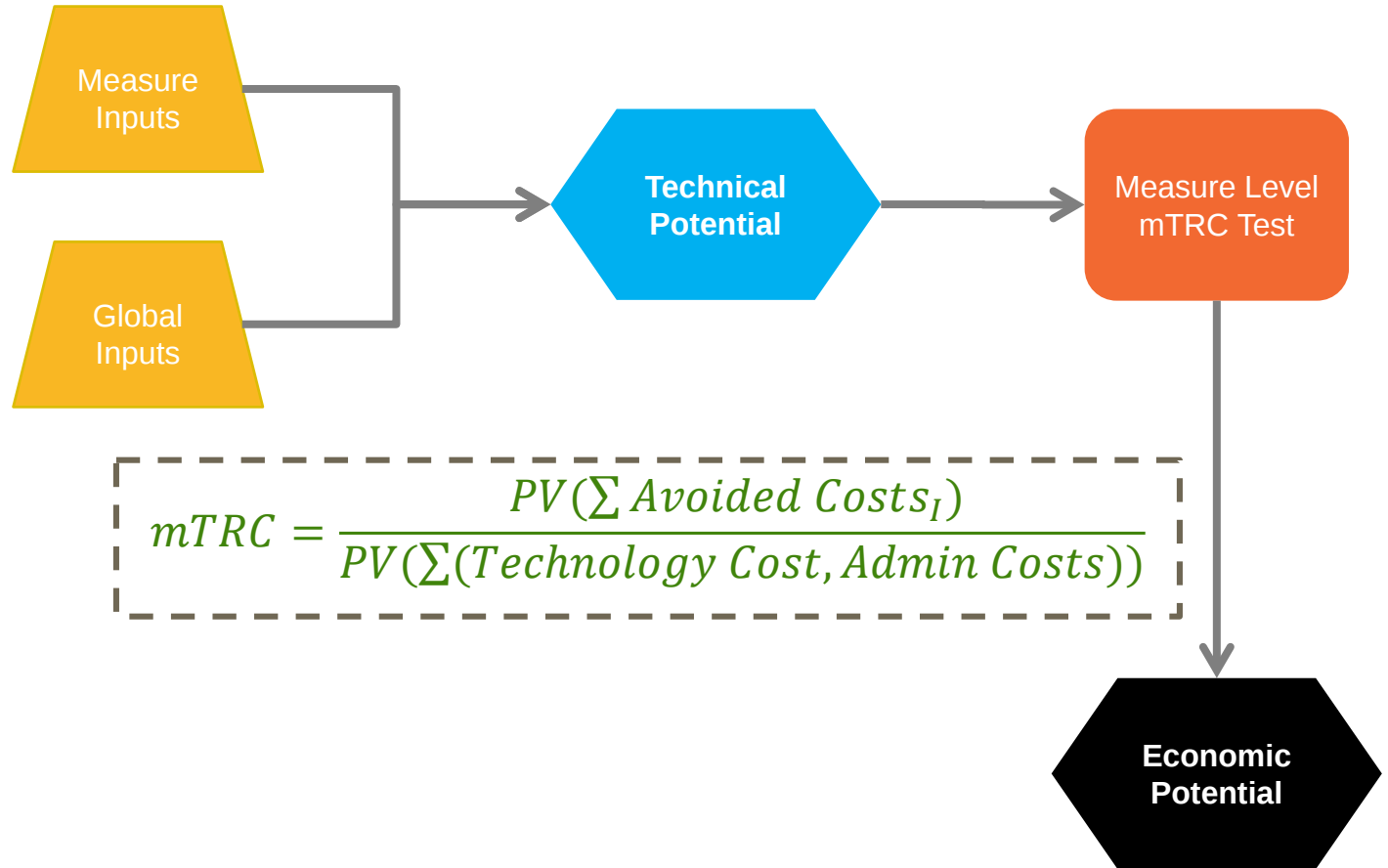


● Primary Data Collection

Economic Potential

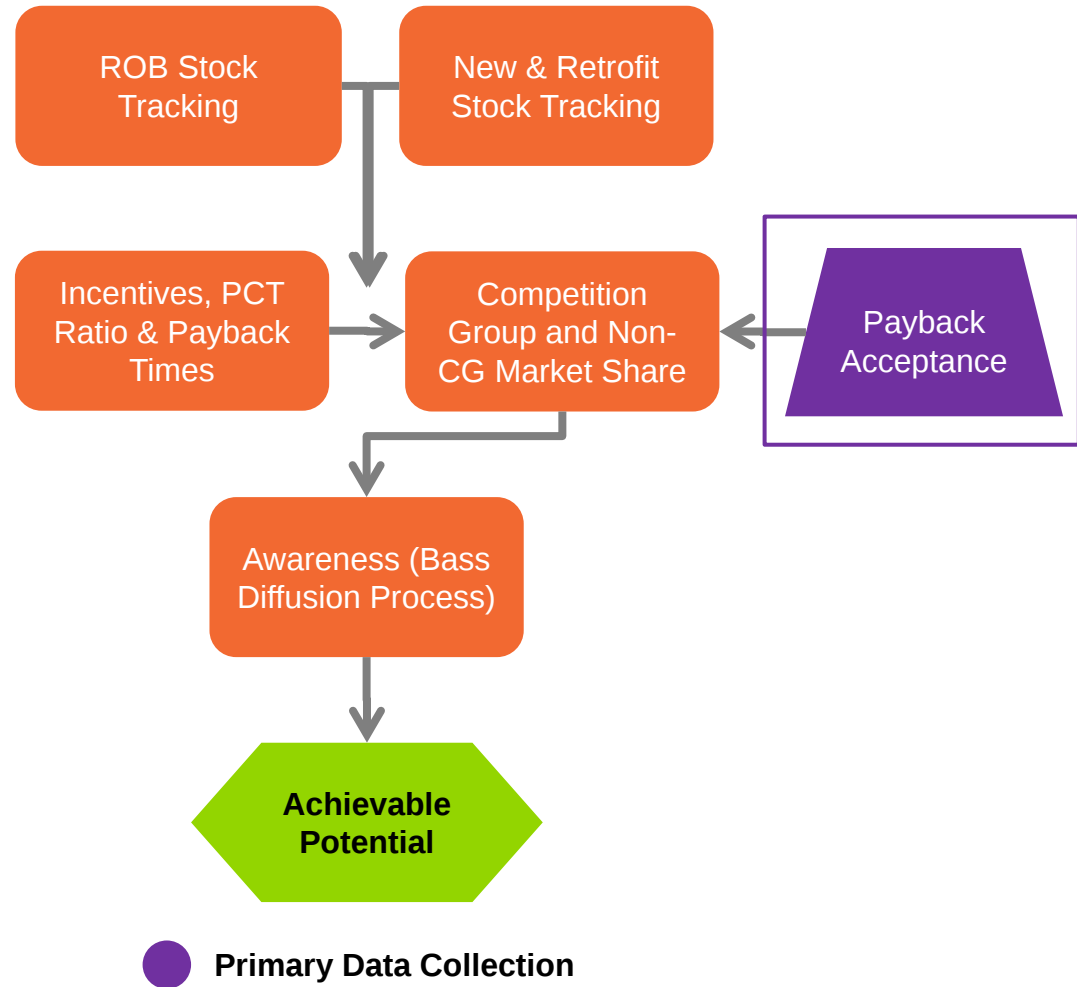
Economic screening further limits potential from selected energy efficient measures

- » **PV()** is the present value calculation that discounts cost streams over time.
- » **Avoided Costs** are the net monetary benefits resulting from electric energy and demand savings.
- » **Technology Cost** is the net incremental equipment cost to the customer.
- » **Admin Costs** are the gross administrative costs incurred by the utility or program administrator.
- » **Impact Types, I**, represent electric energy, winter peak demand, natural gas, water, and biomass

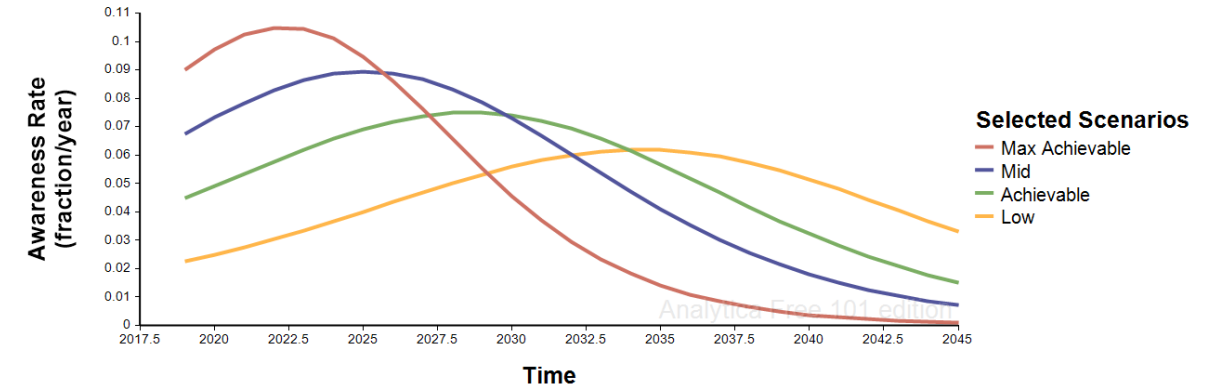


Achievable Potential

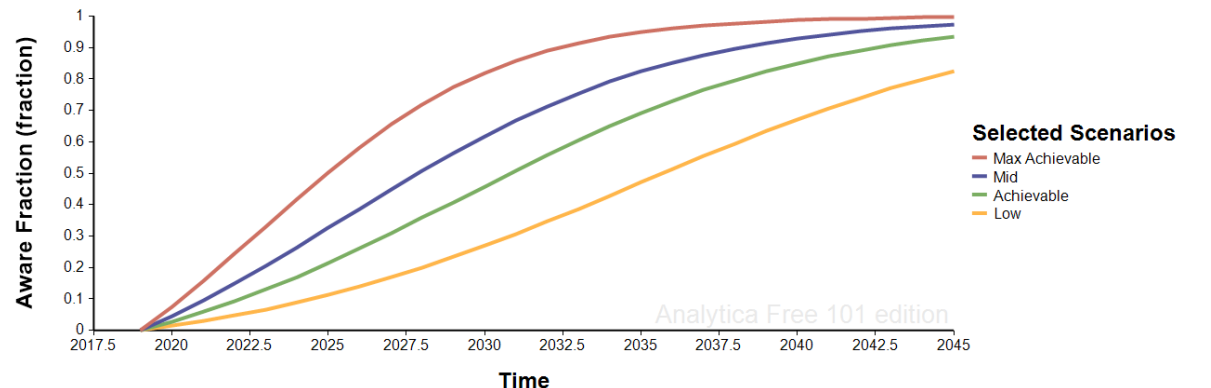
Expected value of potential savings given realistic market conditions



Effect of Marketing on Rate of Awareness



Effect of Marketing on Total Awareness



Improvements since Previous Studies and Additional Considerations



Improvements for the Xcel Energy Colorado DSM Potential Study

Sensitivity Testing

Formal sensitivity testing will be completed on potential levels.

- 2019 study found that removing economic screen had limited impact on overall potential.
- We are focusing primary research on high impact variables from previous studies to reduce uncertainty.
- Parametric sensitivity testing on key model inputs.
- Sensitivity will guide specific potential scenarios.

Evaporative Cooling & Appliance Recycling

Some residential measure program achievements have been higher than previous study achievable potential.

- Evaporative cooling and Appliance Recycling will be a focus of model calibration.

Focus on New Construction

New construction measures drove potential in previous studies and require more attention.

- Previous studies used sales projections as proxy for growth in new construction building stock and new construction measures were characterized at a whole building level. We are revisiting these assumptions.
- We are incorporating program data into estimates of savings for new construction buildings at a whole building and measure level.

Data Centers & EMS

Additional data center measures have been added to the model.

- PSCO program achievement outperformed potential estimates from 2016.
- We added new measures for the data center segment.
- We are sampling data centers explicitly in our baseline study.
- We are collecting additional baseline information on commercial energy management systems.

Additional Considerations for the Xcel Energy Colorado DSM Potential Study

Beneficial Electrification

Considering several approaches to calculate the potential impacts from beneficial electrification.

- Through our primary research efforts, we are collecting the data required to model potential for electrification and report on end use equipment density and efficient saturation for different fuel type customers.
 - Gas only
 - Gas & electric
 - Electric only
- We will analyze the economics of electrification from both the utility and customer perspective.
 - UCT
 - PCT
 - RIM
 - mTRC
- We will consider how electric rates may impact customer economics and adoption of electrification technologies through sensitivity analysis.

Demand Response

Exploring options for supporting Xcel Energy's future demand response needs through this study.

- Deeper dive on permanent peak kW demand reduction from DSM measures in this study.
- Closer look at densities and saturations of demand response enabling technologies within our measure list.
- Discussing other ways in which study activities may meaningfully inform understanding of demand response potential.
- Setting the foundation for future research into demand response potential.

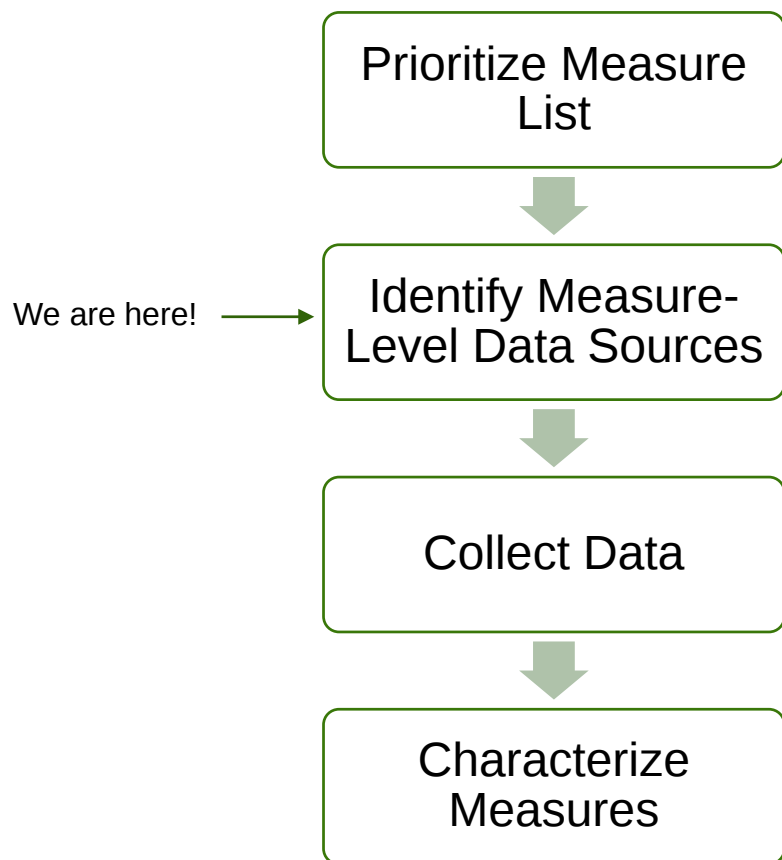
Questions?

Measure Characterization



Measure Characterization – Process and Data Needs

Measure Characterization Steps



Key Measure Data Required for Characterization

- Electric energy and demand savings
- Measure cost
- Replacement type (replace-on-burnout, retrofit add-on, etc.)
- Density (e.g. products per household)
- Saturation (percentage of market that is already efficient)
- Technical suitability of measure for each building type (expressed as percentage)
- Measure lifetime
- Net-to-gross ratio

 Primary Data Collection

Measure Characterization – Technology Types and Data Sources

Technology Types

Existing Technologies

These technologies are defined as technologies that are already a part of the Xcel Energy's Colorado DSM Plan or a part of Xcel Energy's Portfolio of EE programs.

Emerging Technologies

These technologies are known/existing technologies that have a reasonable chance of customer adoption in the frame of the study, and are experiencing rapidly changing costs or efficiencies through economies of scale or R&D. We will not plan to include “generalized” emerging measures as a part of any potential estimate.

Data Sources

The savings and cost measure parameters will be derived from the following data sources:

- Xcel Energy 2021-2022 Colorado DSM Plan – This is the primary source of cost and savings data for majority of the measures.
- Xcel Energy Colorado Program Plan and Technical Assumptions.
- Available and vetted case studies for viable technologies.
- Other (Applicable) TRMs.
- DOE Solid State Lighting Cost Database.

Apart from the primary data collected as a part of this study, market characteristics for the measures will be informed by the following secondary sources:

- Xcel Energy Colorado 2021-2022 DSM Plan.
- Xcel Energy Colorado 2018 Business Lighting Saturation Survey.
- Xcel Energy Colorado 2018 Home Use Energy Survey.
- Xcel Energy Colorado DSM Potential Study (2016 & 2019).
- Other Baseline Studies from Relevant Jurisdictions.

Measure List

Sector and End Use Mix

Residential

Appliances (3)
Electronics and Office Equipment (2)
Hot Water (12)
Lighting (6)
Refrigeration (4)
Space Cooling (5)
Space Heating (4)
Space Heating and Cooling (15)
Whole Building/House (3)

Commercial

Appliances (1)
Electronics and Office Equipment (2)
Hot Water (4)
Lighting (15)
Non-Res Cooking (7)
Non-Res Refrigeration (5)
Space Cooling (5)
Space Heating (3)
Space Heating and Cooling (8)
Whole Building/House (2)

Industrial

Compressed Air (5)
Fans, Blowers, Motors, Drives and
Pumps (7)
Lighting (1)
Process Heat (6)

Xcel Energy Colorado Measure List

Measure List Development

- Starting point - Measure list from the 2016/2019 Xcel Energy Colorado potential study
- Appended the list with new technologies added in Xcel Energy Colorado's DSM Plan
- Identified new and emerging technology measures from other recent potential studies and TRMs
- Updated baselines of measures that have increased efficiency i.e. CFL/Halogen Market Mix as a baseline for LED measures
- Reviewed measure list with individual program teams at Xcel Energy Colorado
- Excluded measures based on the confirmation of the Xcel Energy Colorado Team e.g. pipe insulation and floor insulation that have negligible potential or are becoming standard practice

Questions?

Next Steps



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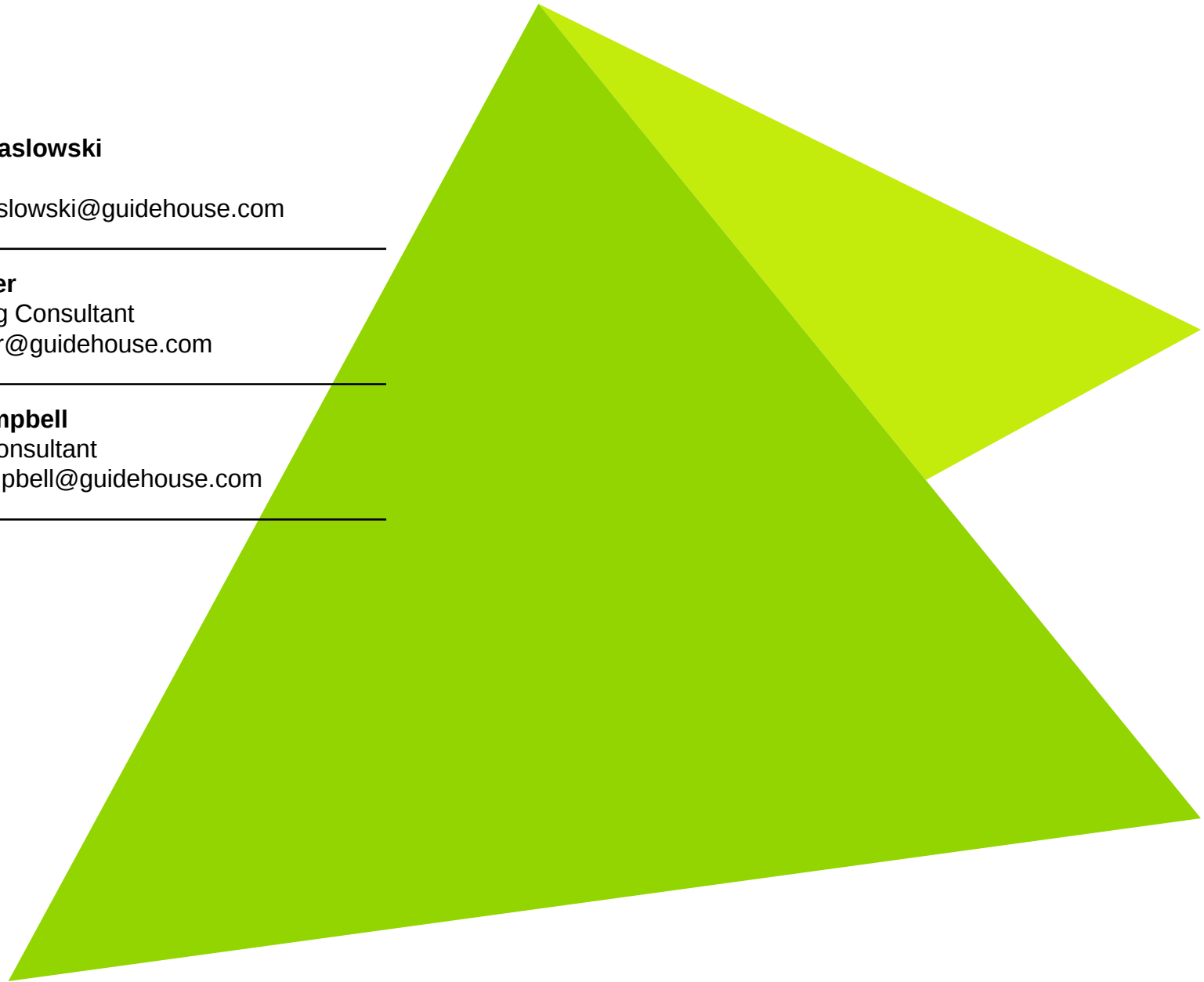
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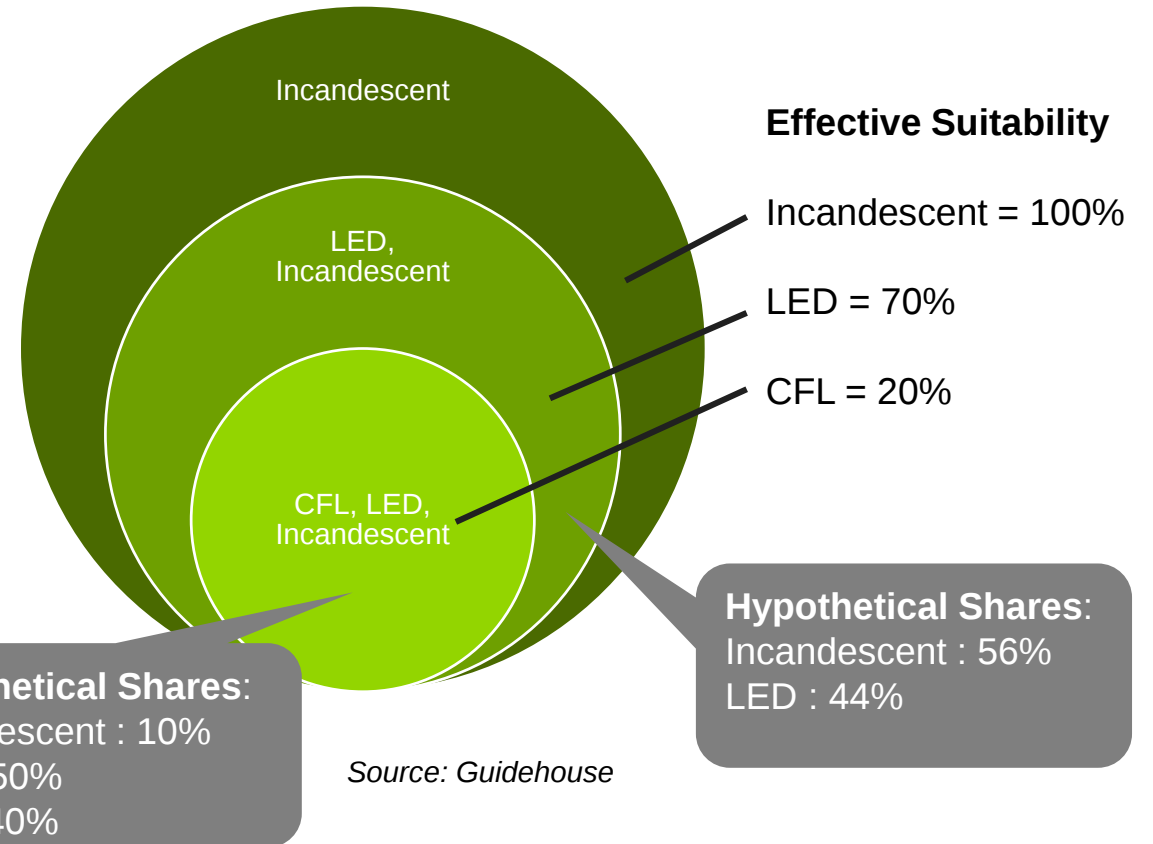
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Nested Competition for Market Share

In-depth look at how competing efficient technologies are compared

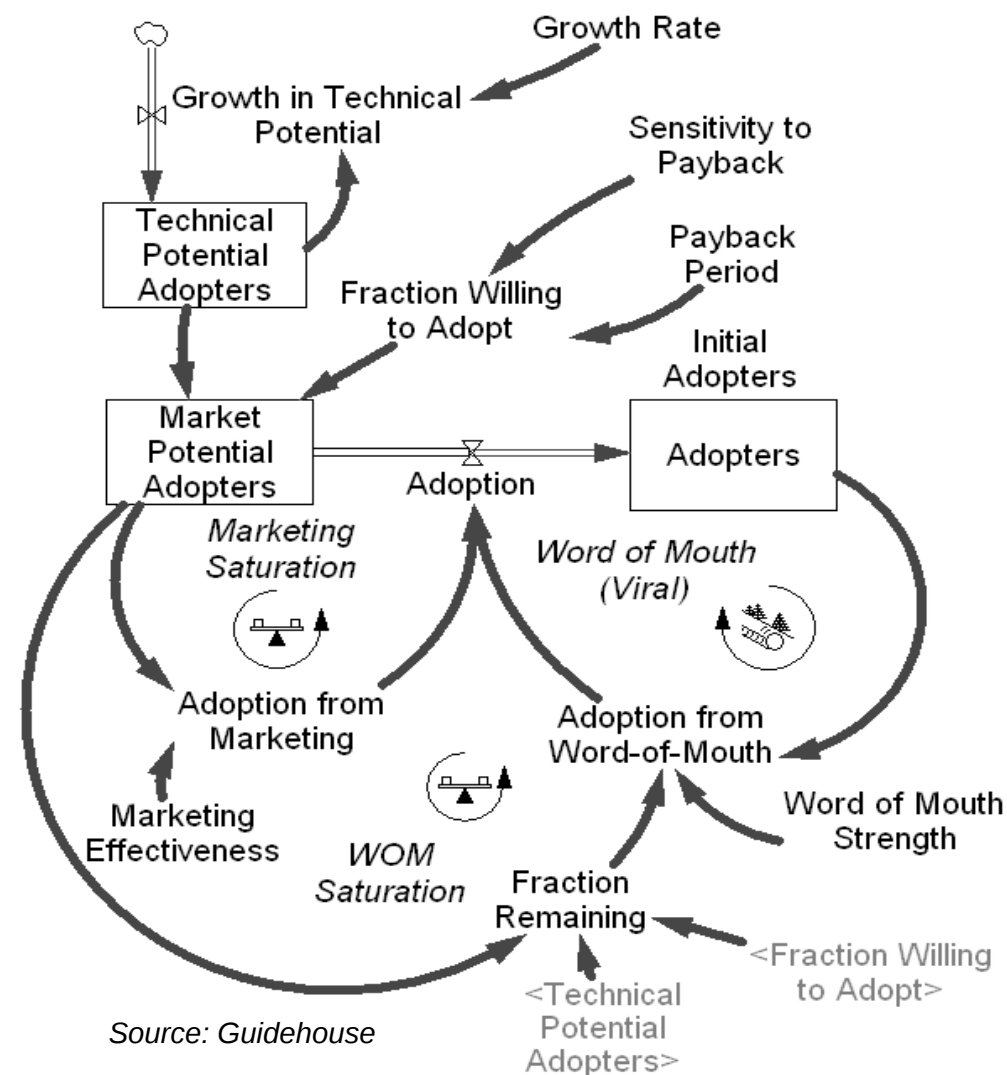
- » Competition groups associate technologies that can replace the same baseline to **prevent double-counting**
- » Competition group measures **compete for nested subsets** of the suitable end use opportunities.
- » Efficient measures compete against each other and the baseline technology
- » The size of each subset is a function of each measure's "effective suitability", which is **limited by awareness and technical suitability**.
- » The **calculated market share** for each measure is the measure's share within each subset times the size of the subset, summed up over all subsets



New Construction and Retrofit Measures

» *New Construction*

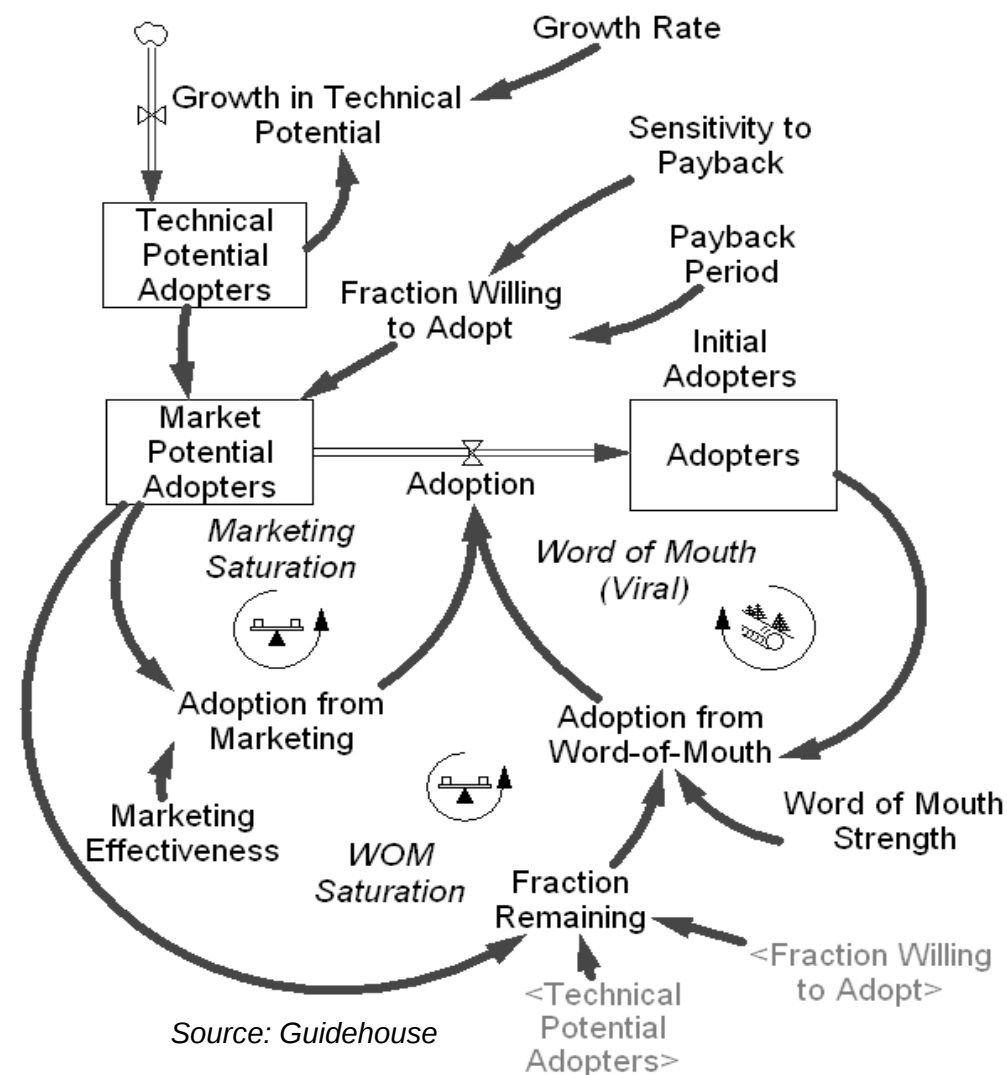
» Retrofit Measures



Replace on Burnout Measures

Stock and Flow Diagram

- » **Upper bound on EE opportunities limited by measure turnover**
 - Measure turnover dictated by measure lifetime exponentially distributed.
- » **Awareness is calibrated to historic program performance (s-shaped bass diffusion) and limits market share when low**



Market Share Appendix Slide

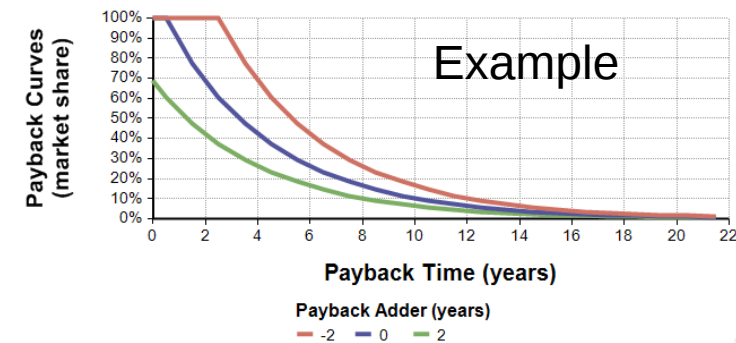
What % of market is comprised of baseline technologies & efficient technologies and how are different competing efficient technologies handled?

» Among competing efficient measures

- Relies on a **logit formulation** for simulating discrete choice of competing EE measures.
- **PCT ratio is the main driver** for participant's selection among EE measures.
- Logit market share is used to determine a simple payback for entire competition group based on the **most economic measure**.

» Among EE and baseline measures

- Relies on **payback acceptance curves** empirically based on Guidehouse-led surveys.
- Competition groups treated as single EE measure to determine total EE market share, which is then re-distributed to competing measures based on **logit market share**.
- Payback adders (positive or negative) can be applied for calibration to observed acceptance levels to account for **market barriers**.



$$CGMarketShare = \frac{e^{PCT_m * \alpha}}{\sum_m e^{PCT_m * \alpha}}$$

- **CGMarketShare** = competition group market share
- **PCT** = participant cost test ratio
- **alpha** = sensitivity to differences in PCT
- **m** = competing measures

Source: Guidehouse

Measure List – Sector and End Use Mix

Sector / End Use	Number of Electric Measures	Number of Gas Measures
Residential - Appliances	3	2
Residential - Electronics and Office Equipment	3	-
Residential - Hot Water	6	6
Residential - Lighting	6	-
Residential - Refrigeration	4	-
Residential - Space Cooling	7	-
Residential - Space Heating	-	4
Residential - Space Heating and Cooling	21	15
Residential - Whole Building/House	4	4
Industrial - Compressed Air	5	-
Industrial - Fans, Blowers, Motors, Drives and Pumps	15	-
Industrial - Lighting	1	-
Industrial - Process Heat	-	5
Industrial - Whole Building/House	4	-
Commercial - Appliances	3	-
Commercial - Electronics and Office Equipment	2	-
Commercial - Fans, Blowers, Motors, Drives and Pumps	7	-
Commercial - Hot Water	2	3
Commercial - Lighting	16	-
Commercial - Cooking	7	7
Commercial - Refrigeration	10	-
Commercial - Space Cooling	11	-
Commercial - Space Heating	-	4
Commercial - Space Heating and Cooling	12	1
Commercial - Whole Building/House	8	2

Residential Measures

End Use	Efficient Measure	Baseline Measure
Space Heating & Cooling	Upgrade to R-49	R 0-15 Attic Insulation
	R value between 30-40 (Insulation level higher than baseline level)	R value between 0-4 (Insulation level higher than baseline level)
	CAC/HP QIV	no CAC/HP QIV
	CAC Tune-up	No Central Air Conditioning Tune-up
	Central Furnace Efficient Fan Motor : ECM Motor	Standard furnace motor : PSC Motor
	Ductless Mini Split Heat Pumps (SEER 18-23)	NEW/ROB: Federal Minimum / ER: Existing conditions
	High Efficiency HP Equipment <17 SEER	Baseline Eff HP Unit
	HE VRF AC/HP operates to share space heat and avoid compressor operation when possible	Baseline Eff (AC)/HP Unit
	High efficiency windows	Standard Single-Pane/Double-Pane Windows
	More than 10% air leakage reduction of the pre-installation reading is required	Upper limit of 4.00 CFM50 per square foot of house floor area
	Interior operable storm windows	No interior storm windows
	Reduced radiant cooling load during summer and heat loss in winter	Standard Window
	Properly programmed programmable thermostat	Manual Thermostat, Programmable Thermostat operated as a manual thermostat, or no thermostat
	ENERGY STAR Smart Thermostat	Manual or Programmable thermostat
	Insulation level higher than baseline level	Retrofit - Existing insulation / NEW - IECC 2009
Lighting	Indoor LED Fixture (hard wired, pin-based)	Incandescent/CFL Bulb (Market Baseline Wattage)
	LED Lamps	Mixed Market Incandescent/CFL/Halogen Bulb
	Outdoor LED Fixture (hard wired, pin-based)	CFL/Halogen Bulbs (Market Baseline Wattage)
	LED Linear Tube	T12/T8 Fluorescents
	Networked/ Connected - Indoor LED Lamp	Mixed Market Incandescent/CFL/Halogen Bulb
	Residential Occupancy Sensors for Common Area in MF Buildings	No Occupancy Sensors

Residential Measures

End Use	Efficient Measure	Baseline Measure
Hot Water	ENERGY STAR storage or tankless water heater	Federal standard minimum efficiencies for electric/gas storage and instantaneous water heaters
	Heat Pump Water Heater	Federal standard minimum efficiencies for electric storage and instantaneous water heaters
	0.5 gpm (bathrooms) 1.0 gpm (kitchens)	Federal standard 2.2 gpm or greater
	Low Flow Shower head - 1.5 GPM	Federal Minimum Standard flow rate 2.5 GPM
	Insulated water heater tank	Uninsulated water heater tank
Electronics	Advanced power strips	Standard power strip or no power strip
	Smart/Wi-Fi plugs	
Space Heating	High efficiency gas-fired condensing rooftop unit (RTU)	Standard efficiency gas-fired rooftop unit (RTU)
	Energy Star 95% AFUE gas furnace	80% AFUE gas furnace
	Gas Furnace Tune Up	No gas furnace tune up
	High Efficiency boiler 95% AFUE or higher	Standard Boiler (80% AFUE)
Space Cooling	More efficient than baseline	NEW/ROB: Federal Minimum / ER: Existing conditions
	Direct evaporative cooling with cooling flow 3x the flow use for the code baseline buildings, effectiveness = 0.85	Federal Minimum: 13 SEER Split System Air Conditioner
	Integrated controls for MSHP	MSHPs without controls
	Smart Ceiling Fans	No ceiling fan
Appliances	ENERGY STAR clothes washers	Non-ENERGY STAR clothes washers
	Heat pump clothes dryers	Non-ENERGY STAR clothes dryers
	ENERGY STAR clothes dryers	
Refrigeration	ENERGY STAR Freezer	Non-ENERGY STAR freezer
	Removal of existing Freezer	
	ENERGY STAR Refrigerator	Non-ENERGY STAR refrigerators
	Removal of existing refrigerator	
Whole House	Home energy reports	No home energy reports
	Energy efficient building	Code compliant building
	Energy Star Home (15% improvement). Higher efficient Energy Star homes can be accounted as improvements over time	2015 IECC code

C&I Measures

End Use	Efficient Measure	Baseline Measure
Space Heating & Cooling	Upgrade to R-49	R 0-15 Attic Insulation
	Upgrade to R-49	R 0-15 Attic Insulation
	R value between 30-40 (Insulation level higher than baseline level)	R value between 0-4 (Insulation level higher than baseline level)
	CAC/HP QIV	no CAC/HP QIV
	CAC Tune-up	No Central Air Conditioning Tune-up
	Central Furnace Efficient Fan Motor : ECM Motor	Standard furnace motor : PSC Motor
	Ductless Mini Split Heat Pumps (SEER 18-23)	NEW/ROB: Federal Minimum / ER: Existing conditions
	High Efficiency HP Equipment <17 SEER	Baseline Eff HP Unit
	HE VRF AC/HP operates to share space heat and avoid compressor operation when possible	Baseline Eff (AC)/HP Unit
	High efficiency windows	Standard Single-Pane/Double-Pane Windows
	More than 10% air leakage reduction of the pre-installation reading is required	Upper limit of 4.00 CFM50 per square foot of house floor area
	Interior operable storm windows	No interior storm windows
	Reduced radiant cooling load during summer and heat loss in winter	Standard Window
	Properly programmed programmable thermostat	Manual Thermostat, Programmable Thermostat operated as a manual thermostat, or no thermostat
	ENERGY STAR Smart Thermostat	Manual or Programmable thermostat
	Insulation level higher than baseline level	Retrofit - Existing insulation / NEW - IECC 2009
	High Efficiency Product/Systems	Less Efficient Product/Systems
	Ductless Mini-Split Heat Pumps (20+ SEER)	Mini split heat pump with 13-14 SEER
	Minimum Baseline Requirements (Federal/Program)	DX RTU Unit 10-13 EER
	Occupancy detectors	Manual Heating/Cooling Temperature Setpoint and Fan On/Off/Auto Thermostat
	Efficiency must exceed IECC 2009	Code Efficiency Requirement

C&I Measures

End Use	Efficient Measure	Baseline Measure
Hot Water	ENERGY STAR storage or tankless water heater	Federal standard minimum efficiencies for electric/gas storage and instantaneous water heaters
	Heat Pump Water Heater	
	Low Flow Aerators 0.5 gpm (bathrooms) 1.0 gpm (kitchens)	Federal standard 2.2 gpm or greater
	Low Flow Shower head - 1.5 GPM	Federal Minimum Standard flow rate 2.5 GPM
	Insulated water heater tank	Uninsulated water heater tank
	Minimum thermal efficiency of 84% or higher - sized 75 MBH and above (BTS-2000 or ANSI Z21.10.3-2004/CSA 4.9-2004)	Existing hot water heating system or existing equipment below ASHRAE 2010 standards
	Gas Storage and Tankless Water Heaters	Standard Storage/Tankless Water Heaters
	Low Flow Spray Valve	Federal standards or average existing conditions
Space Heating	High efficiency gas-fired condensing rooftop unit (RTU)	Standard efficiency gas-fired rooftop unit (RTU)
	Energy Star 95% AFUE gas furnace	80% AFUE gas furnace
	Gas Furnace Tune Up	No gas furnace tune up
	High Efficiency boiler 95% AFUE or higher	Standard Boiler (80% AFUE)
	Condensing Boiler ($\geq 90\%$ efficiency)	70-80% Efficiency
	Furnace with input energy less than 225,000 Btu/hr rated natural gas fired furnace with an Annual Fuel Utilization Efficiency (AFUE) rating of 90% or greater	Gas furnace with an AFUE less than 80%
Whole Building	Energy efficient building	Code compliant building
	Energy Star Home (15% improvement). Higher efficient Energy Star homes can be accounted as improvements over time	2015 IECC code
	Home Energy Reports	No Home Energy Report
	Demand Management Controls	No Demand Management
	Networked Rooftop Unit Controls	Individual Rooftop Unit controls
	Integrated HVAC and Lighting	Separate Lighting and HVAC controls
	Optimized building controls	No building controls

C&I Measures

End Use	Efficient Measure	Baseline Measure
Space Cooling	Direct evaporative cooling with cooling flow 3x the flow use for the code baseline buildings, effectiveness = 0.85	Federal Minimum: 13 SEER Split System Air Conditioner
	Integrated controls for MSHP	MSHPs without controls
	Smart Ceiling Fans	No ceiling fan
	Chiller exceeding code-minimum efficiency	Chiller with code-minimum efficiency
	High Efficiency Product/Systems	Less Efficient Product/Systems
	Reduce air-cooled condensers on DX units energy and usage for 1 ton of cooling capacity	Air-cooled condensers on DX units w/o evaporative pre-cooler for 1 ton of cooling capacity
	Efficiency must exceed IECC 2009	Code Efficiency Requirement
	PTAC exceeding minimum federal efficiency standards	Minimum federal efficiency standards for PTAC
	New plate & Frame exchanger water side economizer	no existing economizer
	RAC exceeding minimum federal efficiency standards	Minimum federal efficiency standards for RAC
Lighting	Indoor LED Fixture (hard wired, pin-based)	Incandescent/CFL Bulb (Market Baseline Wattage)
	Indoor LED Lamps	Mixed Market Incandescent/CFL/Halogen Bulb
	Indoor LED Lamp Networked/ Connected	Mixed Market Incandescent/CFL/Halogen Bulb
	Indoor LED Linear Tubes	Linear Fluorescents T12, T8, T5
	Indoor LED Linear Fixtures	Linear Fluorescents T12, T8, T5
	Indoor LED Fixtures (downlights, other interior commercial fixture applications)	CFL & Halogen Technology Mix
	LED Lights for Industrial Application	Mixed Market Industrial Lights
	Outdoor LED Fixture (hard wired, pin-based)	CFL/Halogen Bulbs (Market Baseline Wattage)
	Outdoor LED Moghul base, pole mounted, other exterior fixtures	Metal Halide/Linear Fluorescents/ HPS Systems
	Residential Occupancy Sensors for Common Area in MF Buildings	No Occupancy Sensors
	Occupancy sensors, photocells	Manual Controls
	Network Lighting Controls	Manual Controls
	Savings in addition to Code Maximum LPD	Code Maximum LPD
	Linear LED Refrigerated Case Lighting	Linear Fluorescents T12, T8, T5 Case Lighting

C&I Measures

End Use	Efficient Measure	Baseline Measure
Appliances	Vending machine controls	No controls
	Ozone system added to a new or existing washing machine	Conventional washing machine with no ozone generator
Electronics and Office Equipment	Advanced power strip	No advanced power strips
	Occupancy sensors for low wattage devices (<150 watts)	Low wattage devices (<150 watts) without occupancy sensors
Refrigeration	ENERGY STAR Freezer	Standard Freezer
	Removal of existing freezer	
	ENERGY STAR Refrigerator	Standard Refrigerator
	Removal of existing refrigerator	
	CEE Tier 2 Ice machine (cube/nugget type)	Inefficient ice machines
	Frame anti-sweat heaters at low-humidity conditions, controls that reduce or turn off the glass door, and relative humidity sensors	No controls
	Evaporator fan derived by ECM for 1) low temp walk-in/reach-in case (freezer), 2) medium temp walk-in case (cooler), or 3) average walk-in case	Evaporator fan driven by shaded pole motor
	Electronic floating head pressure controls implemented on commercial multiple compressor refrigeration system	Commercial multiple compressor refrigeration system with mechanical fixed head pressure controls
	Demand defrost controls on walk-in freezer evaporator coils, defrosting only as needed	Timer defrost controls on a fixed schedule in walk-in freezer
	Cooler or freezer door using multiple panes of glass, inert gas and low-e coatings	Cooler or freezer glass door that is continuously heated to prevent condensation
Cooking	Energy Star Combination Ovens	Combination Ovens
	Commercial kitchen ventilation hoods with Demand Controlled Ventilation	Commercial Kitchen Ventilation Hoods Without Demand Controlled Ventilation
	Energy Star Electric Pressure less Steamer	Electric Pressure less Steamer
	ENERGY STAR Commercial Dishwasher	Conventional unit as defined by ENERGY STAR
	ENERGY STAR Hot Food Holding Cabinet	Conventional unit as defined by ENERGY STAR
	Energy Star Fryer/Fryer Large Vat	Fryer/Fryer Large Vat
	Energy Star Steam Cooker	Steam Cooker

C&I Measures

End Use	Efficient Measure	Baseline Measure
Compressed Air	No air loss drains	New electronic solenoid/timed drains
	Air compressor optimization	No optimization of compressed air
Fans, Blowers, Motors, Drives, & Pumps	Variable Frequency Drives installed on Ag pumps	Standard Efficiency Ag Pumps
	VFD operating at a lower constant speed.	No VFD
	High Efficiency Fan and Fan Energy Management	Standard Efficient Fan and NEMA Premium
	Drip or micro-sprinkler irrigation systems	Conventional Irrigation System
	Green Motors Rewind	Existing Motor
	High Efficiency Pump	Standard Efficient Pump
	Impeller Trimming	Oversized Pump
	VFDs on Industrial Fans and Pumps	No VFD
	HVAC fan or pump, 50 HP or less, controlled by VFD	HVAC fan or pump, not controlled by VFD
	EC plug fan for CRAC/CRAH units	CRAC/CRAH without EC plug fan
Process Cooling	Dew point controls	No purge control for heatless desiccant dryers
	Mist eliminators	New general-purpose filter
Process Heating	High efficiency boiler	Conventional Boiler
	High-efficiency ovens & dryers	Conventional ovens/dryers
	Hot Water Boiler Tune	Conventional Boiler
	Steam trap replacement	Failed steam trap in open position