Stakeholder Meeting 2

New Jersey Potential Study

March 15, 2019
2:00 – 4:00 PM

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Agenda

- Introduction
- Measure characterization
- Key variables in characterization
- Approach to active and passive demand
- Updates on NJ CEP Energy Savings Protocols
- Other upcoming evaluation activities
- What are you most interested in seeing from Potential Study
- Wrap up

Stakeholder Schedule

1. February 28th	Available data and information (re)sources
2. March 15th	Measure characterization review and key model inputs
3. April 26th	Model results*
4. May 3rd	Draft QPIs, allocated utility targets, and incentive structures*

* Suggested dates and topics

Who is Here Today?

- New Jersey Board of Public Utilities
- New Jersey Utilities
- New Jersey Rate Counsel
- Full New Jersey EE Stakeholder group
- Optimal Energy – Consultant to BPU, represented today by Eric Belliveau and Matt Socks

Timeline

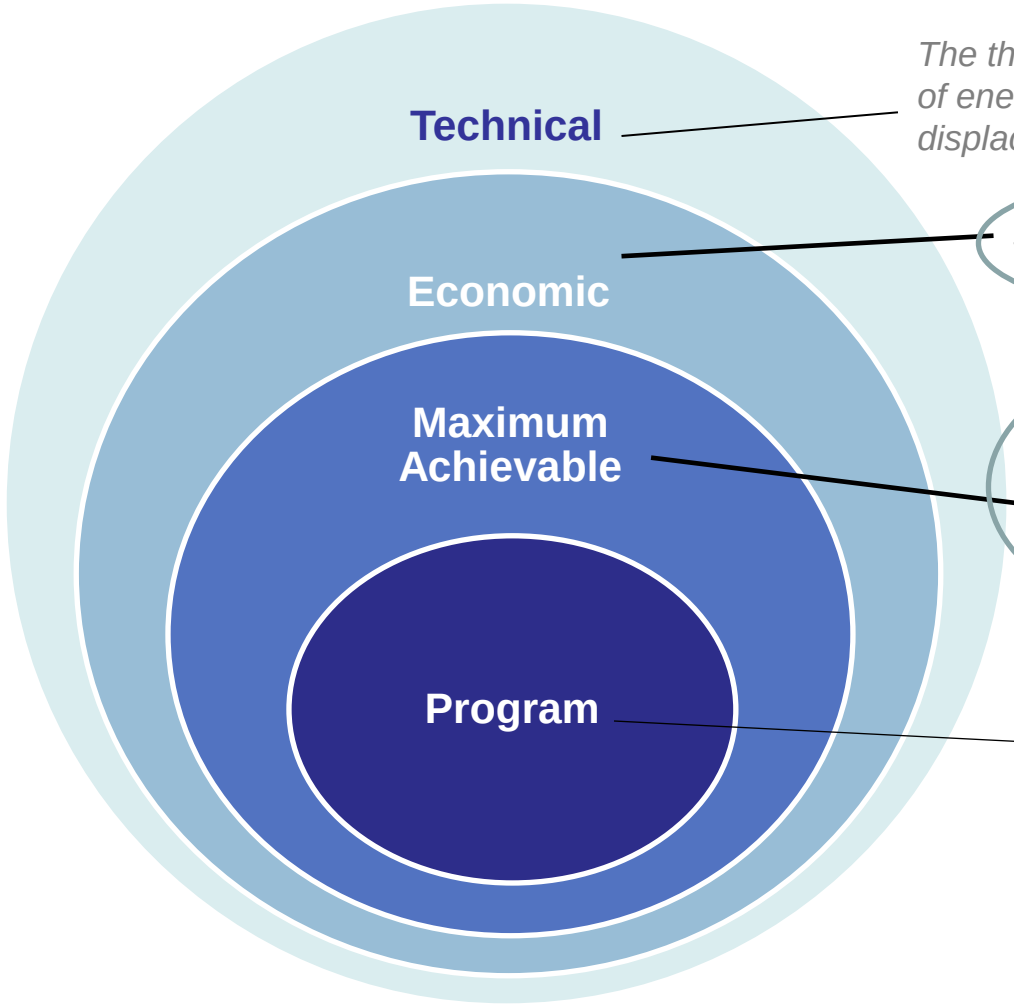
Normal Schedule: **six months**, from start to **draft model**

New Jersey Schedule: **three months**, from start to **draft report**

	Schedule, by Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	21-Jan	28-Jan	4-Feb	11-Feb	18-Feb	25-Feb	4-Mar	11-Mar	18-Mar	25-Mar	1-Apr	8-Apr	15-Apr	22-Apr	29-Apr	6-May
Proj Launch																
Literature & Information Review																
EE Mkt Assess & Potential Studies																
Dev Energy Savings & Peak Reduction Targets																
Develop QPIs																
Draft Findings													Draft Due			
Stakeholder Presentations																
Review Draft Findings with BPU																
Final Findings Rpt																Final Due

Potential Model Overview

Technical / Economic / Achievable / Program Potential



The theoretical maximum amount of energy use that could be displaced by efficiency

Subset that is cost-effective

This Study

Subset that is achievable considering market barriers, and program costs, given the most aggressive program scenario possible

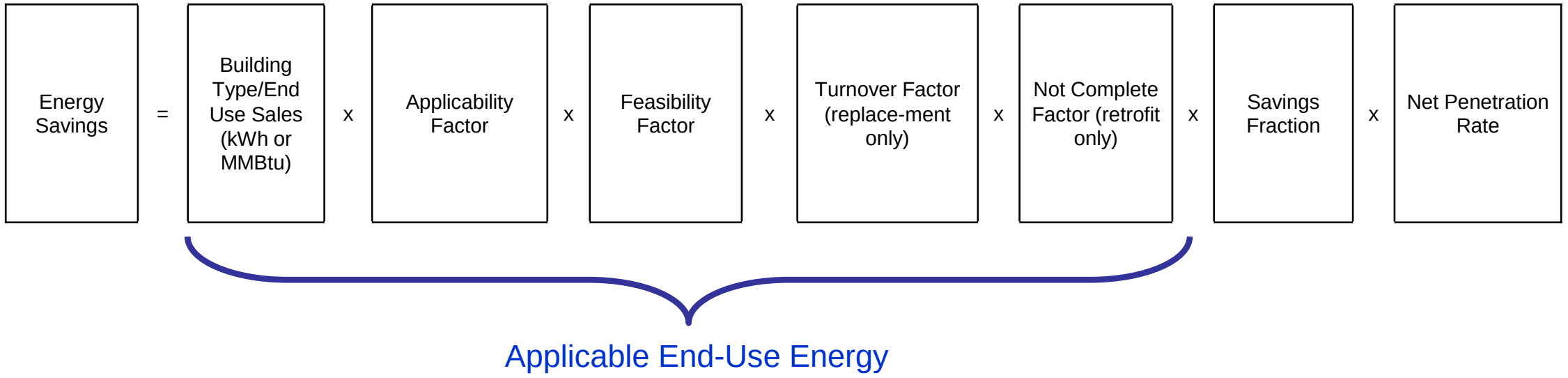
Subset of achievable, given constraints in implementing a particular portfolio of programs

Hybrid Top-down / Bottom-Up Analysis

- Top-down approach of actual sales combined with bottom-up measure level data
- Begins with energy sales forecast
  - Disaggregated by sector, segment (typically building type), and end use
  - Further disaggregated to individual measures
- Measure savings expressed as a percentage of total *applicable end-use energy*
- Measure costs in terms of dollars per unit energy saved
- Penetrations are a percent of total available savings in any given year

Hybrid Top-down / Bottom-Up Analysis

- By end use and building type
  - Applicability (to a particular technology)
  - Feasibility (technically feasible)
  - Turnover rate (replacement)
  - Not-complete (retrofit)



Measure Characterization – Developing the Measure List

Required Technologies / Practices

Residential Energy Efficiency	Commercial & Industrial Energy Efficiency
• Heating Ventilation and Air Conditioning • Controls/home automation • Lighting • Appliances • Consumer electronics • Thermal envelope • Water heating • New construction • Education/information • Demand response • Geothermal technologies • Solar thermal	• Lighting; • Space conditioning; • Motors/drives; • Water heating; • Process technologies; • Facilities operations; • New construction; • Thermal envelope; • Commissioning; • Demand response; • Geothermal technologies; • Solar thermal; • Combined heat and power (CHP)

Sources of Measure Data

- New Jersey Clean Energy Program Energy Savings Protocols
- Regional Technical Reference Manuals (TRM)
- Other potential studies, especially those with similar market characteristics, including market maturity
- Evaluation studies (including baseline studies, equipment saturation surveys)
- R.S. Means cost data; incremental cost studies
- U.S. Census
- Optimal Measure Database

Measure List Taxonomy

- Sector – residential, commercial, industrial
- Energy (fuel) used – gas, electric
- End use
- Opportunity type – market driven or retrofit

Technologies and the Top-Down Approach

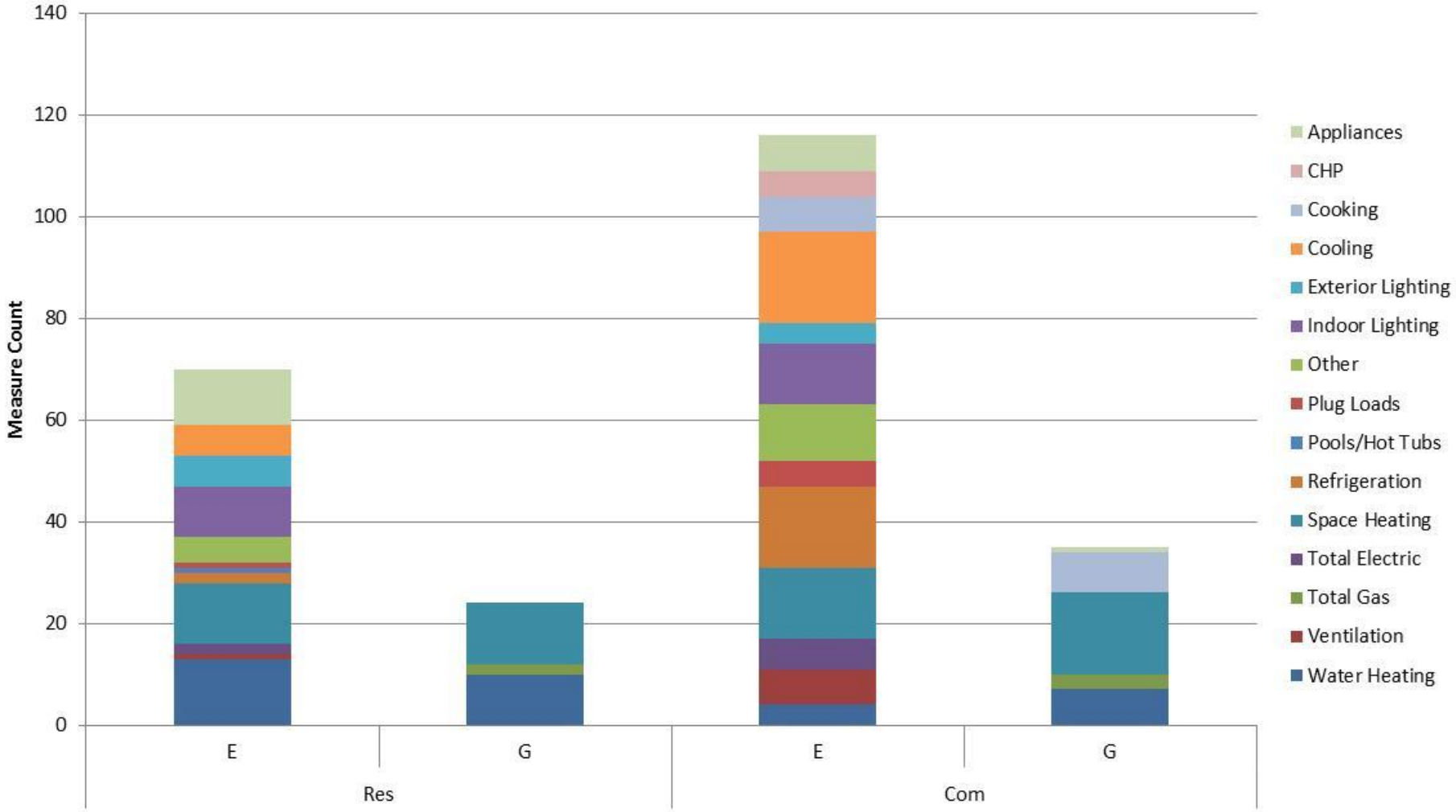
- Technologies may impact multiple end uses (e.g., thermal envelope improvements)
- Designation of primary and secondary fuels / end uses.
- Linked measures (multi-components across fuels and / or end uses)

Measure Count

- More than 250 measures
  - 94 residential
  - 151 commercial
  - 20 industrial

- When combined with building types and markets, will yield thousands of permutations

Measure Count by Sector and Primary Fuel End Use



Measure Characterization – Developing Measure Characteristics

Measure Characterization Inputs

- Full measure characterizations include numerous inputs…

- **General Inputs**
  - Sector
  - Market
  - Primary Fuel and End Use
  - Secondary Fuel and End Use
  - Measure Effective Useful Life (EUL)
  - % Savings (Primary Fuel, relative to baseline)
  - Secondary Fuel Savings (relative to primary fuel savings, MMBtu/kWh or kWh/MMBtu)
  - Efficient Equipment Cost
  - Baseline Equipment Cost
  - Incremental Cost per kWh or MMBtu Saved

- **O&M and Water Inputs**
  - Efficient Component Life
  - Efficient Component Replacement Cost
  - Baseline Component Life
  - Baseline Component Replacement Cost
  - O&M Levelized Annual Cost
  - Water Savings

Only used for select measures

- **Early Replacement Retrofit Inputs**
  - Baseline Remaining Useful Life (RUL)
  - Baseline Cost per kWh or MMBtu Saved
  - Baseline Shift Savings Factor

Used only for early retirement / replacement measures

Additional Measure Inputs (Building-Type Specific)

- Applicability (to a particular technology)
- Feasibility (technically feasible)
- Turnover rate (replacement)
- Not-complete (retrofit)

Key Variables

- Measure Effective Useful Life (EUL)
- % Savings Factor
- Incremental Cost per kWh or MMBtu Saved
- Applicability
- Not-complete

Measure Characterization Example

General Characterization Approaches

- TRM – Deemed
  - Fixed kWh/MMBtu savings by widget
  - Baseline consumption estimate needed
- TRM – Algorithm
  - Usually straightforward to estimate % savings with algorithm
  - Often need to develop weighted average of many different measure permutations
- Case Studies / Other
  - Not conducive to estimate from a simple equation (e.g., shell measures, industrial process)
  - Meta-analyses

Measure Characterization Example – TRM Algorithm

- **LED Linear Fixture**
  - **Sector** | Commercial / Industrial
  - **Segment** | Office
  - **Market** | Retrofit (RET)
  - **Primary Fuel** | Electric (E)
  - **Primary End Use** | Interior Lighting
  - **Secondary Fuel** | Gas (G)
  - **Secondary End Use** | Space Heating

Measure Characterization Example

- **LED Linear Fixture: Effective Useful Life (EUL)** | 15

Commercial Sector	
Lighting End Use	
Performance Lighting	15
Prescriptive Lighting	15
Refrigerated Case LED Lights	16
Specialty LED Fixtures (Signage)	16
Lighting Controls	8

Source: NJ BPU. 2018. Protocols to Measure Resource Savings. p. 181

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Measure Characterization Example

- **LED Linear Fixture: % Savings (Primary Fuel, relative to baseline)** | ??

- TRM provides generic savings algorithm using baseline existing and installed fixture data.
- Additional calculations are needed to adapt TRM savings values to “% Savings” factors.

Algorithms

$$\Delta kW = (\#\ of\ replaced\ fixtures) * (baseline\ fixture\ wattage\ from\ table) - (\#\ of\ fixtures\ installed) * (wattage\ of\ new\ fixture)$$

$$\text{Energy Savings}\left(\frac{\text{kWh}}{\text{yr}}\right) = (\Delta\text{kW}) * (Hrs) * (1 + HVAC_e)$$

Source: NJ BPU. 2018. Protocols to Measure Resource Savings. p. 73

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Measure Characterization Example

- **LED Linear Fixture: % Savings (Primary Fuel, relative to baseline)** | ??

Algorithms

$$\Delta kW = (\#\ of\ replaced\ fixtures) * (baseline\ fixture\ wattage\ from\ table) - (\#\ of\ fixtures\ installed) * (wattage\ of\ new\ fixture)$$

$$\text{Energy Savings}\left(\frac{\text{kWh}}{\text{yr}}\right) = (\Delta\text{kW}) * (Hrs) * (1 + HVAC_e)$$

Substituting / Simplifying

*% Savings = (baseline kW – new kW) * (1 + $HVAC_e$) / (baseline kW)*

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Measure Characterization Example

- **LED Linear Fixture: % Savings (Primary Fuel, relative to baseline)** | ??

$$\% \text{ Savings} = (\text{baseline kW} - \text{new kW}) * (1 + HVAC_e) / (\text{baseline kW})$$

0.097 0.049 0.097

RT/NC	Measure Name	Baseline Lamp or Fixture	Proposed Lamp or Fixture	kW Base	kW Prop	Baseline Fixture Cost	Proposed Fixture Cost
RT	LED Troffer	FT8-48-GEN-25-2-Fixt-EB-HE-HBF-XX	LED-1x4-TROF-19-1-Fixt-XX-XX-XX-XX	0.058	0.019		$139.90
RT	LED Troffer	FT8-48-GEN-25-3-Fixt-EB-HE-LBF-XX	LED-1x4-TROF-19-1-Fixt-XX-XX-XX-XX	0.059	0.019		$139.90
RT	LED Troffer	FT8-48-GEN-28-2-Fixt-EB-HE-HBF-XX	LED-1x4-TROF-19-1-Fixt-XX-XX-XX-XX	0.064	0.019		$139.90
RT	LED Troffer	FT8-48-GEN-28-2-Fixt-EB-HE-NBF-XX	LED-1x4-TROF-19-1-Fixt-XX-XX-XX-XX	0.049	0.019		$139.90
RT	LED Troffer	FT8-48-GEN-28-3-Fixt-EB-HE-LBF-XX	LED-1x4-TROF-19-1-Fixt-XX-XX-XX-XX	0.066	0.019		$139.90
RT	LED Troffer	FT8-48-GEN-32-2-Fixt-EB-HE-LBF-XX	LED-1x4-TROF-19-1-Fixt-XX-XX-XX-XX	0.058	0.019		$139.90

Source: State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs Version 3.0. 2019. Appendix B

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Measure Characterization Example

- **LED Linear Fixture: % Savings (Primary Fuel, relative to baseline)** | ??

*% Savings = (baseline kW – new kW) * (1 + $HVAC_e$) / (baseline kW)*

HVAC Interactive Effects

Building Type	Demand Waste Heat Factor ($HVAC_d$)		Annual Energy Waste Heat Factor by Cooling/Heating Type ($HVAC_e$)			
	AC (Utility)	AC (PJM)	AC/ Non-Elec	AC/ ElecRes	Heat Pump	NoAC/ ElecRes
Office	0.35	0.32	0.10	-0.15	-0.06	-0.25
Retail	0.27	0.26	0.06	-0.17	-0.05	-0.23
Education	0.44	0.44	0.10	-0.19	-0.04	-0.29
Warehouse	0.22	0.23	0.02	-0.25	-0.11	-0.27
Other[32]	0.34	0.32	0.08	-0.18	-0.07	-0.26

Source: NJ BPU. 2018. Protocols to Measure Resource Savings. p. 72

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Measure Characterization Example

- **LED Linear Fixture: % Savings (Primary Fuel, relative to baseline)** | 54%

$$\%\ Savings = (baseline\ kW - new\ kW) * (1 + HVAC_e) / (baseline\ kW)$$

$$= (0.097 - 0.049) * (1 + 0.1) / (0.097)$$

$$= \mathbf{54\%}$$

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Measure Characterization Example

- **LED Linear Fixture: Incremental Cost per kWh or MMBtu Saved |** ??

Incremental Cost per kWh = Incremental Cost / Energy Savings (kWh/yr)

$191

RT/NC	Measure Name	Baseline Lamp or Fixture	Proposed Lamp or Fixture	kW Base	kW Prop	Baseline Fixture Cost	Proposed Fixture Cost
RT	LED Troffer	FT8-48-GEN-25-2-Fixt-EB-HE-HBF-XX	LED-1x4-TROF-19-1-Fixt-XX-XX-XX-XX	0.058	0.019		$139.90
RT	LED Troffer	FT8-48-GEN-25-3-Fixt-EB-HE-LBF-XX	LED-1x4-TROF-19-1-Fixt-XX-XX-XX-XX	0.059	0.019		$139.90
RT	LED Troffer	FT8-48-GEN-28-2-Fixt-EB-HE-HBF-XX	LED-1x4-TROF-19-1-Fixt-XX-XX-XX-XX	0.064	0.019		$139.90
RT	LED Troffer	FT8-48-GEN-28-2-Fixt-EB-HE-NBF-XX	LED-1x4-TROF-19-1-Fixt-XX-XX-XX-XX	0.049	0.019		$139.90
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RT	LED Troffer	FT8-48-GEN-32-2-Fixt-EB-HE-LBF-XX	LED-1x4-TROF-19-1-Fixt-XX-XX-XX-XX	0.050	0.019		$139.90

Source: State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs Version 3.0. 2019. Appendix B

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Measure Characterization Example

- **LED Linear Fixture: Incremental Cost per kWh or MMBtu Saved |** ??

*Energy Savings (kWh/yr) = (baseline kW – new kW) * Hrs * (1 + $HVAC_e$)*

Building Type	Sector	CF	Hours
Medical - Clinic	Large Commercial/Industrial & Small Commercial	0.8	3,909
Medical - Hospital	Large Commercial/Industrial & Small Commercial	0.8	8,760[30]
Office	Large Commercial/Industrial	0.7	2,969
	Small Commercial	0.67	2,950

Source: NJ BPU. 2018. Protocols to Measure Resource Savings. p. 71

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Measure Characterization Example

- **LED Linear Fixture: Incremental Cost per kWh or MMBtu Saved |** ??

*Energy Savings (kWh/yr) = (baseline kW – new kW) * Hrs * (1 + $HVAC_e$)*

*= (0.097 – 0.049) * 2,950 * (1 + 0.1)*

= 156 kWh

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Measure Characterization Example

- **LED Linear Fixture: Incremental Cost per kWh or MMBtu Saved |** $1.22

Incremental Cost per kWh = Incremental Cost / Energy Savings (kWh/yr)

= 191 / 156

*= **$1.22***

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Measure Characterization Example

- **LED Linear Fixture: Applicability |** 81.5%

- Q: Of all interior lighting end-use energy in offices, to what portion does this measure apply?
- A: All non-high bay linear lighting

Estimated Percentage of Interior Lighting Energy Consumption by Lighting Type

Lighting Type	Office	Education	Grocery	Hospital	Food Service	Health Service	Lodging	Retail	Warehouse
All Linear Lighting	83.5%	80.6%	89.5%	87.6%	42.7%	66.6%	29.7%	71.9%	94.4%
Linear Lighting, High-Bay	2.0%	4.3%	0.0%	0.0%	0.0%	0.0%	0.0%	6.1%	56.6%
Linear Lighting, Non-High-Bay	81.5%	76.3%	89.5%	87.6%	42.7%	66.6%	29.7%	65.8%	37.8%

Source: Preliminary data from the Commercial Statewide Baseline Study of New York State. Anticipated publication in Q2 2019.

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Measure Characterization Example

- **LED Linear Fixture: Not-Complete |** 91%

- Q: Of the end-use energy to which this measure applies, what portion is NOT already consumed by the efficient case?
- A: All non-high-bay, non-LED, linear fixtures.

Estimated Percentage of Interior, Non-High-Bay, Linear Lighting Energy Consumption by Technology Type

Lighting Type	Office	Education	Grocery	Hospital	Food Service	Health Service	Lodging	Retail	Warehouse
Linear Lighting, Non-High-Bay, Non-LED	90.9%	89.5%	55.8%	100.0%	70.8%	85.6%	35.7%	61.0%	87.9%
Linear Lighting, Non-High-Bay, LED	9.1%	10.5%	44.2%	0.0%	29.2%	14.4%	64.3%	39.0%	12.1%

Source: Preliminary data from the Commercial Statewide Baseline Study of New York State. Anticipated publication in Q2 2019.

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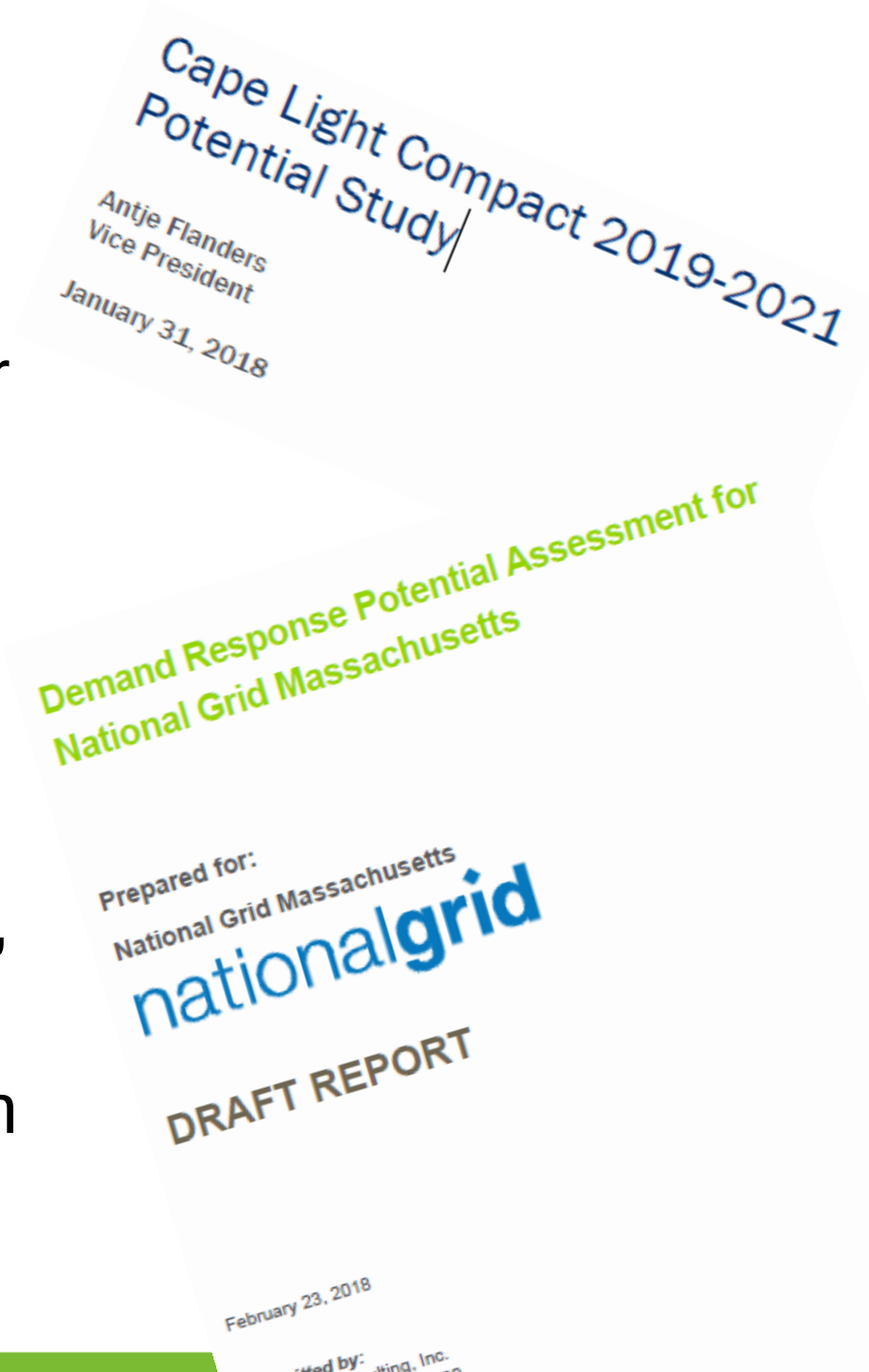
Measure Characterization Example Summary

- Measure Effective Useful Life (EUL) | 15 years
- % Savings Factor | 54%
- Incremental Cost per kWh or MMBtu Saved | $1.22
- Applicability | 81.5%
- Not-complete | 91%

Approach to Estimating Active and Passive Demand

Literature Review

- Review peak demand reduction, cost per kwh, and participation rates for demand response
- Review actual participation rates and costs from existing DR programs in the US
- Review recent DR potential studies (e.g., Massachusetts)
- Review data on current PJM participation



Residential and Small Commercial Measures

- Direct load control
- Automated demand response
- Critical peak pricing and peak time rebate WITHOUT enabling technology
  - Mutually exclusive
  - Likely focus on the former due to higher savings
- Critical peak pricing and peak time rebate WITH enabling technology

Large Commercial Measures

- Standard offer program
- Direct load control
- Automated demand response

Applying New Jersey-Specific Data

- Total peak demand forecast by sector
- Peak demand disaggregated by end use
- Number of customers per sector
- Planned roll out of advanced metering infrastructure

Questions?

Proposed Updates to **FY19 NJCEP Protocols to Measure Resource Savings**

Fiscal Year 2020

Correction to EFLHs Lists

Pages 90, 96, 99, 136, 147, 150

EFLH Table

Facility Type	Heating EFLH$_h$	Cooling EFLH$_c$
Retail – big box	191	1279
Retail – Grocery	191	1279
Retail – large	545	882
Retail – large	2101	1068

Where highlighted above and in similar charts regarding equivalent full load hours (EFLHs), "Retail – large" will be changed to correct a typo & subsequently will read "Retail – small".

Correction to Residential ENERGY STAR Lighting Protocol

Pages 61-65

- **Current Protocols** : Fuel savings are attributed to the installation of ENERGY STAR Lighting, in error

- **Proposed Correction:** Apply a fuel penalty to account for the reduction in heat generated by more efficient lighting

Other Evaluation Activities

Fiscal Year 2019

Current EE Evaluation Activities

- **Multifamily Baseline Study** – Baseline study of multifamily residential buildings in New Jersey with 5+ units
- **Cost-Benefit Analysis of the NJCEP Energy Efficiency Programs:** FY2017 Retrospective & FY2019 Summary Reports
- **Energy Efficiency Cost-Benefit Analysis Avoided Cost Assumptions -** 2017
- **Non-Energy Benefits, Net vs. Gross and Energy Code Compliance – EM&V Approaches with Applications to NJCEP CBA**

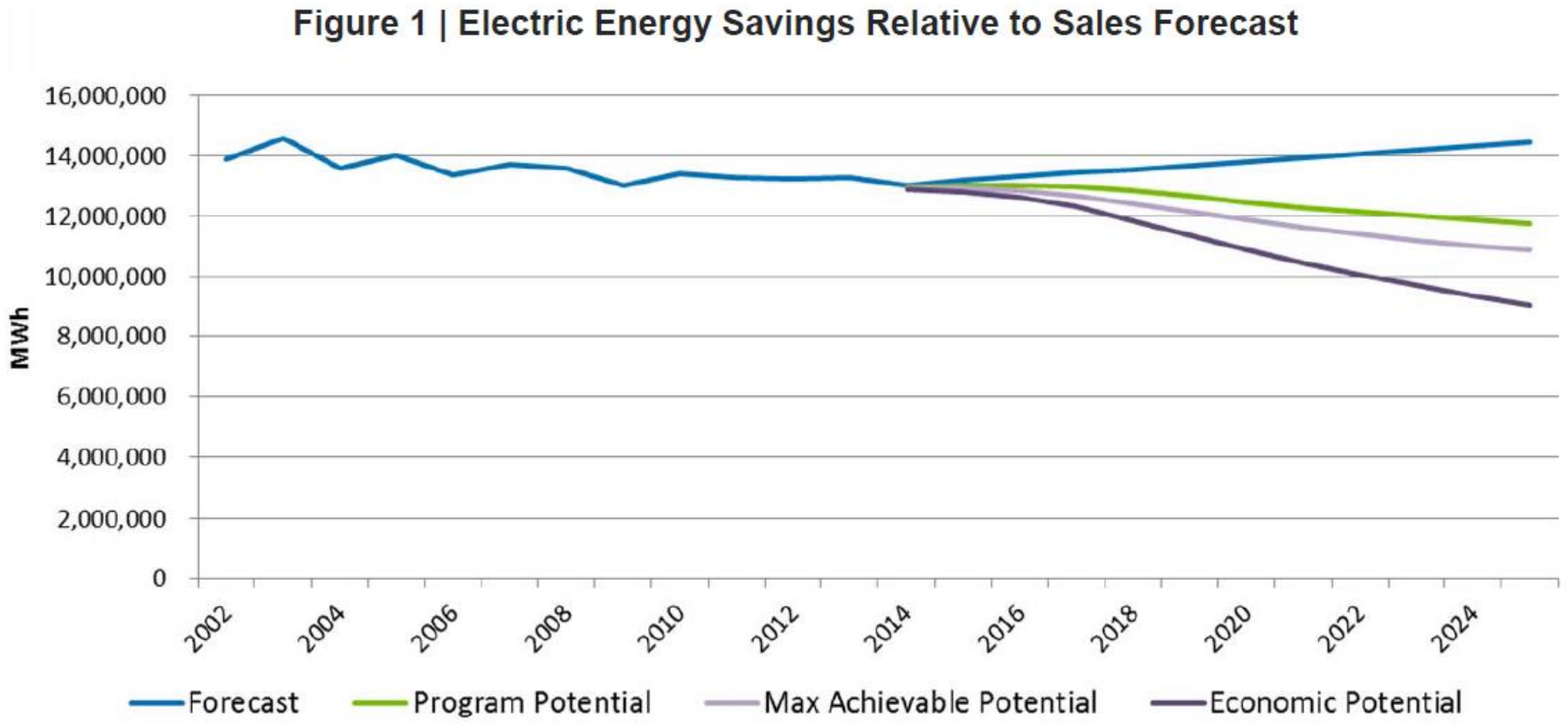
What are stakeholders most interested in seeing in Potential Study?

What is useful to you?
What is useful to the State?

Discussion

Sample Outputs

Example Outputs – Charts and Figures



Example Outputs – Charts and Figures

Figure 5 | Residential Electric Energy Savings by End Use, 2025

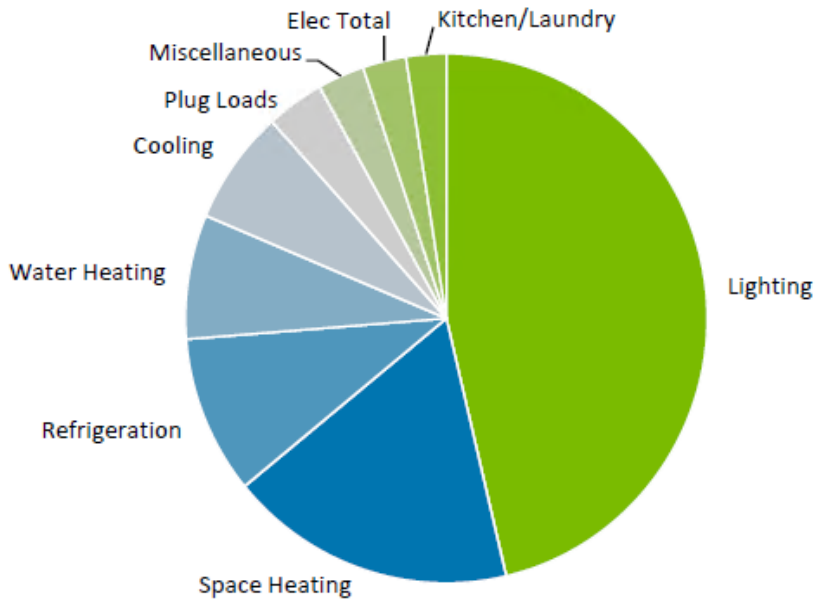


Table 11 | Residential Electric Energy Top Saving Measures, 2025

Measure Name	Cumulative MWh (2025)	Percent of Total	TRC BCR
LED Screw Based Lamp retail 450 to 1600 Lumens	129,852	14.6%	5.1
LED Direct Install	89,857	10.1%	4.8
Exterior LED >1600 Lumens	45,586	5.1%	8.6
Exterior LED 450 to 1600 Lumens	45,586	5.1%	6.5
Electric Heat Pump Water Heater <55gal	43,971	4.9%	1.6
Air Sealing –Heat	43,220	4.9%	1.1
Air Sealing –Cool	37,157	4.2%	2.8
LED Screw Based Lamp retail >1600 Lumens	36,342	4.1%	5.5
Refrigerator Retirement	35,349	4.0%	2.3
LED Screw Based Lamp retail <450 Lumens	34,179	3.8%	4.4
Total	**541,099**	**60.8%**	

Questions / Discussion

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