How Much Energy Efficiency should we Plan for in the Future?:

Modeling EE as a Supply-Side Resource

Etan Gumerman

Tibor Vegh

2017 ACEEE National Conference on Energy Efficiency as a Resource
October 2017

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Outline

I. Introduction

II. Supply Curve vs. Fixed Supply

III. Data & Challenges

IV. Steps to Assemble Our Supply Curve

V. Using the Supply Curve

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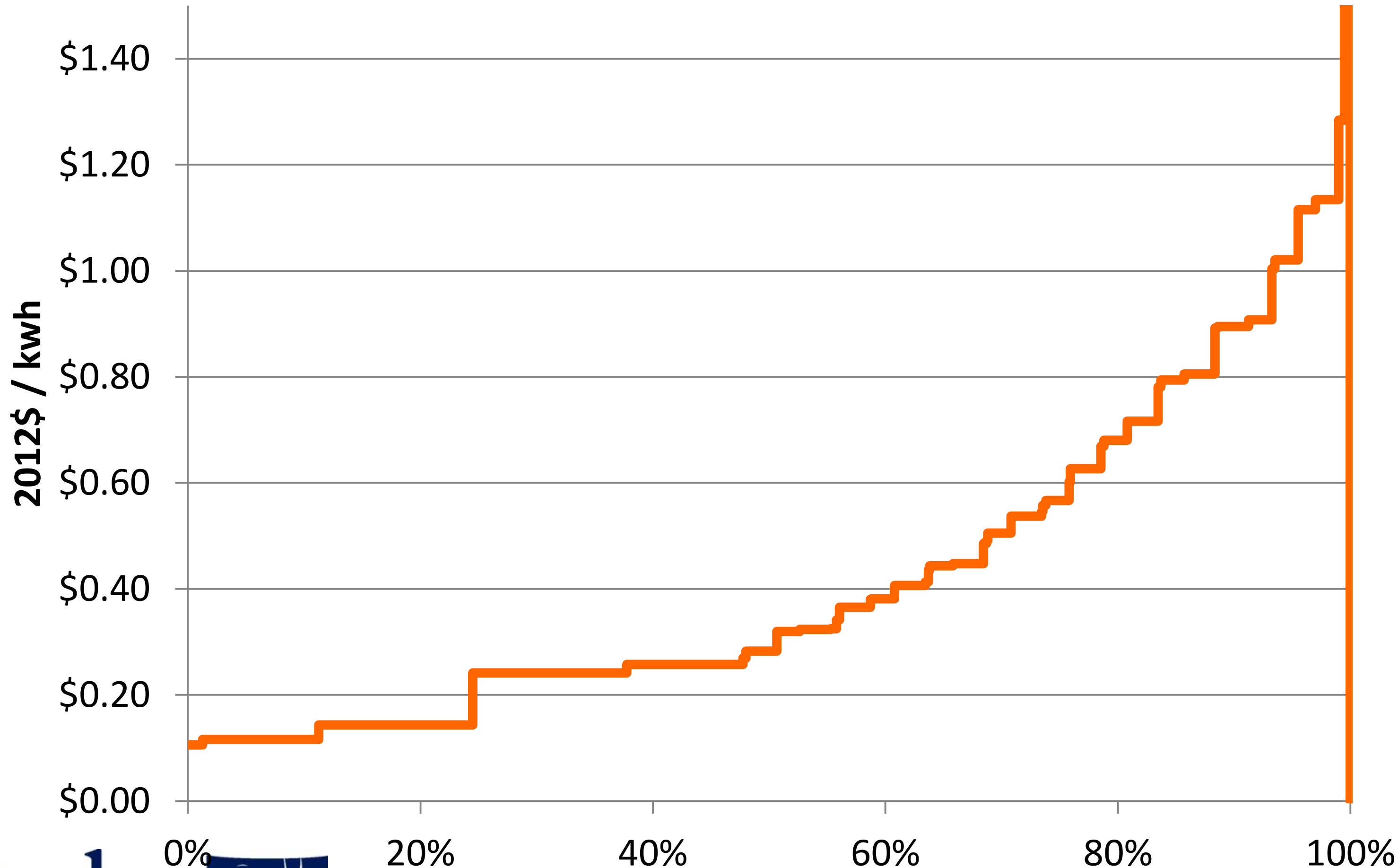
Our Supply Curve:

First Year EE Costs by % Available EE



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Why is EE Forecast Important?

a. Future Demand Fundamental for Electricity Planning and IRPs.

b. Energy Efficiency is one element of Demand Growth.

c. Implicit = Less Important

d. EE should not be static.

WHY USE ENERGY EFFICIENCY SUPPLY CURVE?

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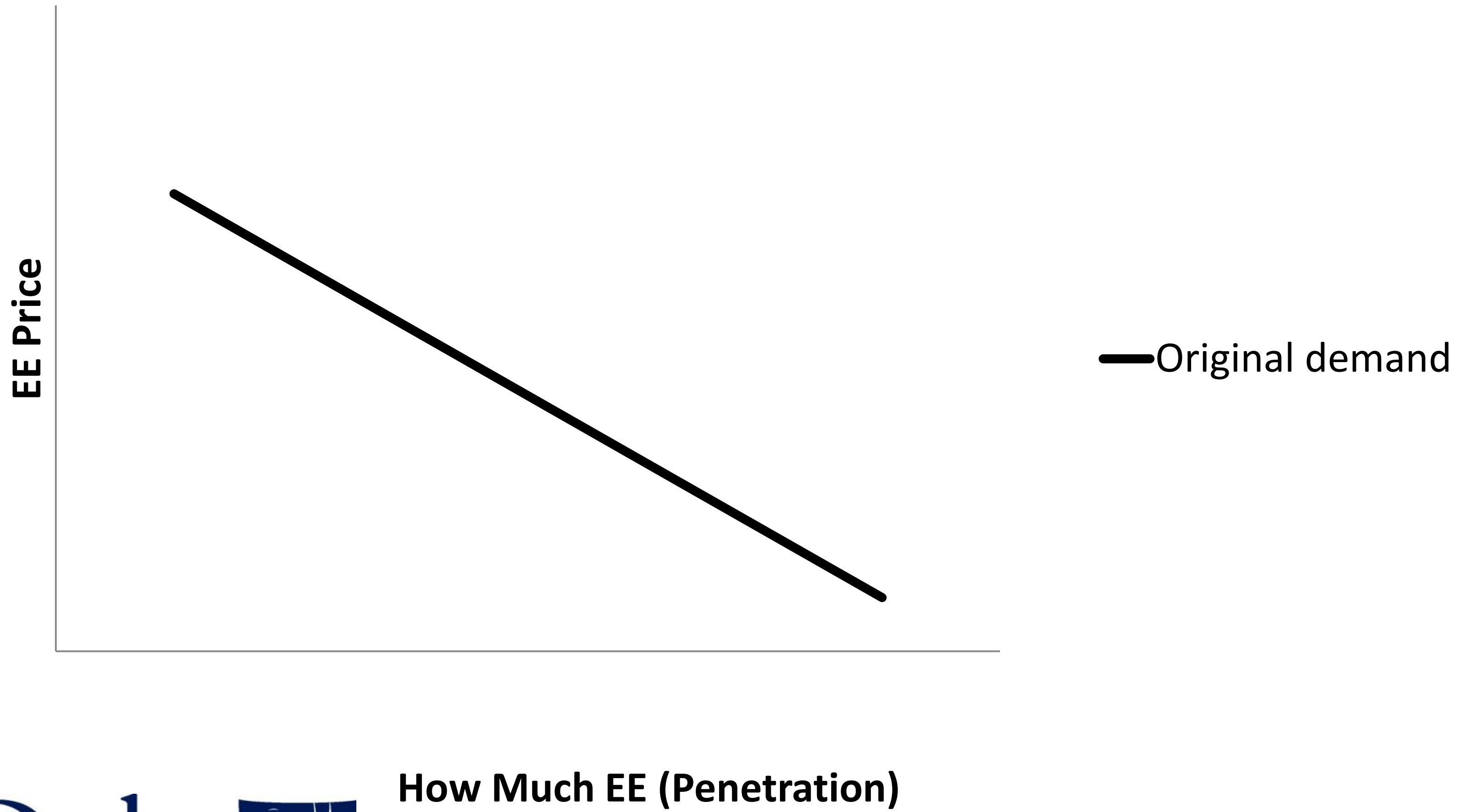
Incorporating an EE supply function



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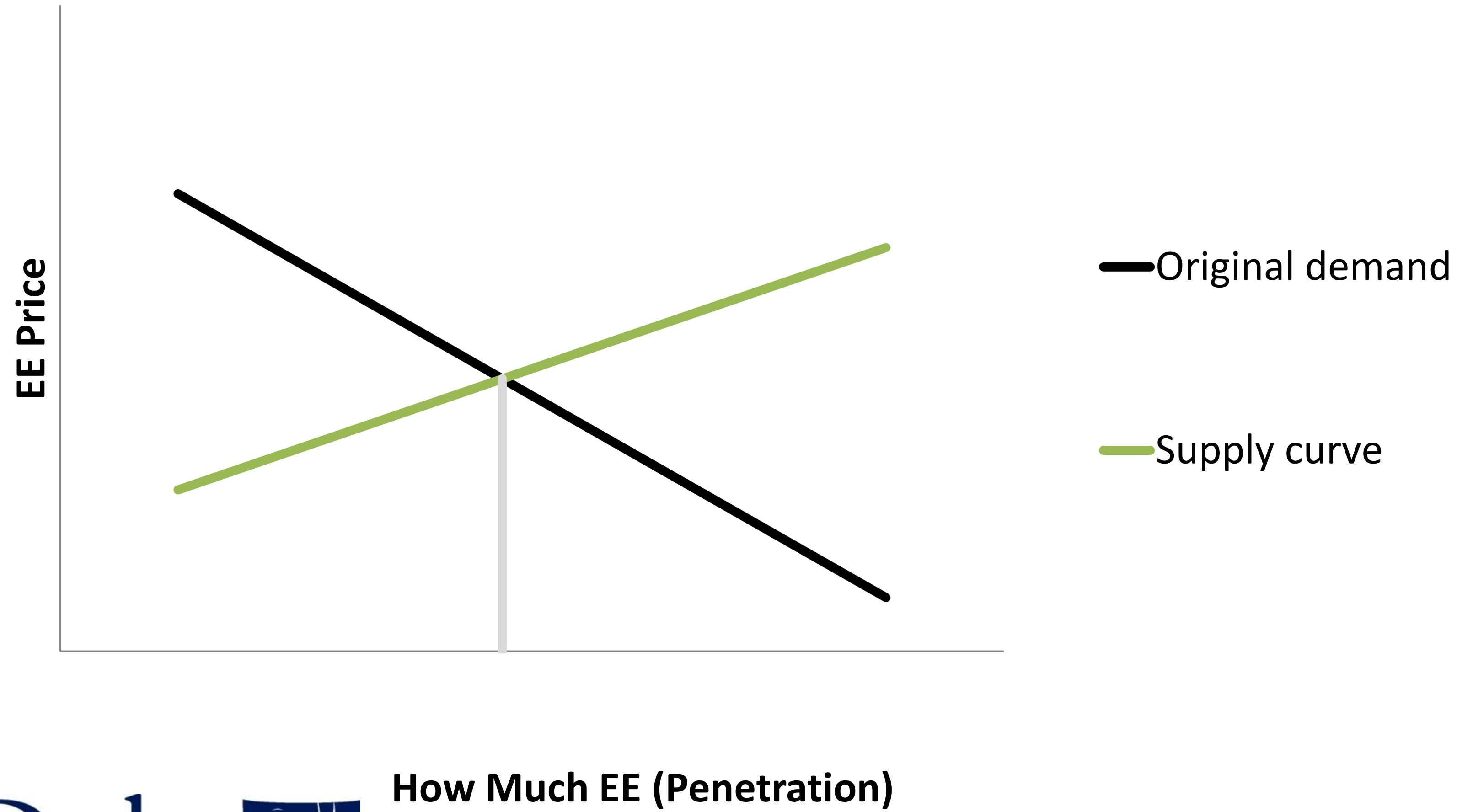
Incorporating an EE supply function



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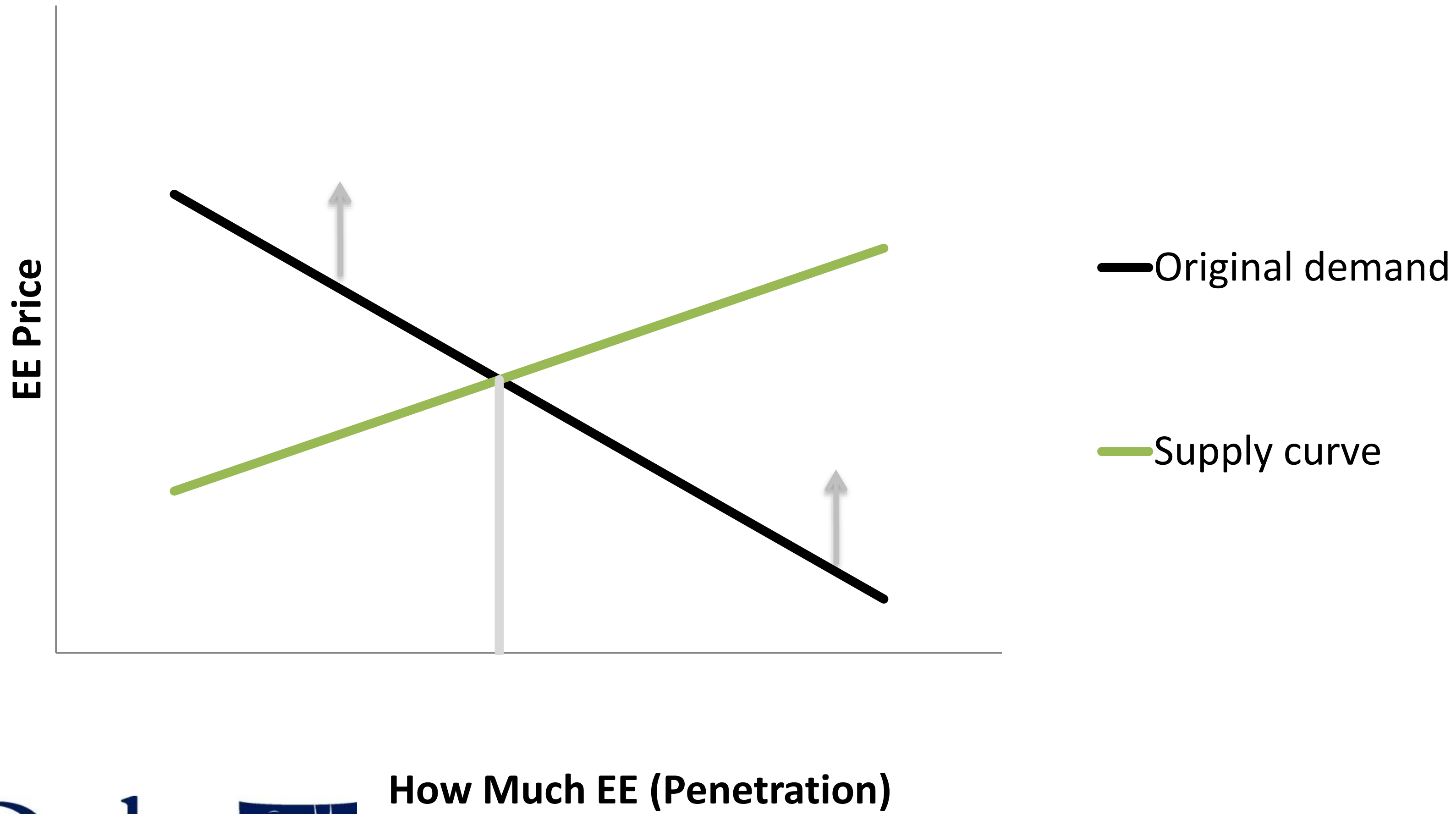
Incorporating an EE supply function



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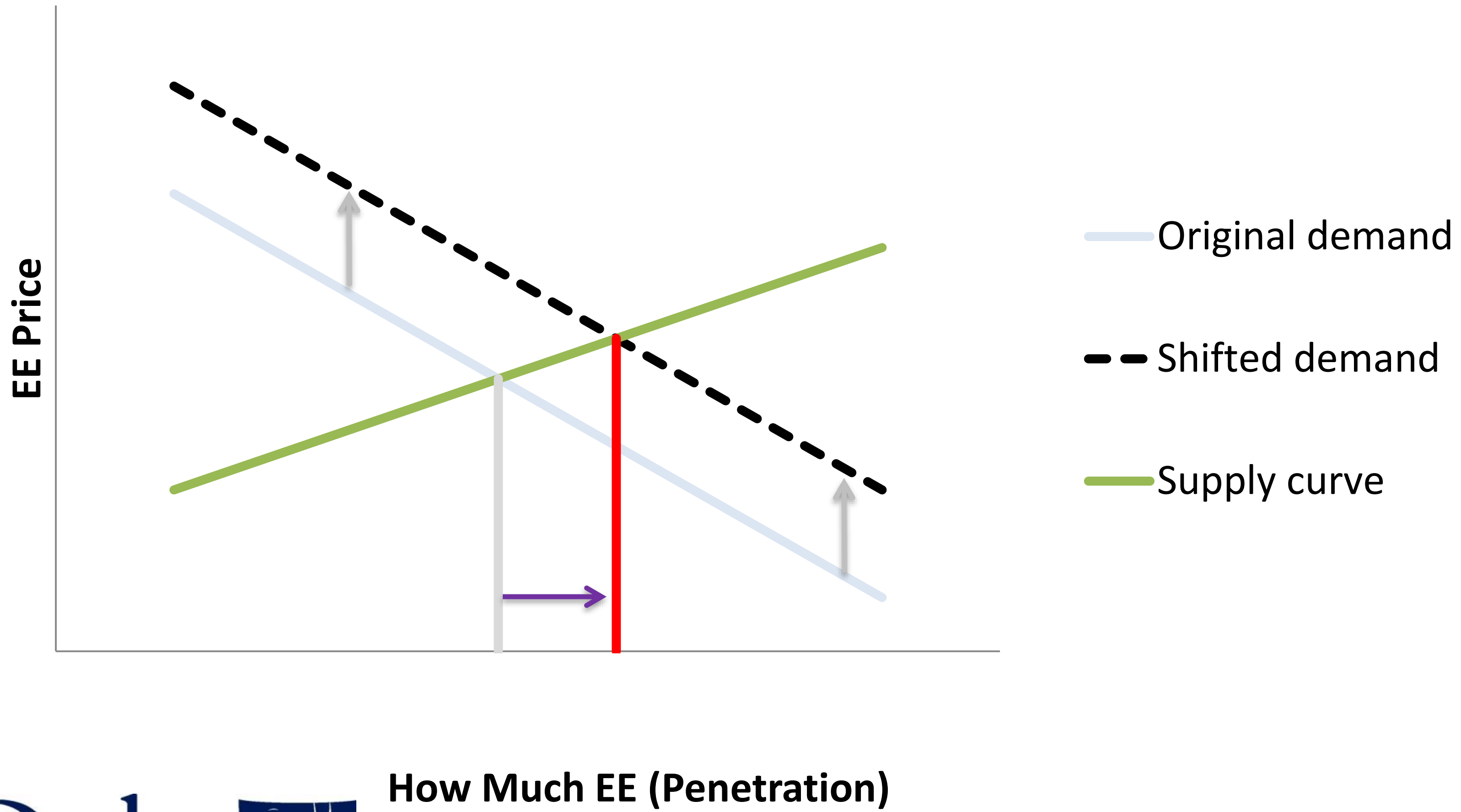
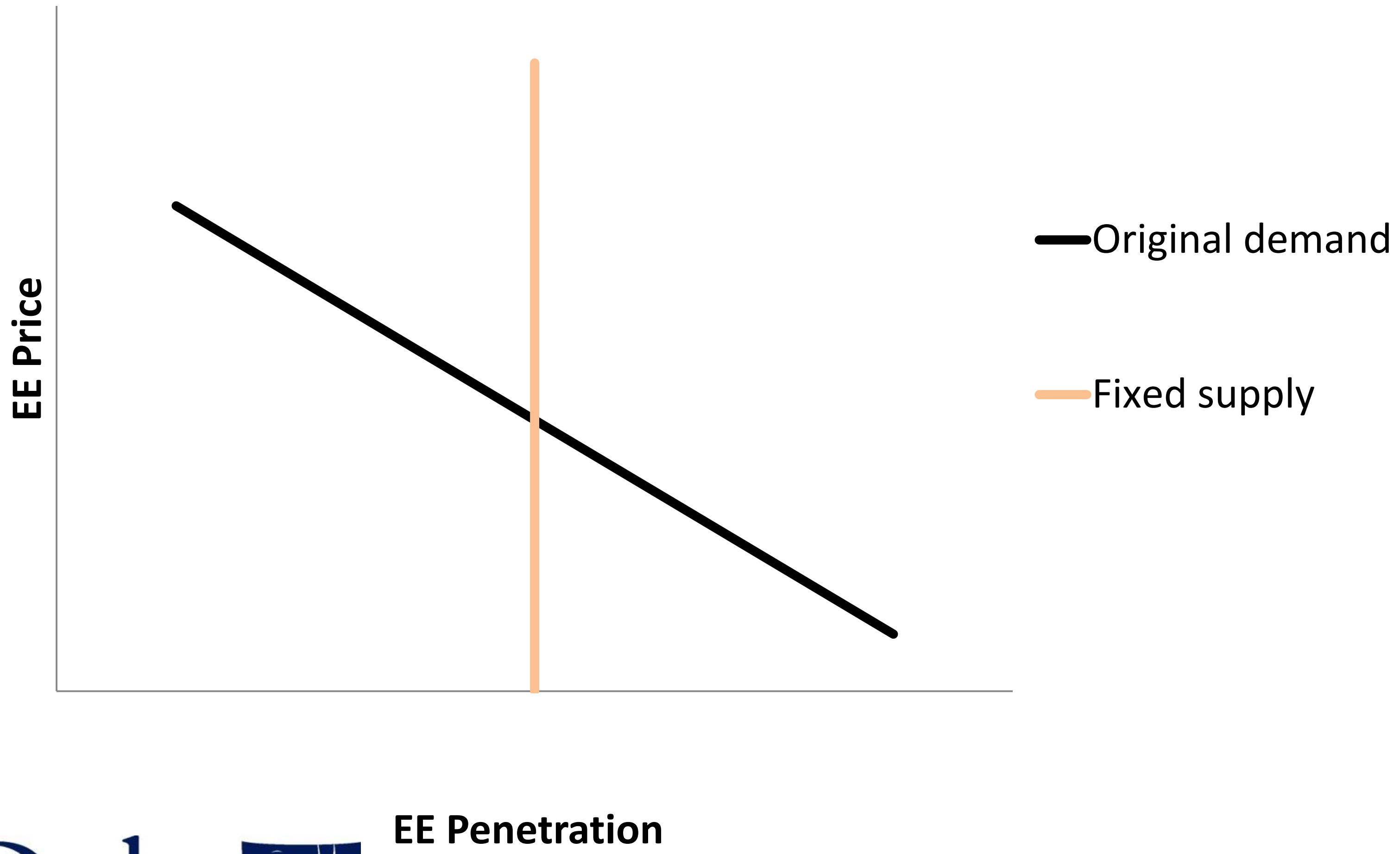
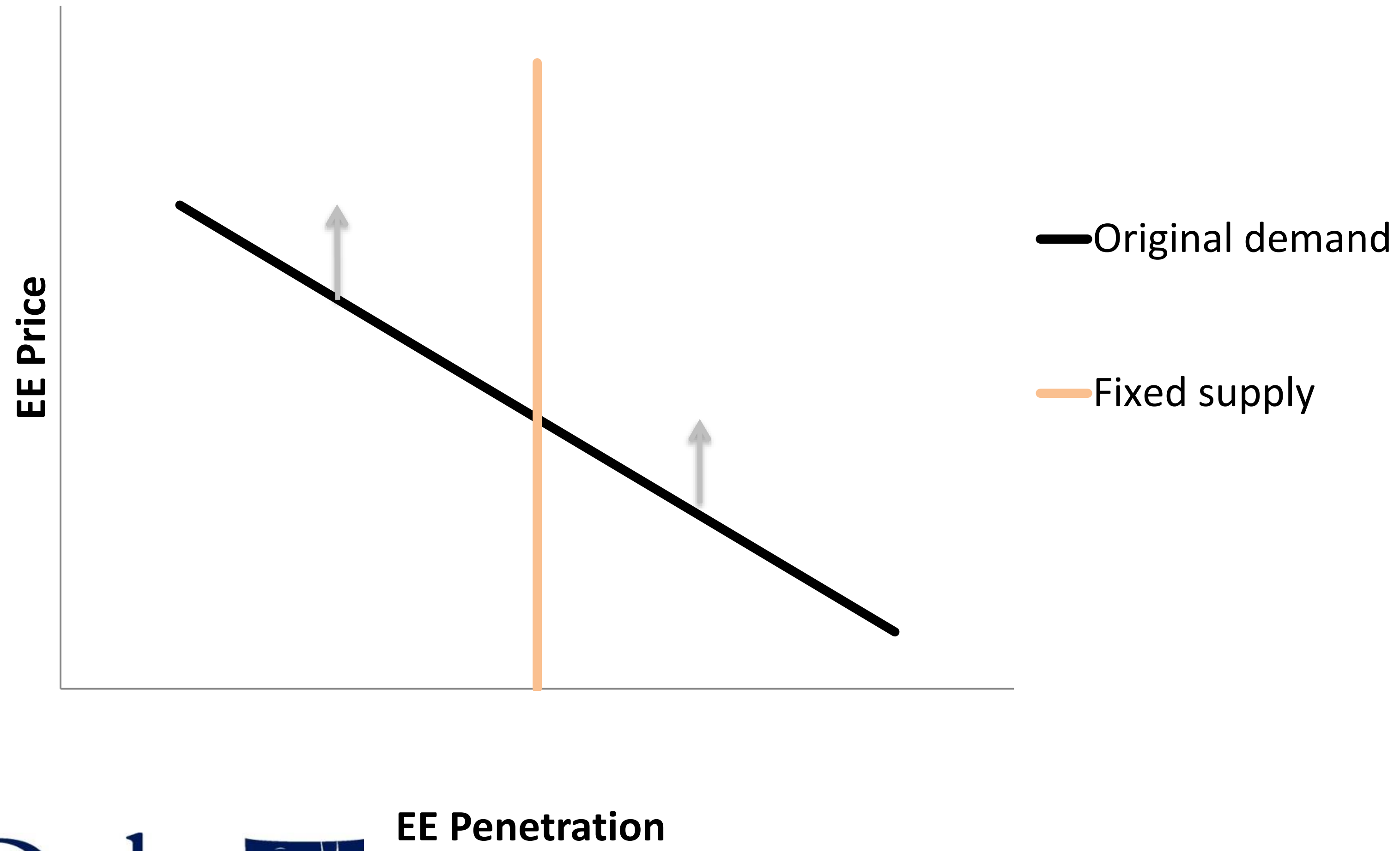
Using a Supply Curve can Shift Penetration



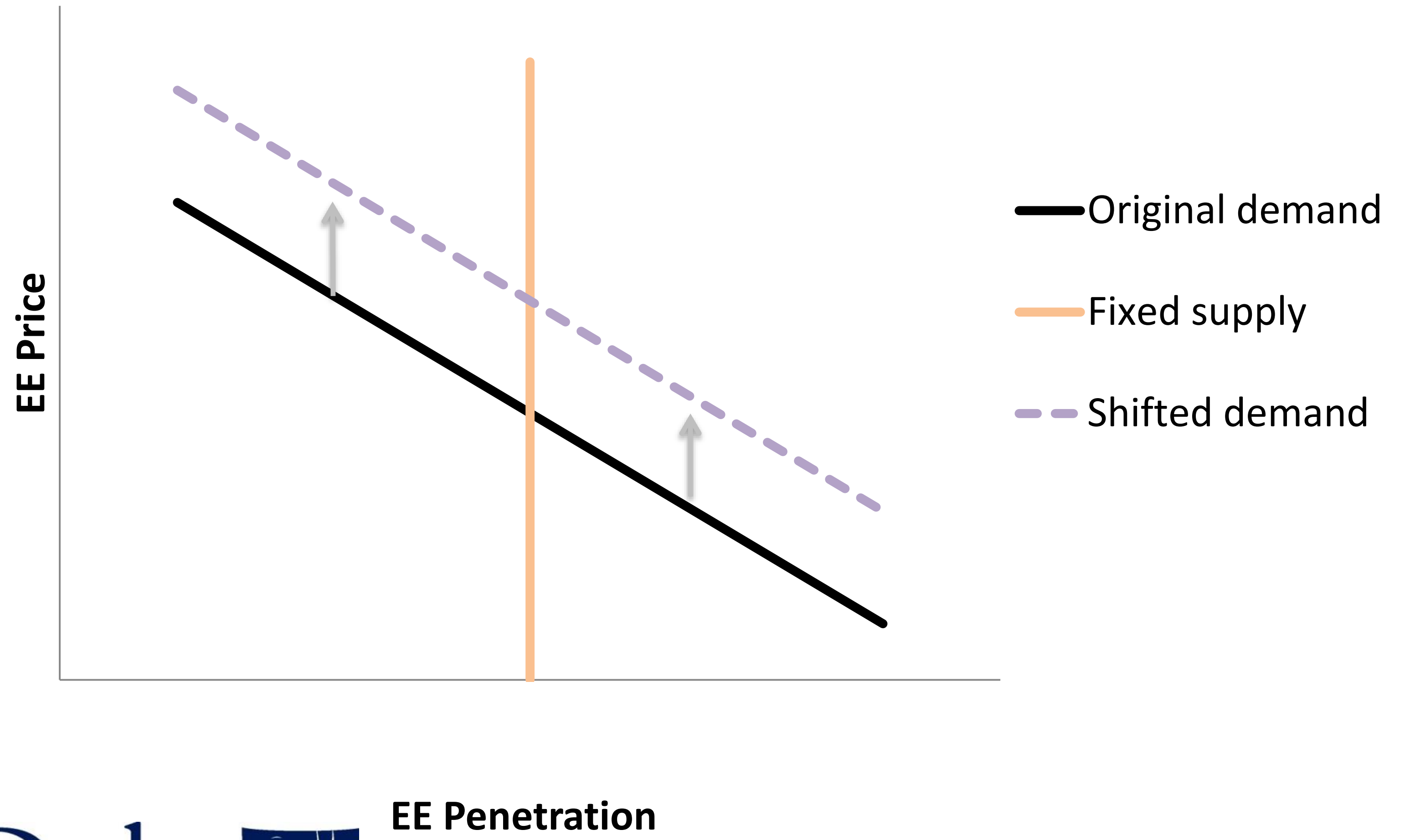
Fixed EE Supply



Fixed EE Supply



Insensitive Penetration



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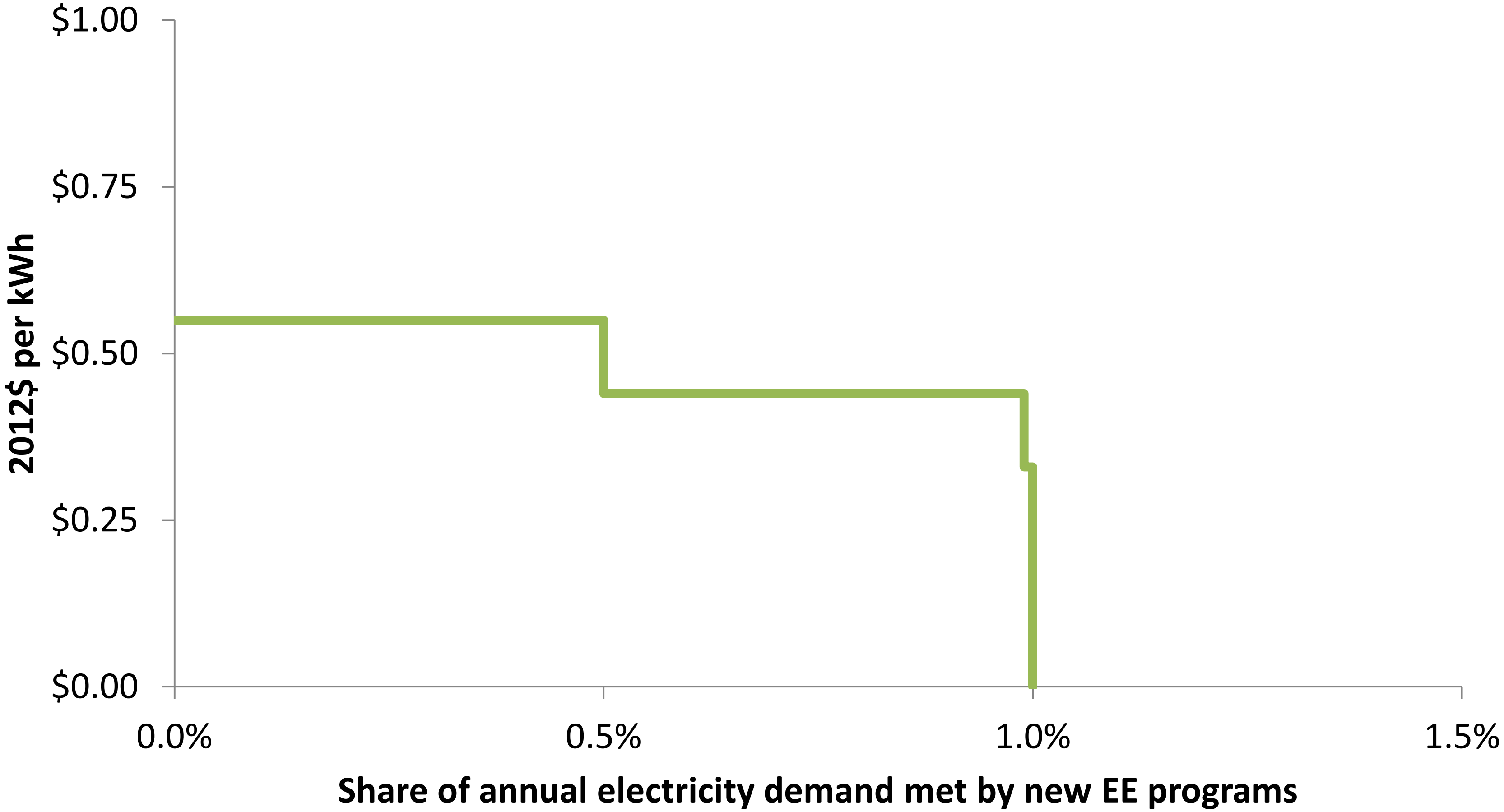
EPA’s EE Approach

(for Clean Power Plan Analysis)



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DATA & CHALLENGES:

ANNUAL EE POTENTIAL AND COSTS

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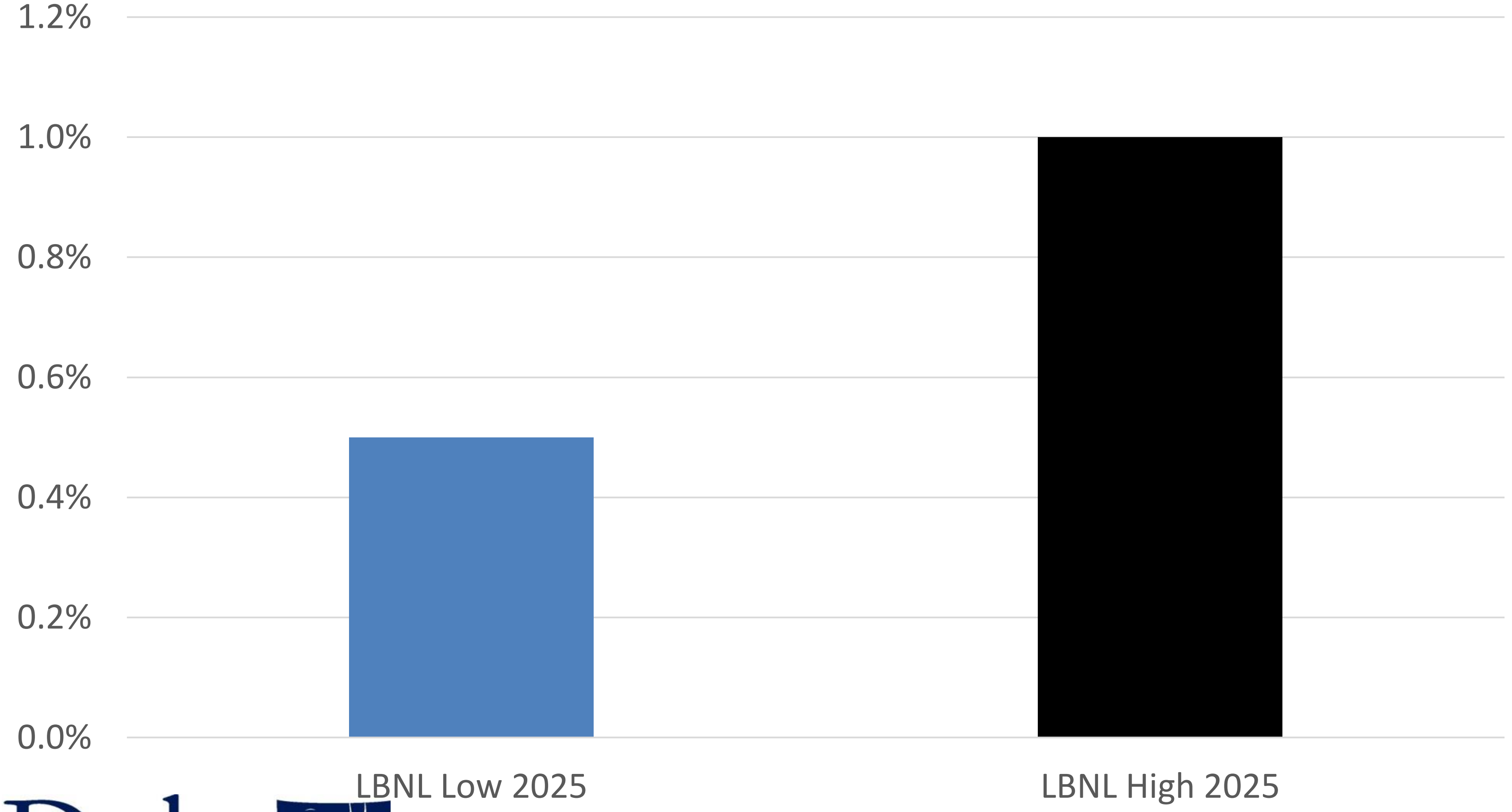
National EE Potential Estimates



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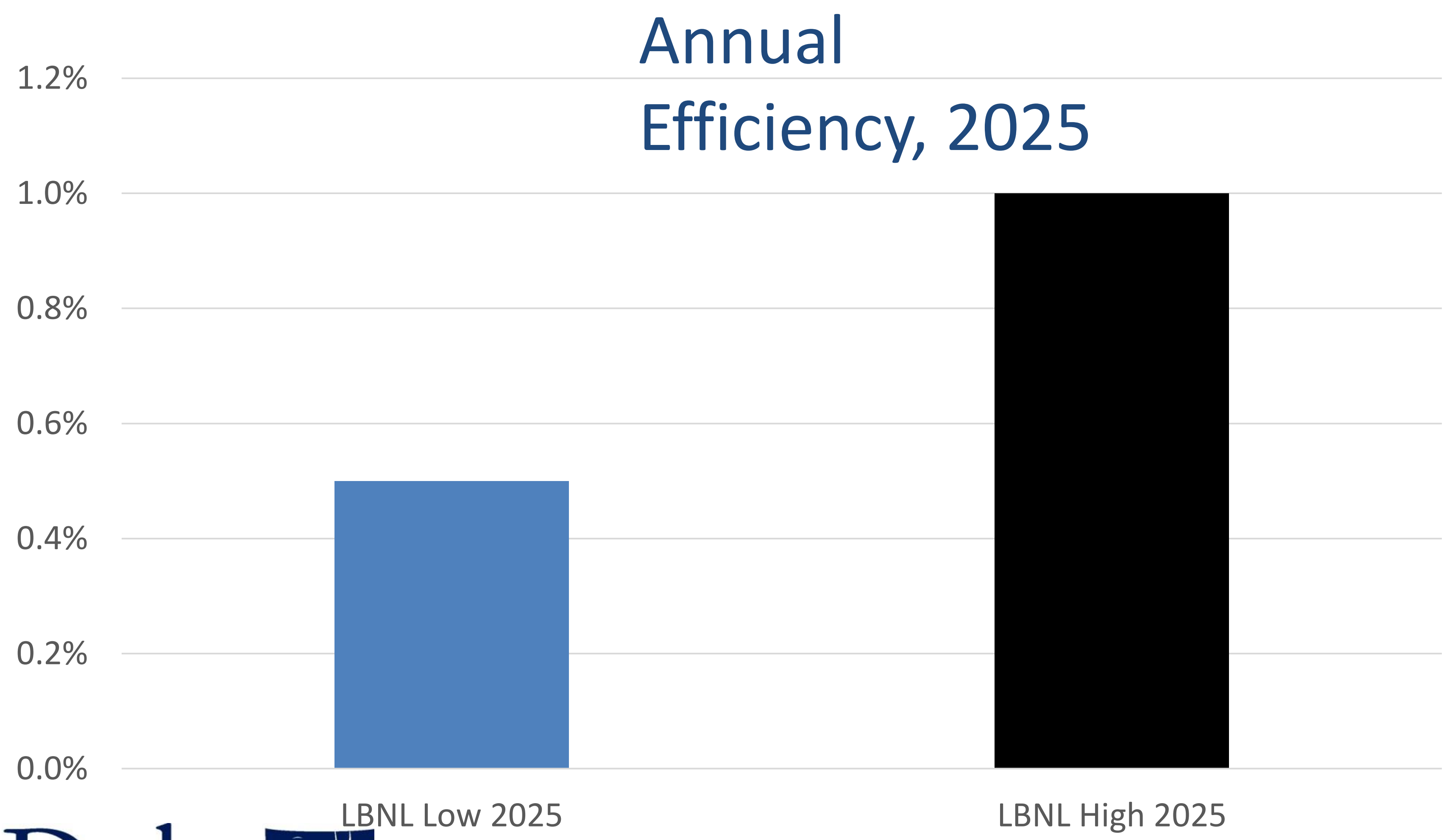
National EE Potential Estimates



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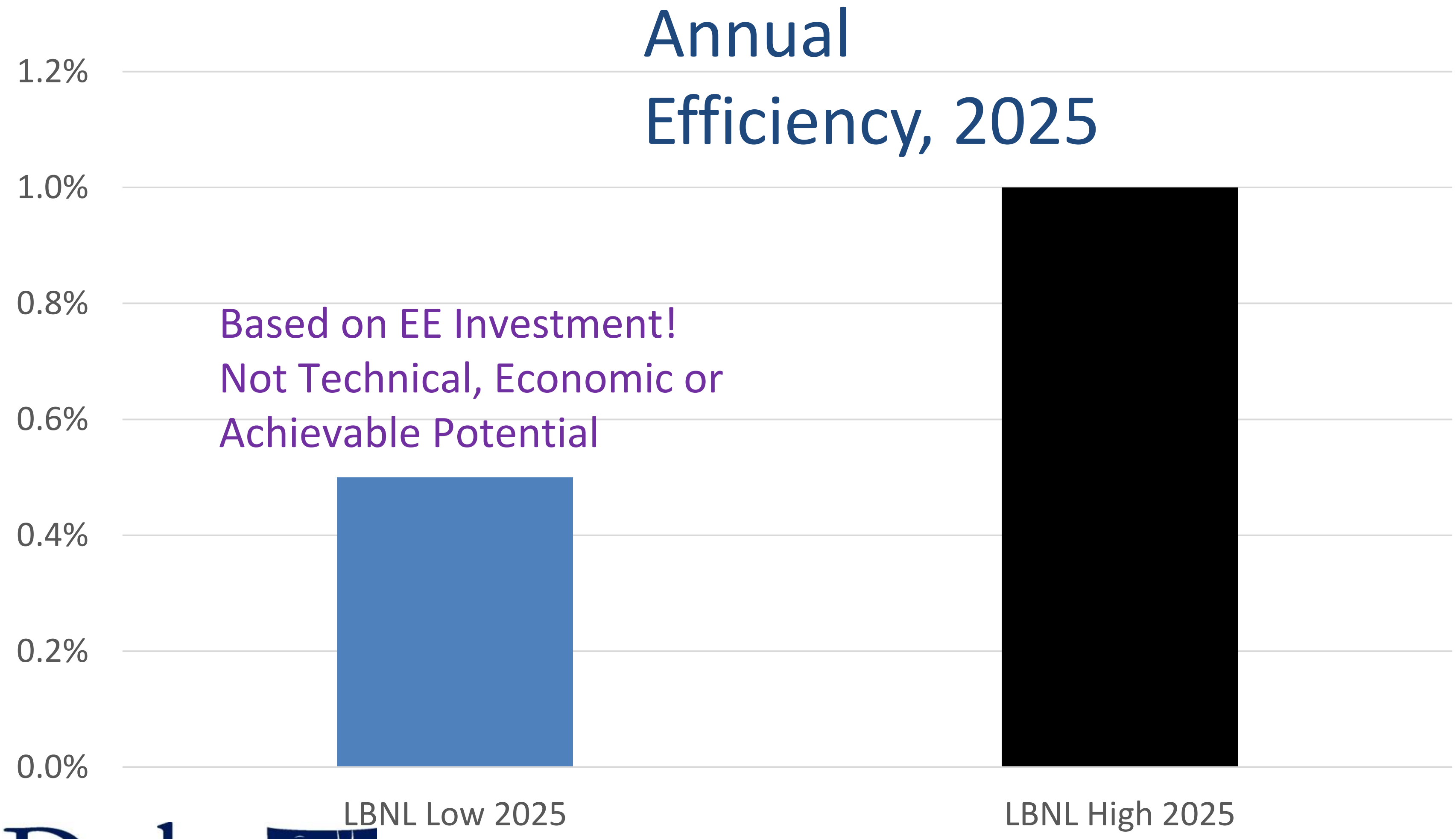
National EE Potential Estimates



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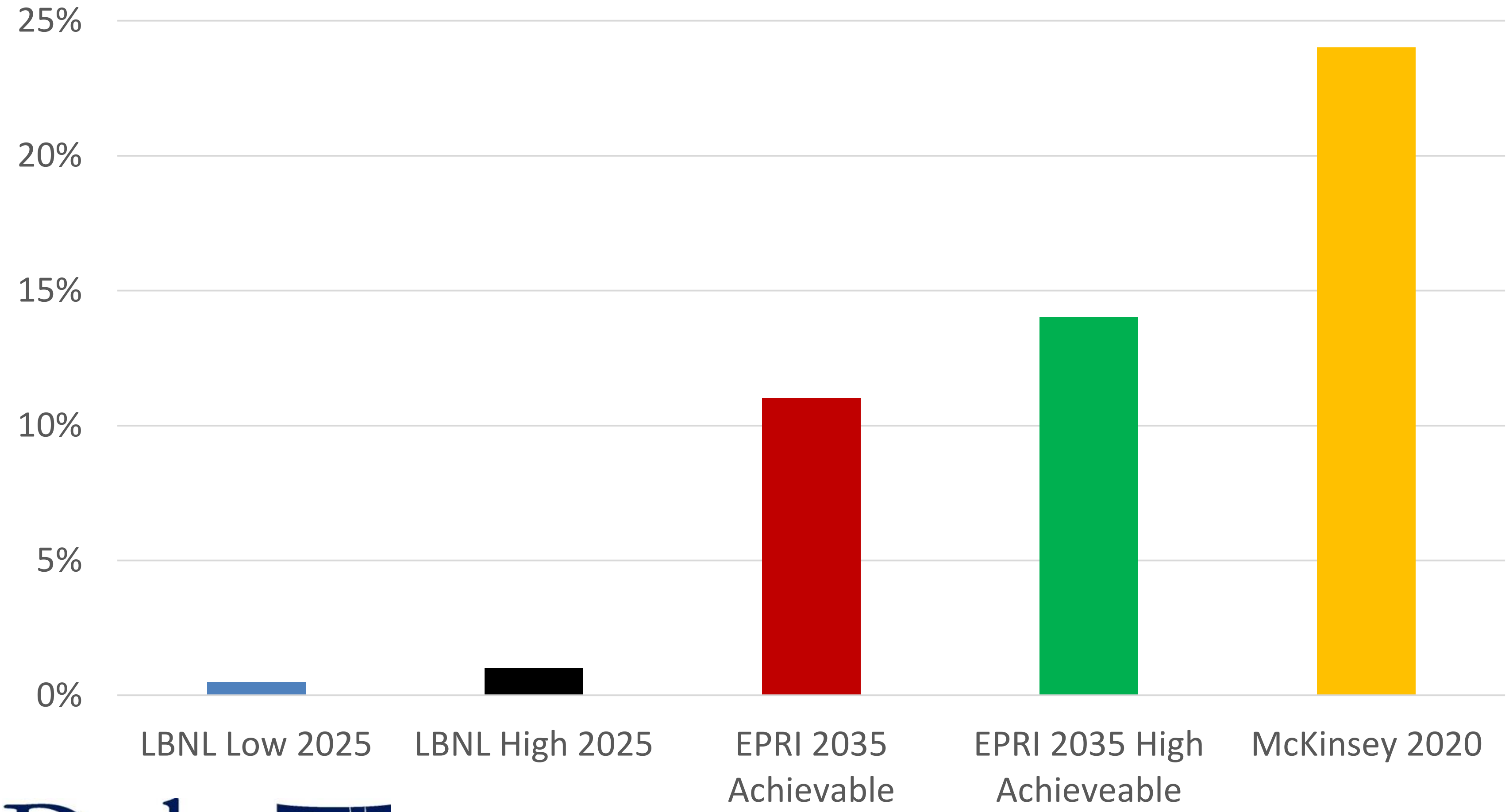
National EE Potential Estimates



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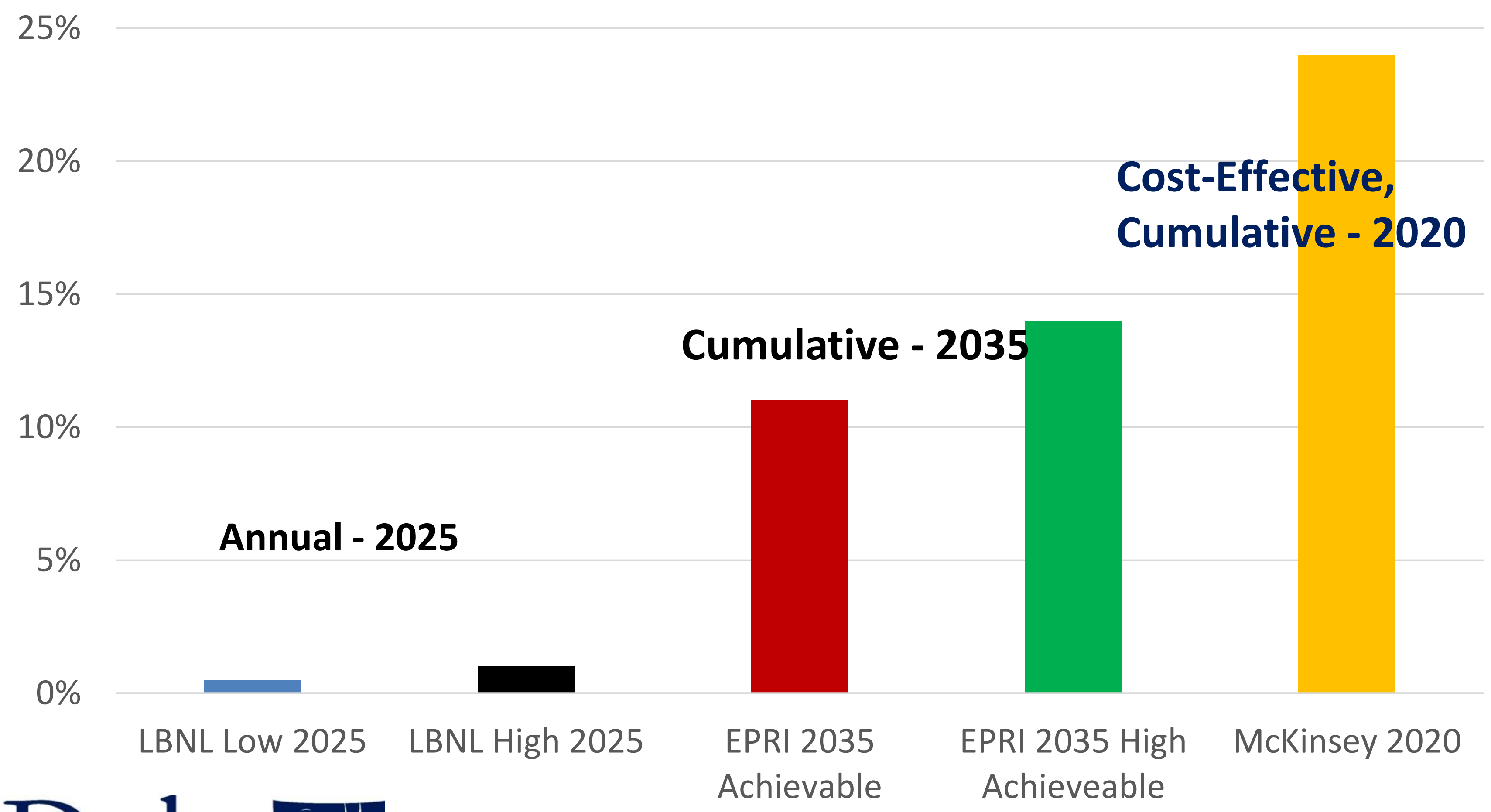

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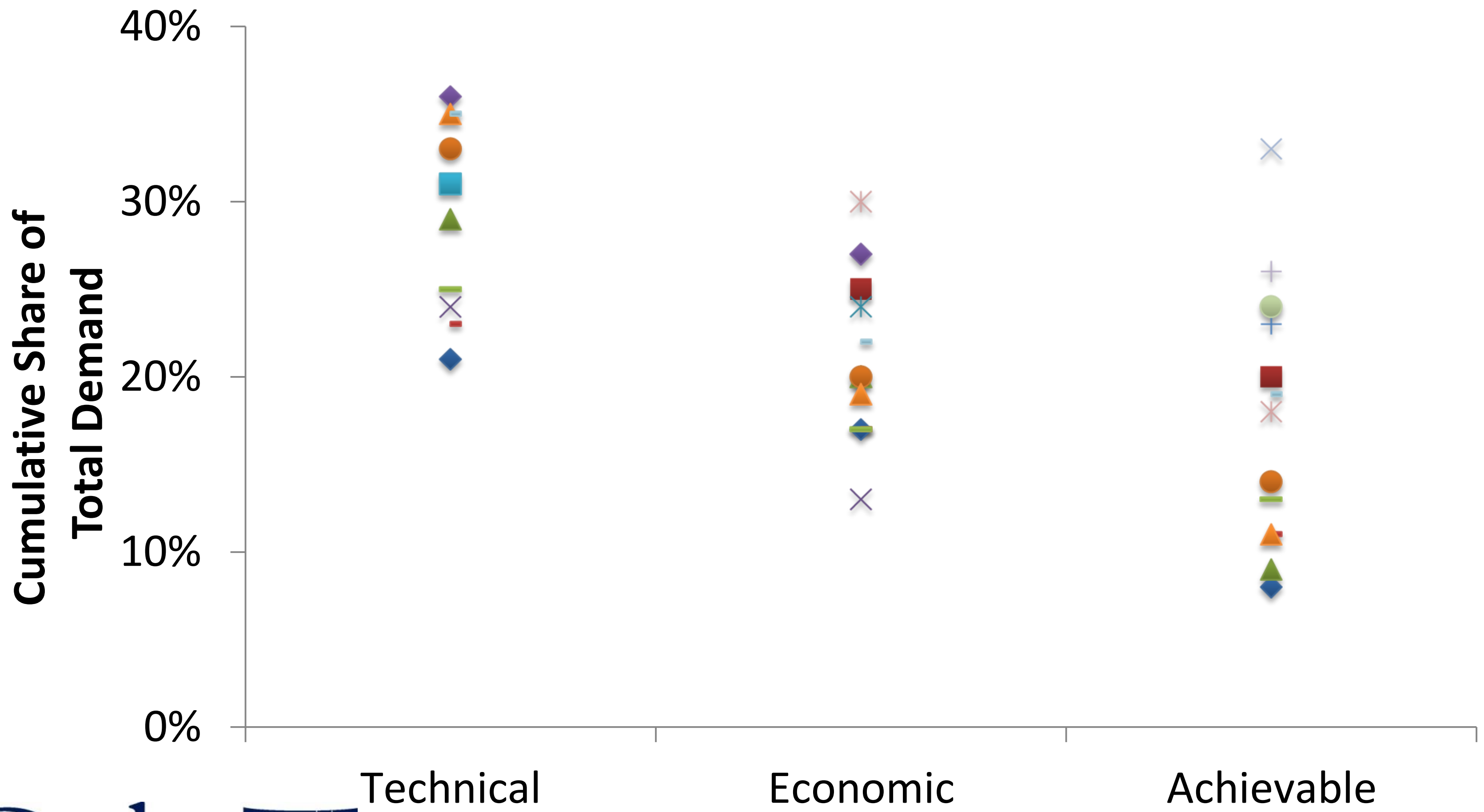
Annual Potentials
(data from EE Potential Studies)



MAKING THE NI SUPPLY CURVE:

USING THE DSM PROGRAM IMPACT DATABASE

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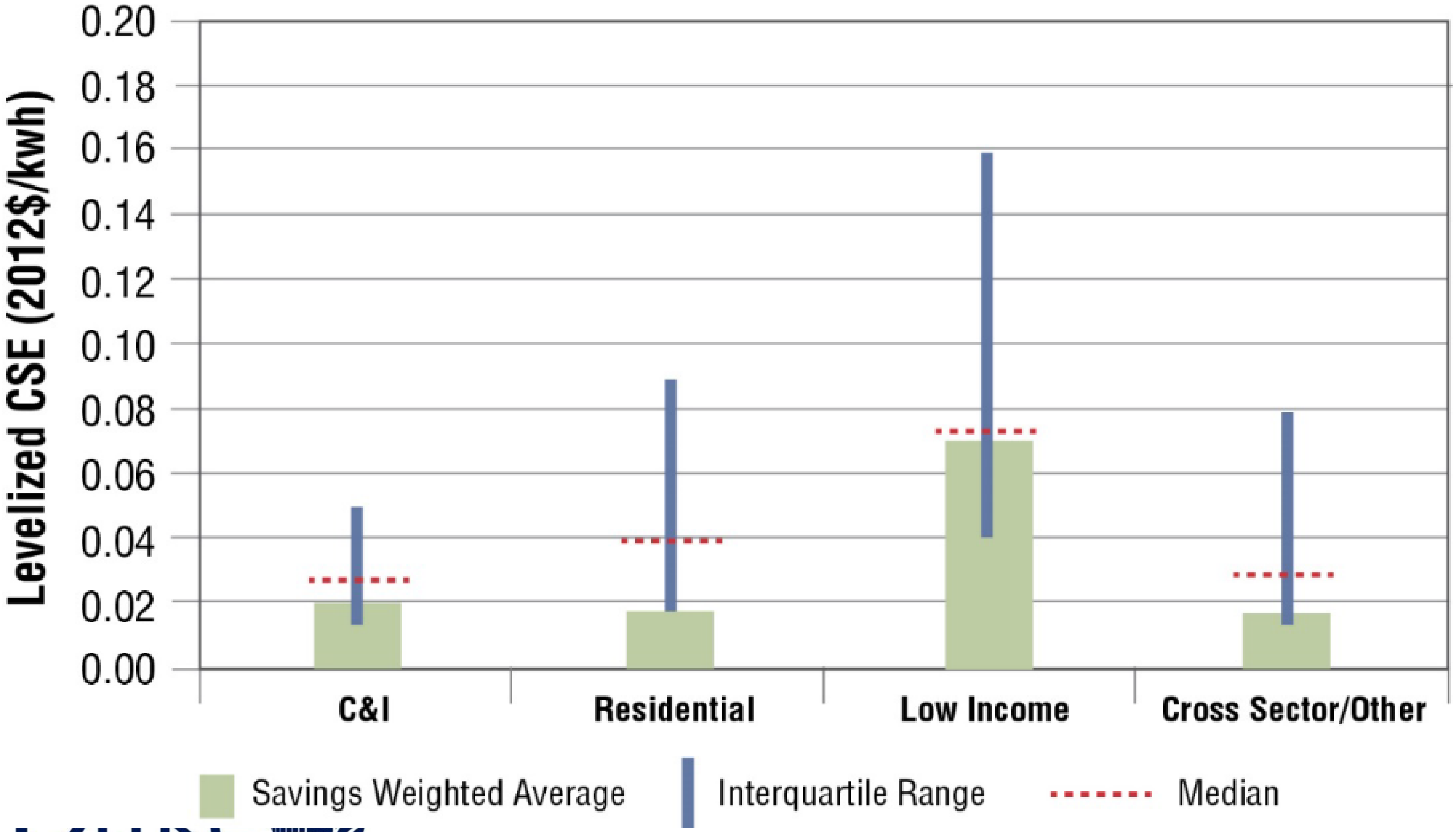
LBNL's National Levelized Cost of Saved Energy from DSM Program Impact Database



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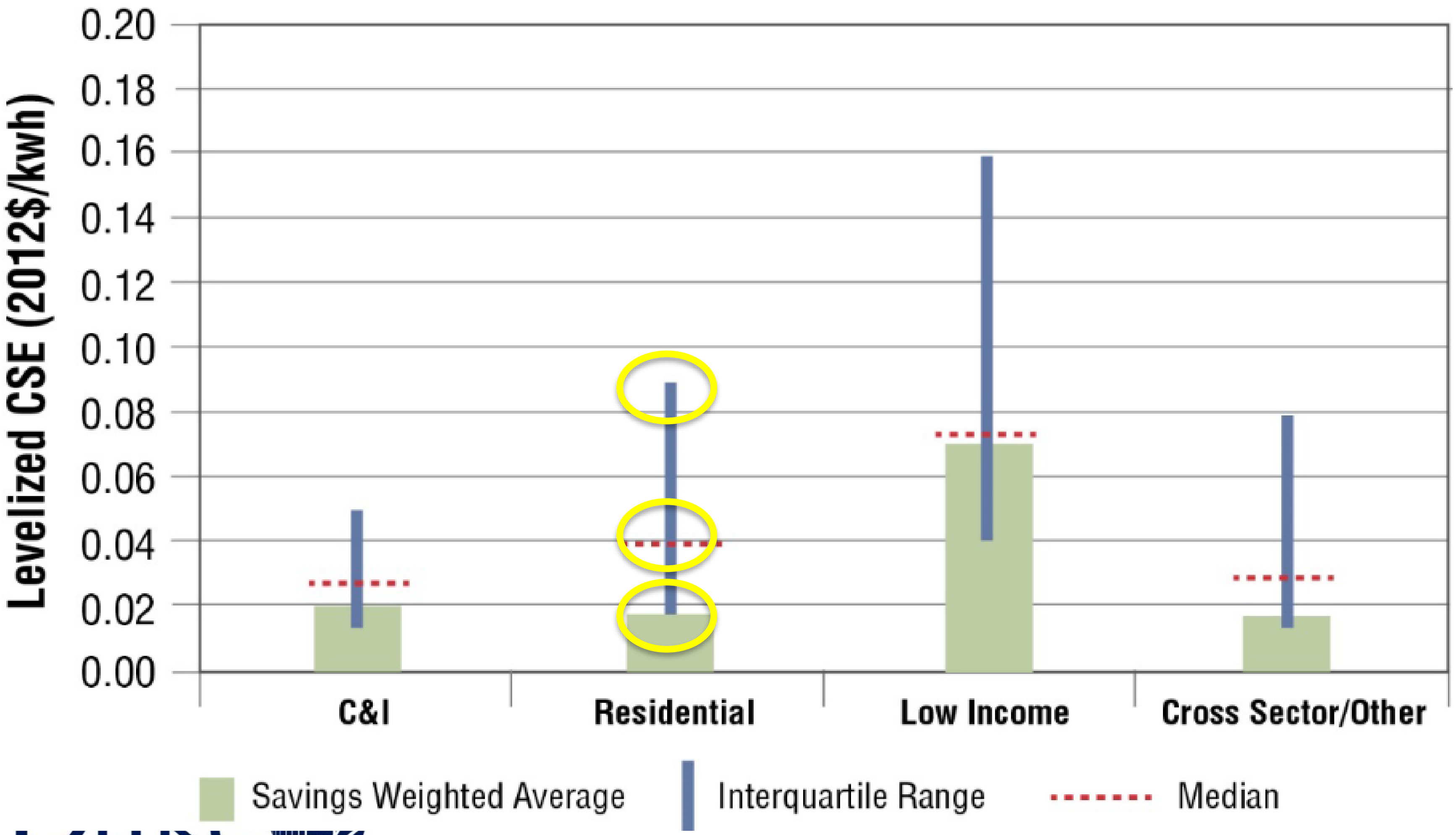
Residential Interquartile Levelized Costs Highlighted



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Program Administrator Cost of Saved Energy for 4,000 EE program-years (2009-2011)

		Levelized CSE	First-Year CSE
Commercial & Industrial (C&I)		$ 0.021	$ 0.188
Residential		$ 0.018	$ 0.116
Low Income		$ 0.070	$ 0.569
Cross Sectoral/Other		$ 0.017	$ 0.120

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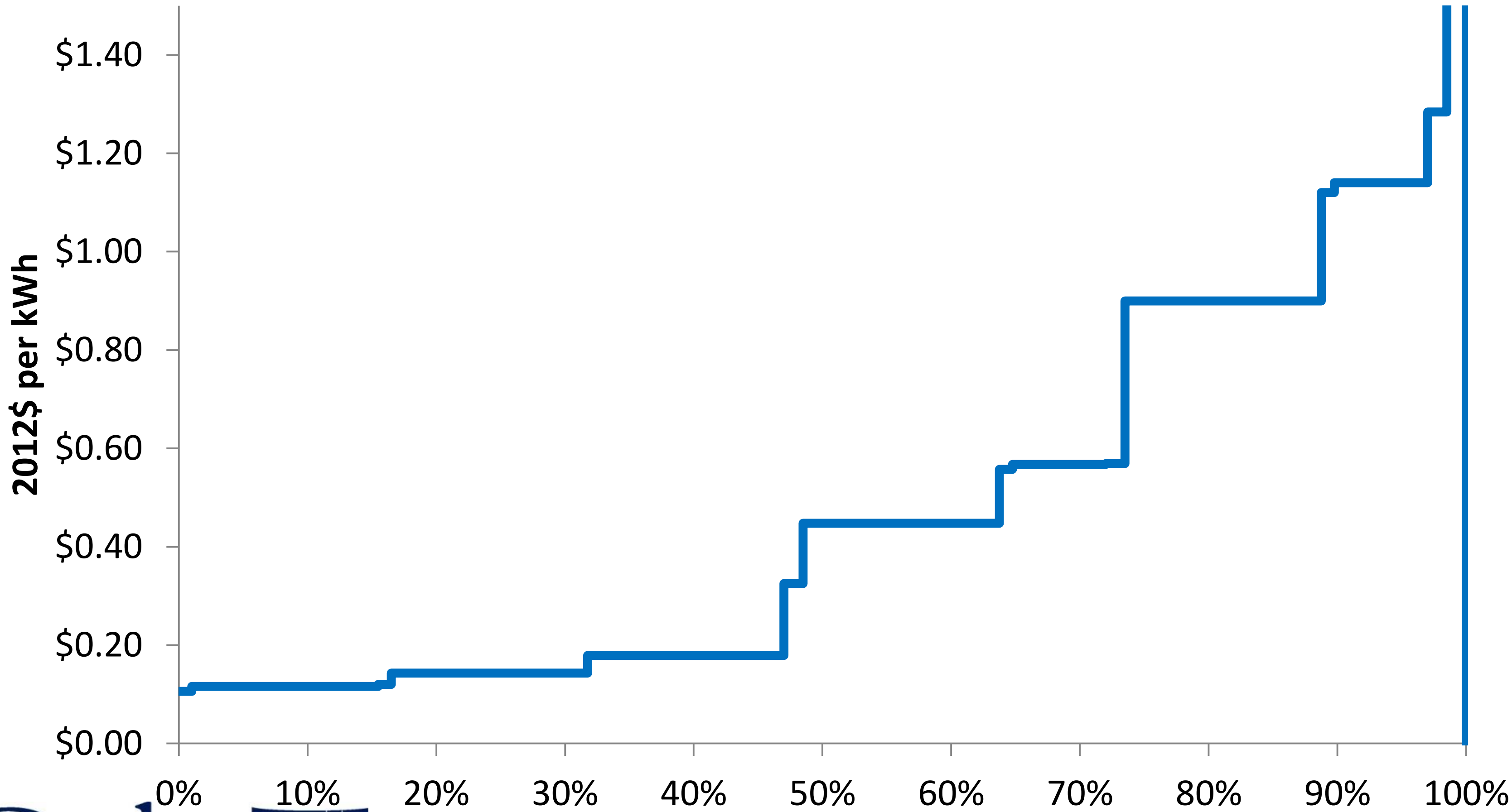
	Quartile	Share of Potential	Cost for each Quarter Potential
Commercial and Industrial	1	13.25%	
	2	13.25%	
	3	13.25%	
	4	13.25%	
Residential	1	10.00%	
	2	10.00%	
	3	10.00%	
	4	10.00%	
Low Income	1	0.50%	
	2	0.50%	
	3	0.50%	
	4	0.50%	
Cross Sectoral or Other	1	1.25%	
	2	1.25%	
	3	1.25%	
	4	1.25%	

	Quartile	Share of Potential	Cost for each Quarter Potential
Commercial and Industrial	1	13.25%	$0.14
	2	13.25%	$0.24
	3	13.25%	$0.45
	4	13.25%	
Residential	1	10.00%	$0.12
	2	10.00%	$0.26
	3	10.00%	$0.57
	4	10.00%	
Low Income	1	0.50%	$0.33
	2	0.50%	$0.60
	3	0.50%	$1.28
	4	0.50%	
Cross Sectoral or Other	1	1.25%	$0.11
	2	1.25%	$0.20
	3	1.25%	$0.56
	4	1.25%	

	Quartile	Share of Potential	Cost for each Quarter Potential
Commercial and Industrial	1	13.25%	$0.14
	2	13.25%	$0.24
	3	13.25%	$0.45
	4	13.25%	$0.90
Residential	1	10.00%	$0.12
	2	10.00%	$0.26
	3	10.00%	$0.57
	4	10.00%	$1.13
Low Income	1	0.50%	$0.33
	2	0.50%	$0.60
	3	0.50%	$1.28
	4	0.50%	$2.57
Cross Sectoral or Other	1	1.25%	$0.11
	2	1.25%	$0.20
	3	1.25%	$0.56
	4	1.25%	$1.12

Previous Table Sorted: First Year EE Savings and Costs (Program Costs)



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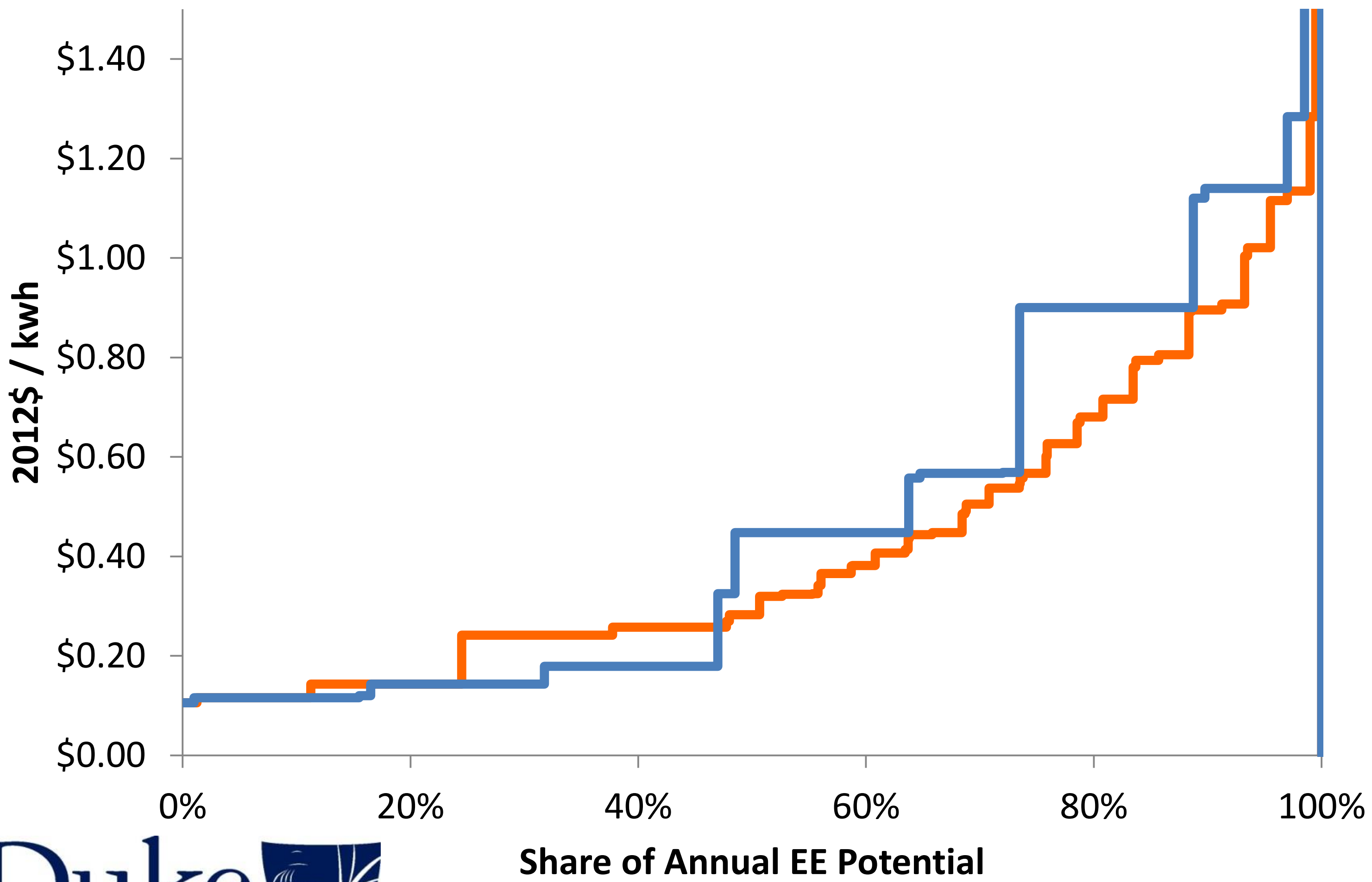
Final Supply Curve Compared to Original



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USING SUPPLY CURVE

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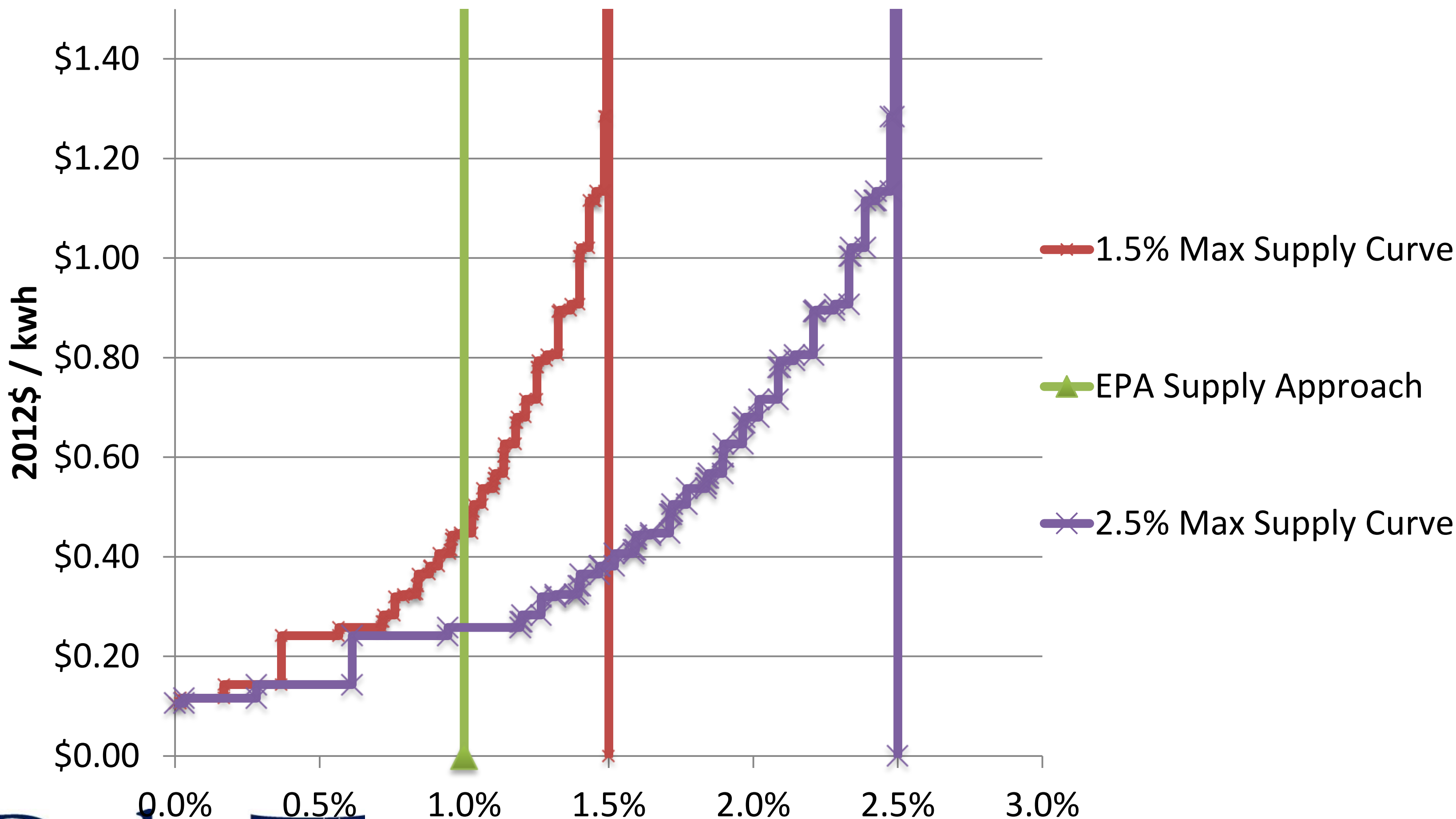
Nicholas Institute EE Supply Curve

(2 versions compared to EPA EE)



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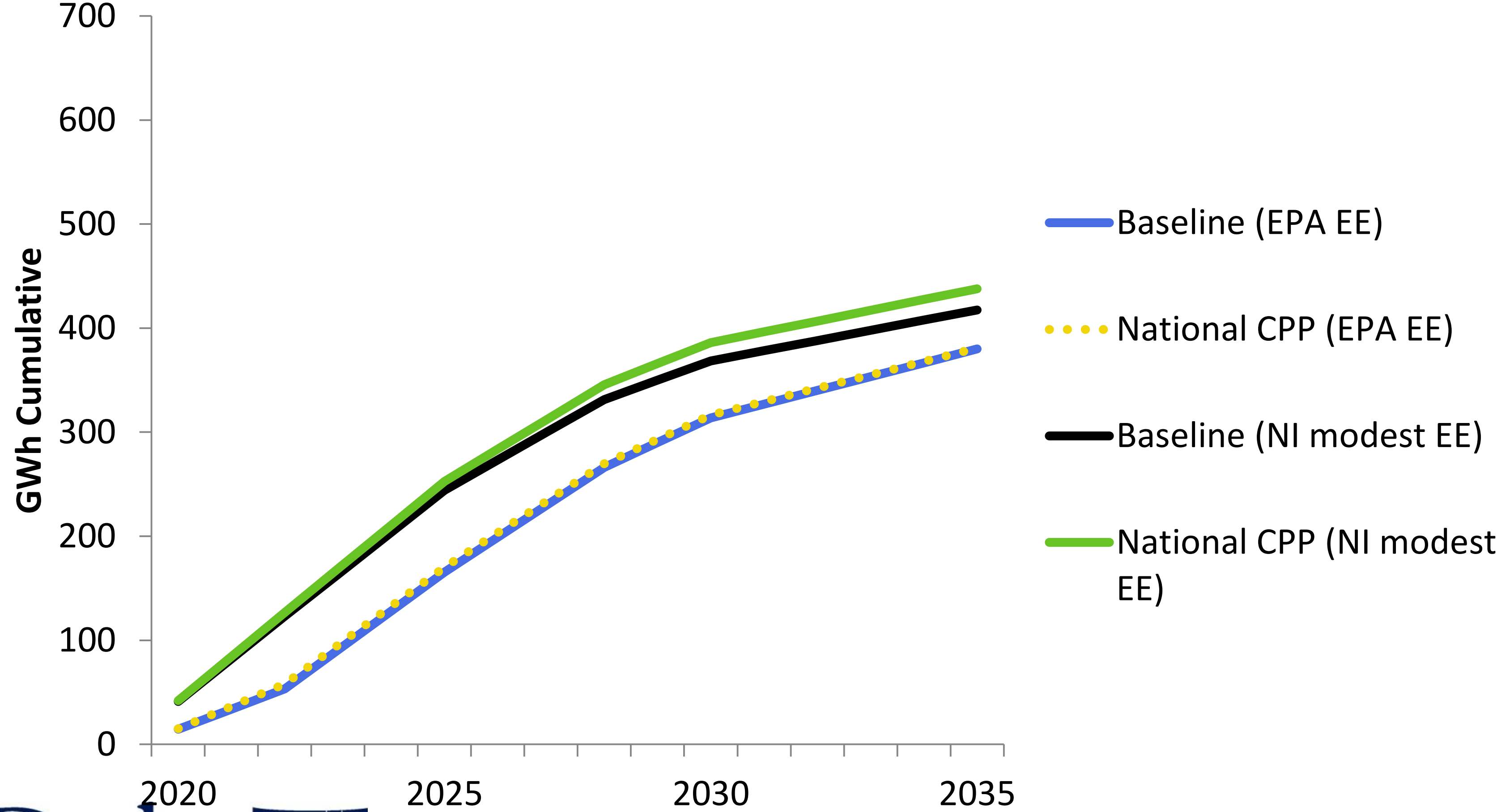
Example: Supply Curve vs. EE Shape



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Thanks!

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Working Paper: Modeling Energy Efficiency as a Supply Side Resource

ni_wp_17_06

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EXTRAS

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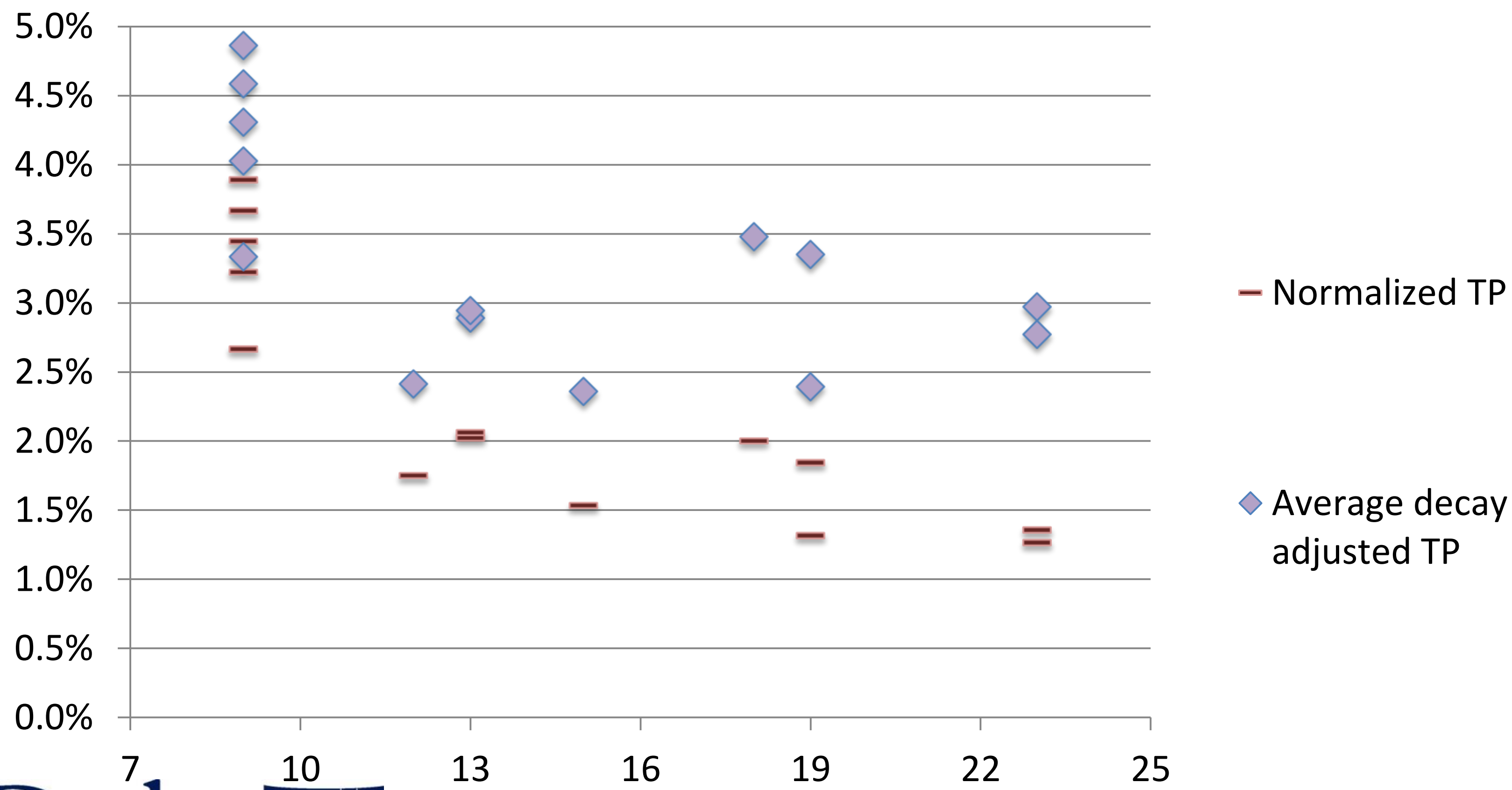
Estimates of Annual Technical Potential by # years in Forecast



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Modeling and IRP Analysis of EE Resources in the Southwest

SWEEP

Jeff Schlegel, Ellen Zuckerman, & Adam Bickford

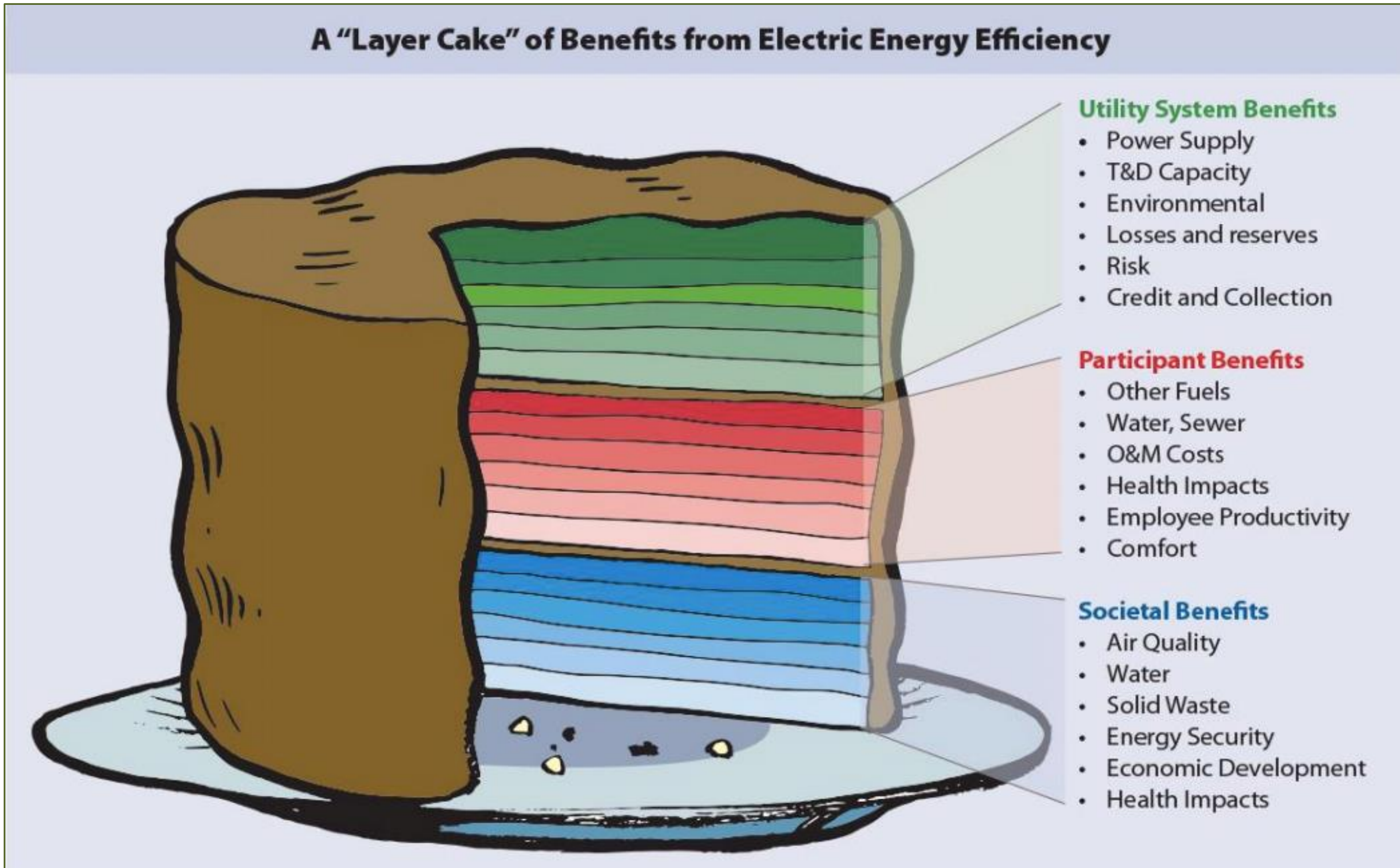
Southwest Energy Efficiency Project (SWEEP)

ACEEE EE as a Resource Conference -- October 31, 2017

EE and Integrated Resource Planning on Halloween – Trick or Treat?

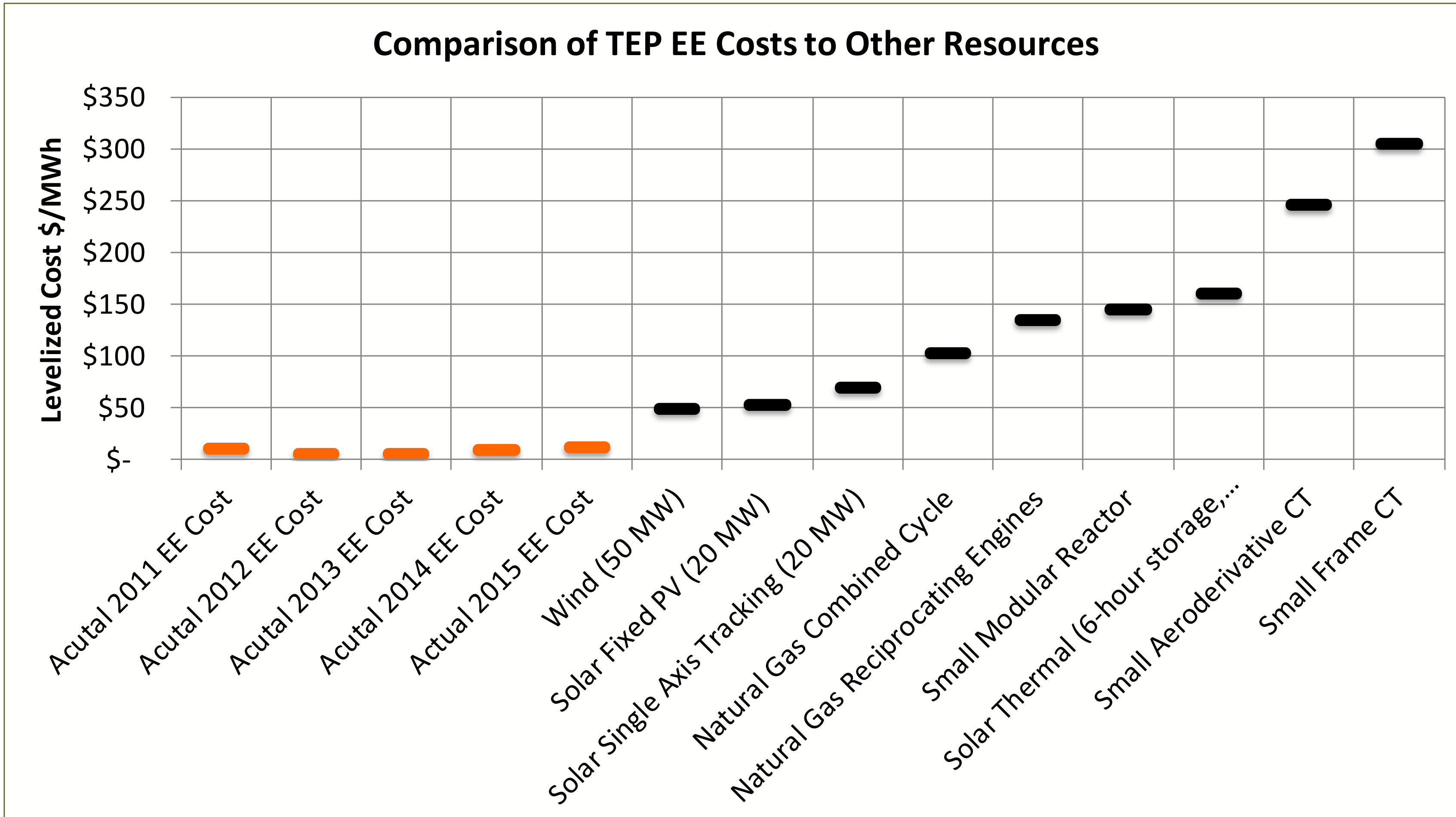
- IRP can be a treat…
  - 3 slides
- …but beware of the tricks
  - 3 slides
- Some new ideas are pretty spooky
  - The scary remainder of the slides

IRP can assess the integrated benefits of EE (vs. markets, which are often single-issue)



Source: Regulatory Assistance Project, "A Layer Cake of Benefits: Recognizing the Full Value of Energy Efficiency," 2013.

IRP enables comparisons across resources



Source: Tucson Electric Power (TEP) 2016 Preliminary Integrated Resource Plan and Supplement; TEP 2011-2015 DSM Reports; and APS 2011-2015 DSM Reports. EE costs exclude costs and savings of demand response. Costs are all portfolio costs including rebates and incentives; training and technical assistance; consumer education; program implementation; program marketing; planning and administration; measurement, evaluation, and research; and the utility performance incentive.

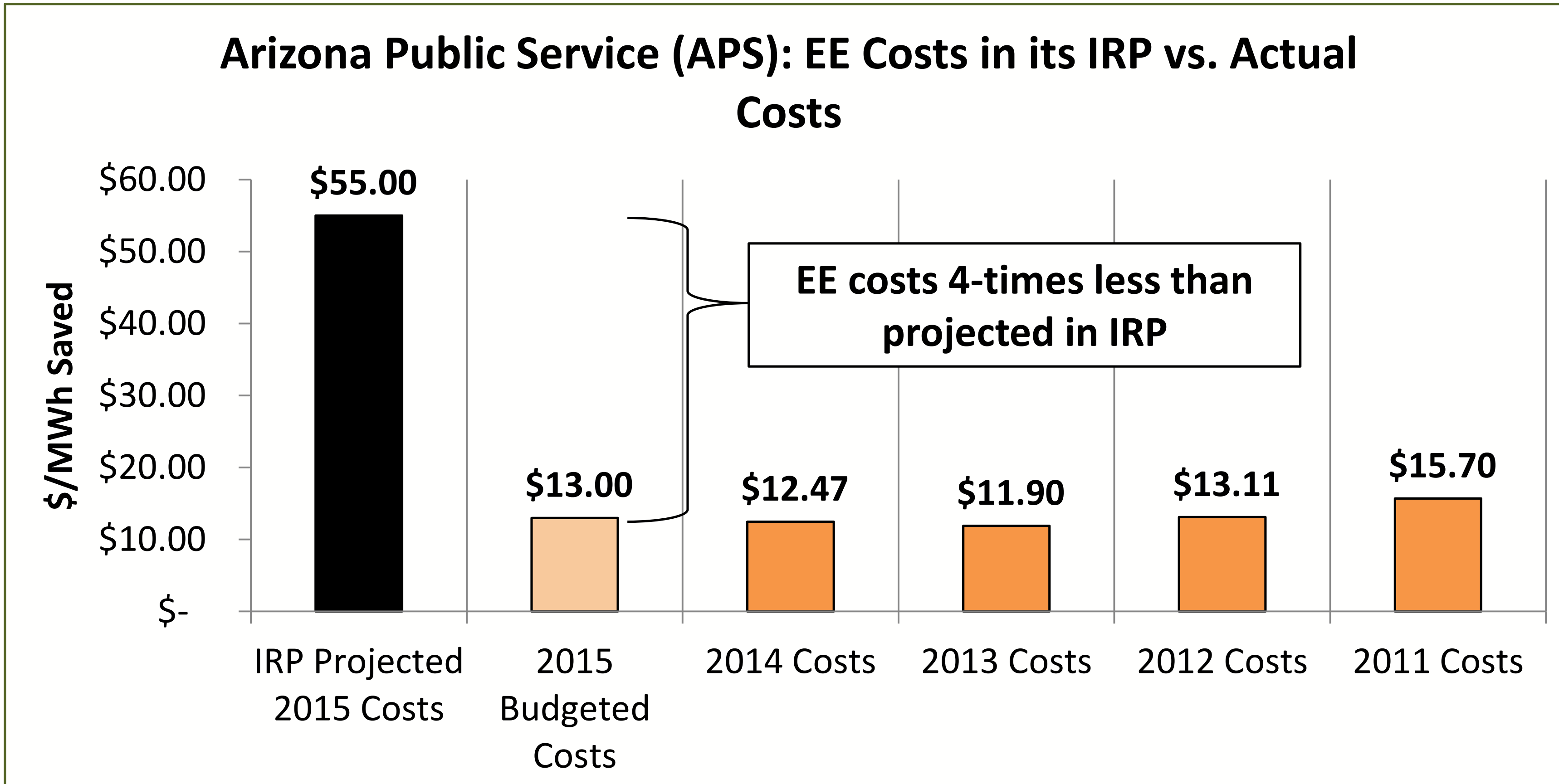
IRP can show that under-investing in EE will result in investment in more expensive supply-side resources

SWEEP examined a hypothetical scenario where EE capacity is replaced with supply side resources in TEP’s 2016 IRP. We assumed the alternative supply side resource would be a 102MW combustion turbine (such as the one proposed by APS at Ocotillo).

The figure illustrates the build out of combustion turbine units necessary to provide capacity resources equivalent to the capacity provided by EE in TEP’s 2016 IRP. As shown in this figure, failure to invest in EE will result in significant investment in supply side resources that are comparatively more expensive. Indeed, TEP would need to build three combustion turbines over the planning horizon and would need to commence construction immediately.

Source: Tucson Electric Power (TEP) 2016 Preliminary Integrated Resource Plan and Supplement.

Guard against bias in IRP analysis, in benefits or costs



In its 2012 IRP, APS estimated that EE would cost $55/MWh in 2015 (despite actual experience to-date demonstrating much lower costs). Then in its EE plan, APS projected that EE would cost $13/MWh in 2015 (an amount 4-times less than its initial IRP projection). Had the Arizona Corporation Commission relied on APS' IRP alone to set EE investments levels and savings targets, APS would have under-invested in EE.

Source: Arizona Public Service Company, 2012 Integrated Resource Plan, Annual Demand Side Management Reports 2011-2014

“End effects” of EE measures at end of lifetimes should be addressed appropriately

- EE measures cause the reduction in energy use
- At the end of the effective useful life of the measure, the reduced level of energy use continues after the measure life ends
  - Usage does not increase up to an inefficient level
  - Any replacement of the older EE measure is expected to be the same efficiency level (the replacement is not expected to be less efficient)

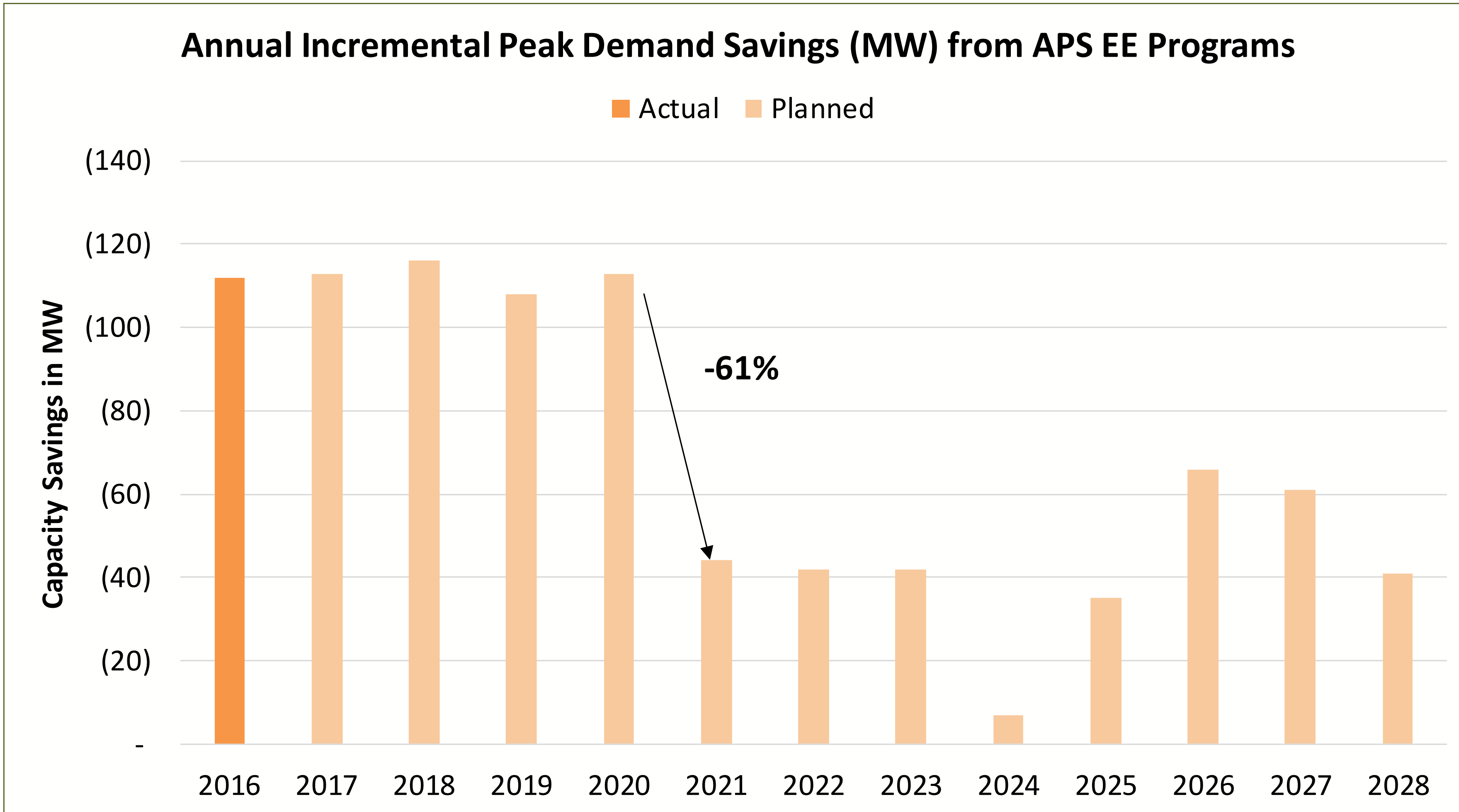
How varied are avoided costs and EE measure lives? Know your avoided costs.

Estimates of Program-Specific Benefits (Avoided Costs) Per Unit of Lifetime Energy Savings ($/kWh)

	Arizona			Colorado	Nevada		New Mexico	Utah
	APS	**SRP**	**TEP**	**PSCo**	**NPC**	**SPPC**	**PNM**	**RMPU**
Residential Programs/Applications								
Lighting	$0.0304	$0.0170	$0.0360	$0.0971	$0.0196	$0.0195	$0.0295	$0.0541
Cooling	$0.0488	$0.0590	$0.0765	$0.1579	$0.0565		$0.0158	$0.1631
Building Retrofit	$0.0496			$0.1946			$0.0419	$0.0536
New Construction	$0.0425	$0.0270	$0.1387	$0.1411				
Commercial Programs/Applications								
Lighting	$0.0284	$0.0130	$0.0573	$0.0432	$0.0163	$0.0200		$0.0512
Cooling			$0.0459	$0.0652	$0.0142	$0.0174		$0.0983
Building Retrofit							$0.0458	
New Construction	$0.0403	$0.0370	$0.0494	$0.0579			$0.0393	
Small Business Lighting	$0.0284	$0.0940	$0.0410	$0.0388				
Small Business Cooling			$0.0328					

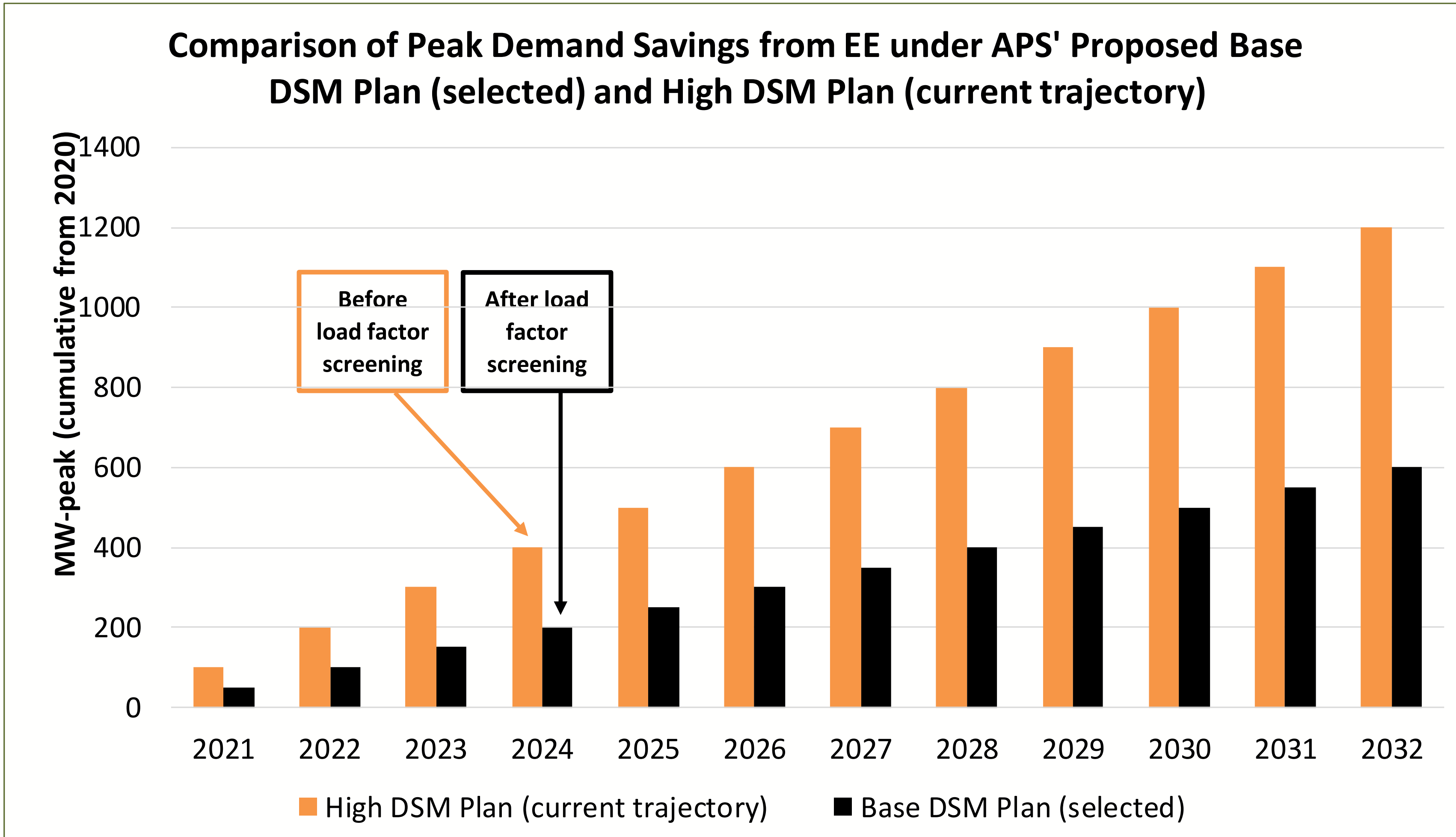
Source: Bickford, Adam and Howard Geller (2017). *Time-Sensitive Valuation of Electricity Savings in the Southwest*, SWEEP, July 2017.

APS and TEP IRPs rely less on EE savings after 2020, the end of the EE Standard



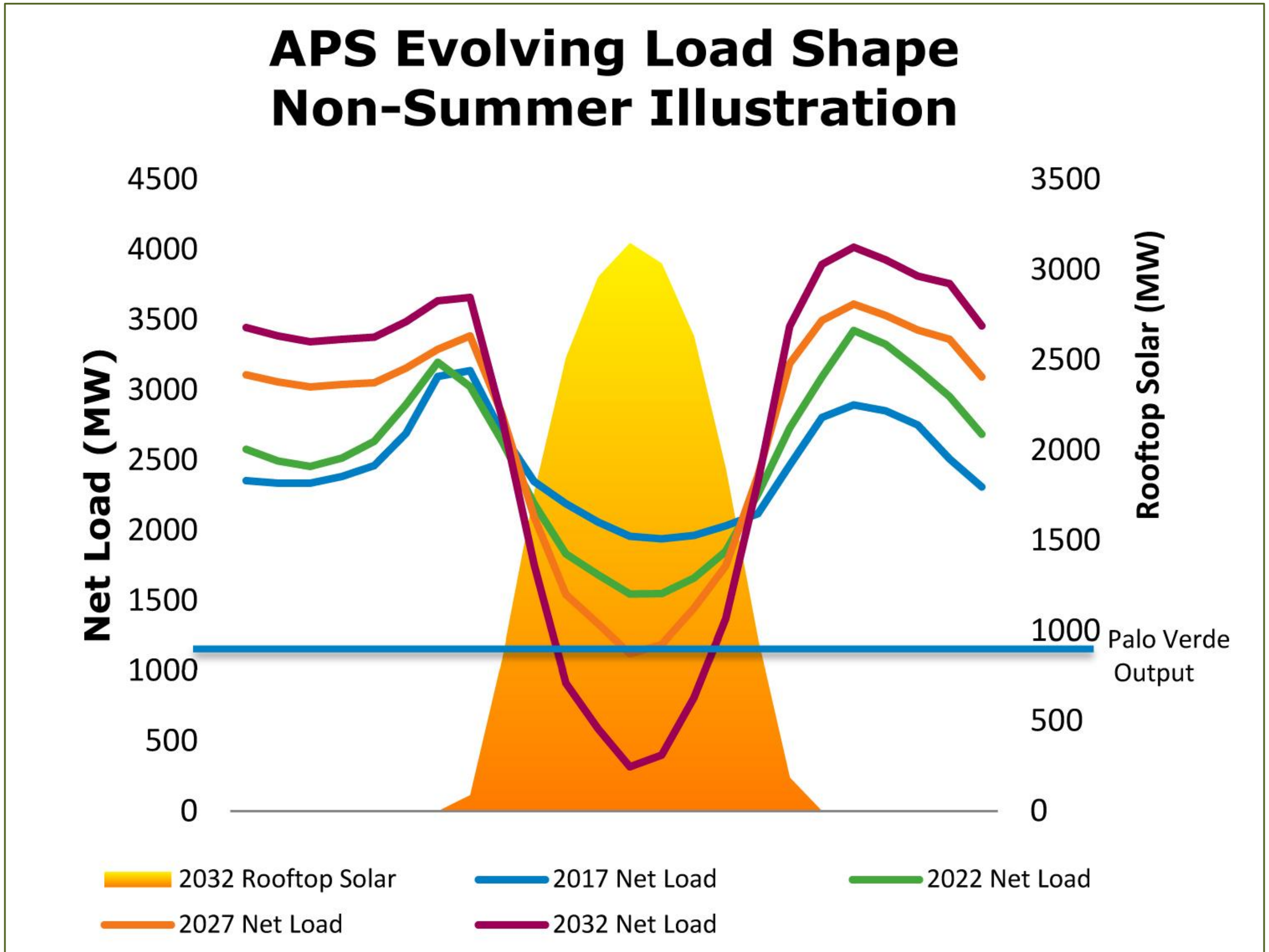
Data Source: EE Program Capacity Savings (MW) as projected in APS' IRP. Source: APS 2017 IRP, ATTACHMENT C.1(A) – COINCIDENT PEAK DEMAND BY MONTH AND CUSTOMER CLASS, p 237-244.

Screening by load factor to focus more on peak savings actually results in less peak savings



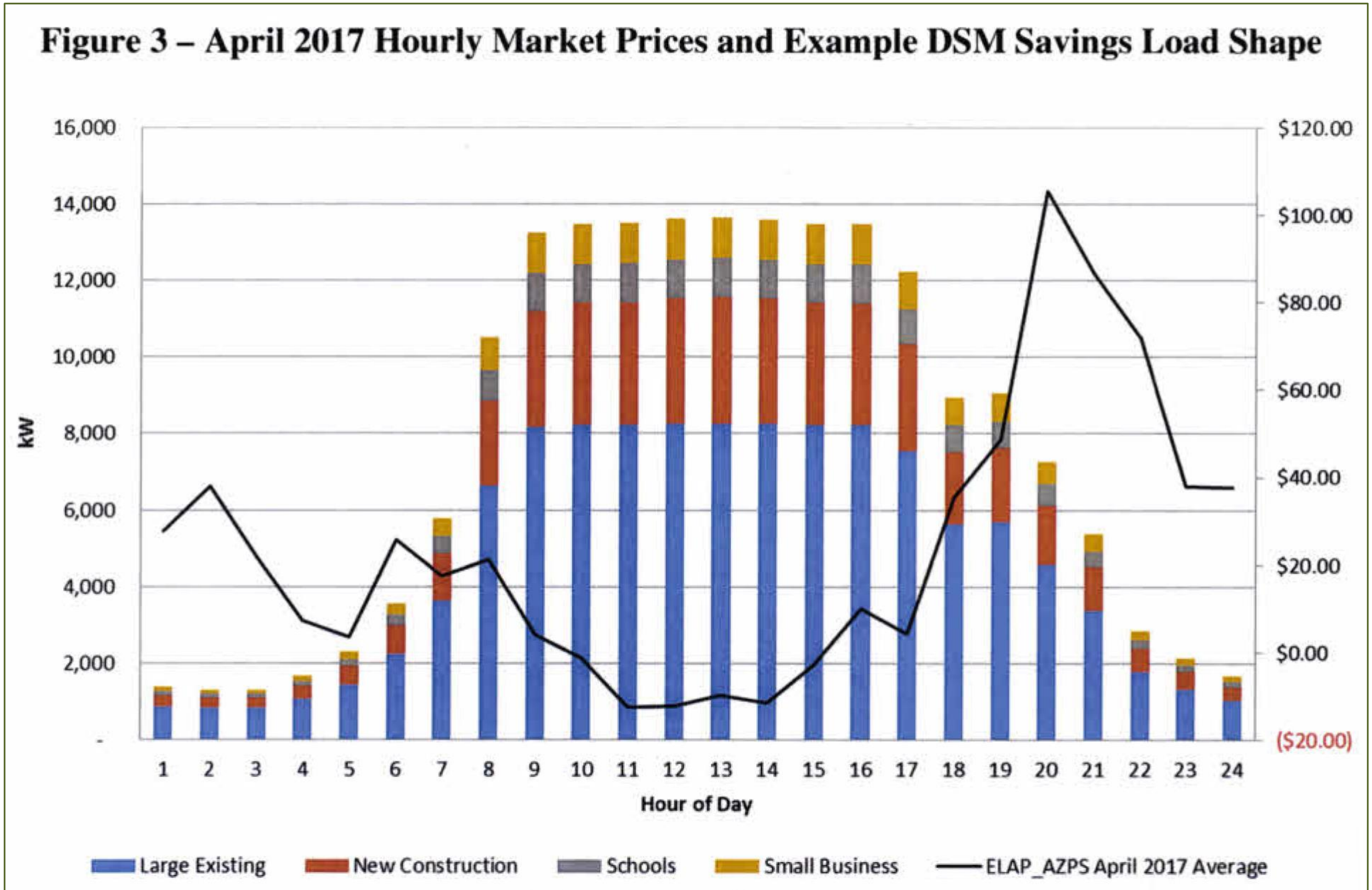
Source: Comparison of peak demand savings between Arizona Public Service Company's (APS) Base DSM Plan (blue) included in its Selected Portfolio and its High DSM Plan which continues the current trajectory. The load factor screening applied by APS to reach the Base DSM Plan results in a significant reduction in peak demand savings. Source: APS 2017 IRP Table D-15 and D-16, p 170.

Beware of the use of the "duck curve" and negative prices to reduce EE investment



Source: Arizona Public Service Company (APS) 2018 Demand Side Management Plan.

Beware of the use of the "duck curve" and negative prices to reduce EE (continued)



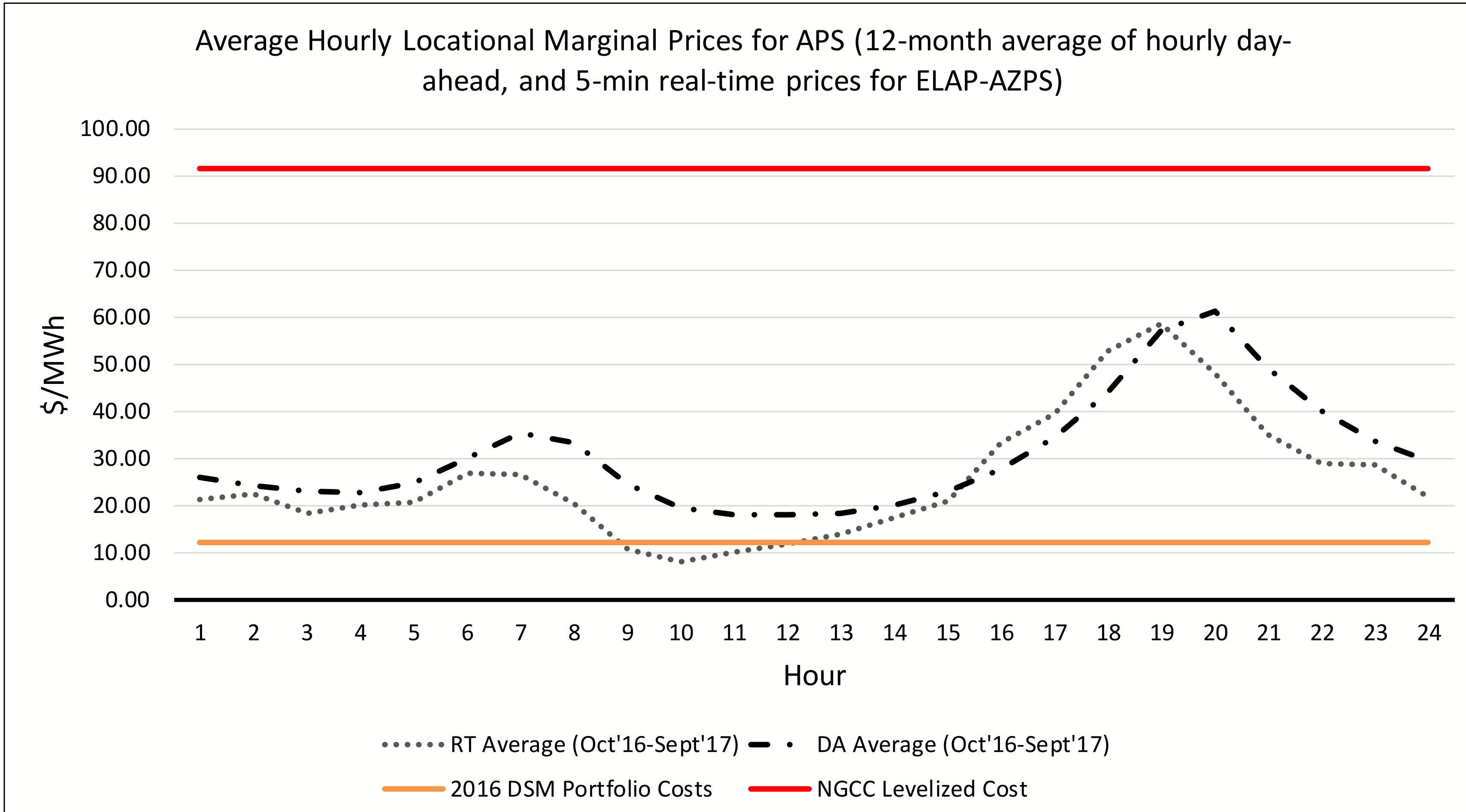
Source: Arizona Public Service Company (APS) 2018 Demand Side Management Plan.

"Duck curve" and negative price arguments can be misleading or overemphasized

- The recent impact of negative price events on costs to customers is relatively small. According to data provided by APS, energy purchased on the wholesale market in 2017 (YTD) for a negative price has amounted to ~50 GWh or <0.2% of APS total energy load forecast for the entire year. Any benefit that customers may derive from increasing load during these hours (e.g. via reduction in efficiency measures) must be weighed against the cost of increasing load during other hours.
- E.g., if the 50 GWh purchased by APS in 2017 came at a price of -$20/MWh, this equates to approximately $1M in customer savings. In contrast, APS EE programs delivered $62M in net benefits in 2016.
- An appropriate evaluation of the energy value from an EE measure should consider the savings generated (and costs incurred) throughout the life of a measure – not just for a specific interval. Thus, if a time-based approach is used, it should be based on either 8760 hour values or an average annual value for a specific time period of savings.

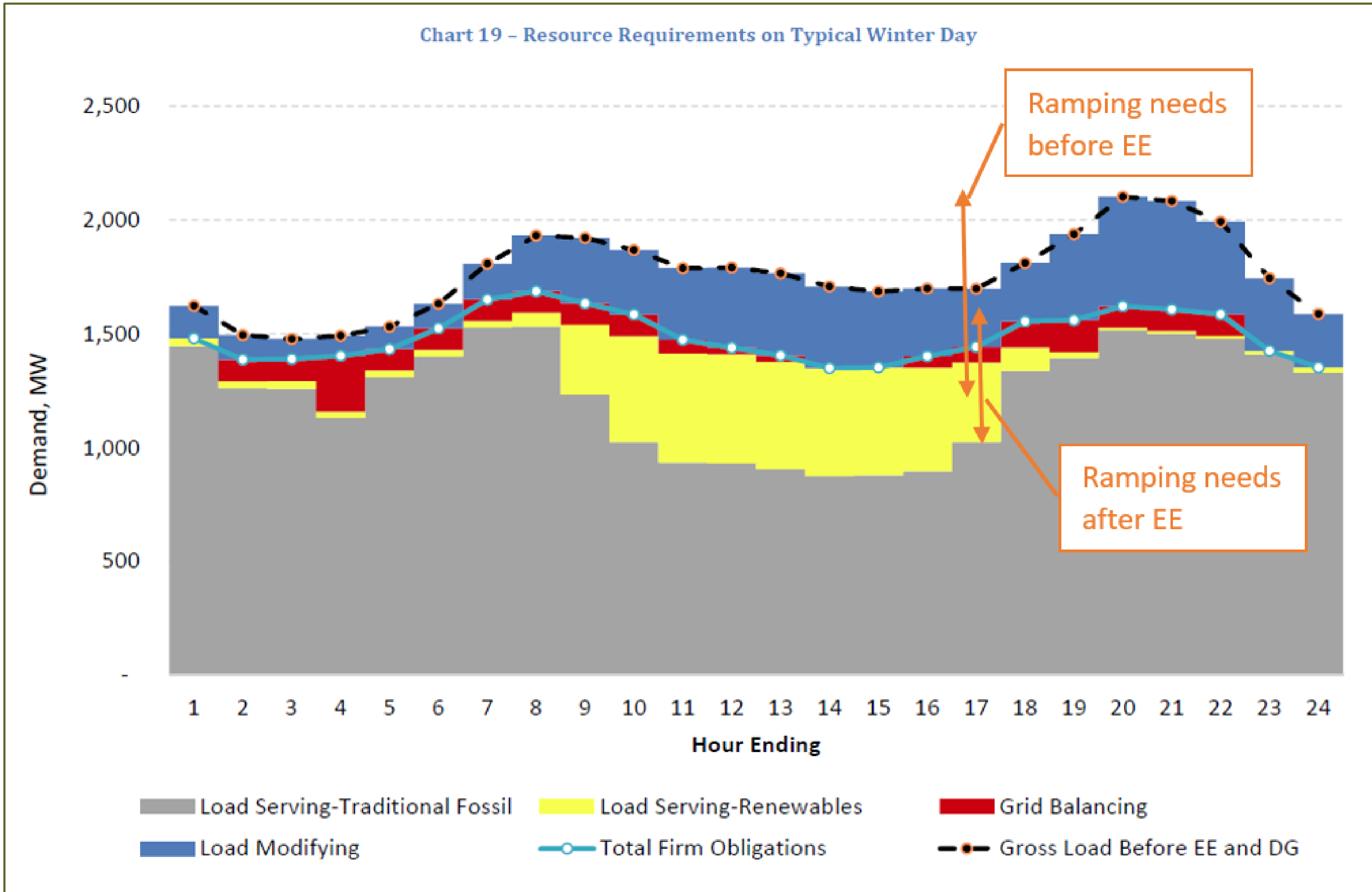
Source: SWEEP Comments on APS IRP, October 2017

Average prices are positive in all hours, and nearly all avg. prices exceed DSM costs



Source: Average Real-time and Day-ahead locational marginal pricing data for the AZPS load aggregation point as reported by the CAISO OASIS system. This reflects the marginal cost of production for both the real-time (5-minute) market intervals and day-ahead (hourly) schedules. Source: CAISO OASIS, retrieved October 2017. EE portfolio cost data based on APS 2016 DSM Reports; NGCC Cost Data based APS 2017 IRP Attachment D.3 – Generation Technologies (p 312).

EE can help to mitigate the ramping needs associated with the "duck curve"



Source: Tucson Electric Power (TEP) 2016 Integrated Resource Plan; SWEEP comments on TEP IRP (October 2017)

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Additional information and resources at: www.swenergy.org

Integrated Resource Planning: Giving a Fair Shake to the Lowest Cost Resource

Presented at the 2017 ACEEE National Conference on Energy Efficiency as a Resource

October 31, 2017

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MIDWEST ENERGY EFFICIENCY ALLIANCE

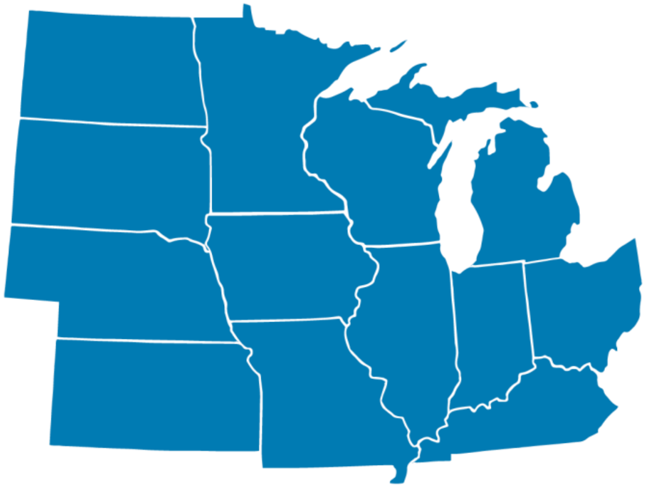
About MEEA

The Trusted Source on Energy Efficiency

We are a nonprofit membership organization with 160+ members, including:

- Utilities
- Research institutions
- State and local governments
- Energy efficiency-related businesses

As the key resource and champion for energy efficiency in the Midwest, MEEA helps a diverse range of stakeholders understand And implement cost-effective energy efficiency strategies that provide economic and environmental benefits.



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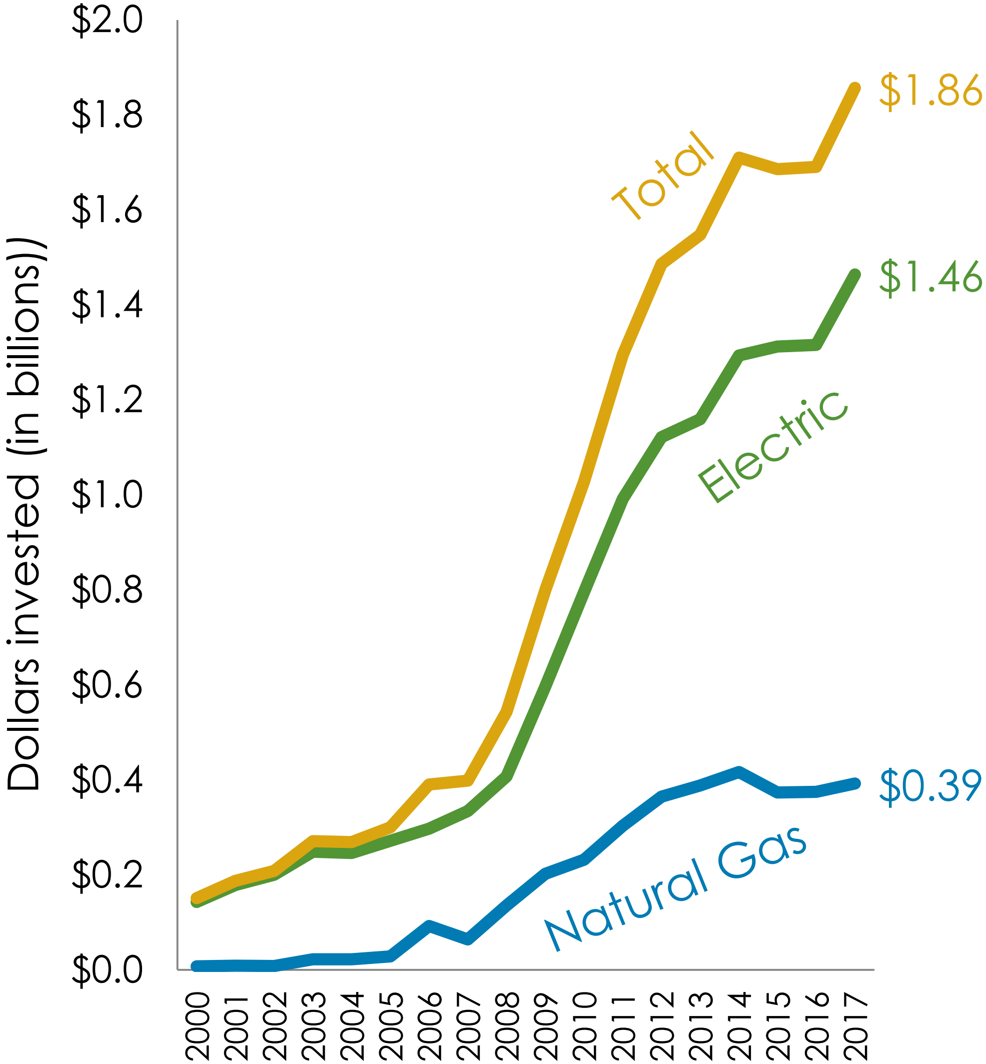
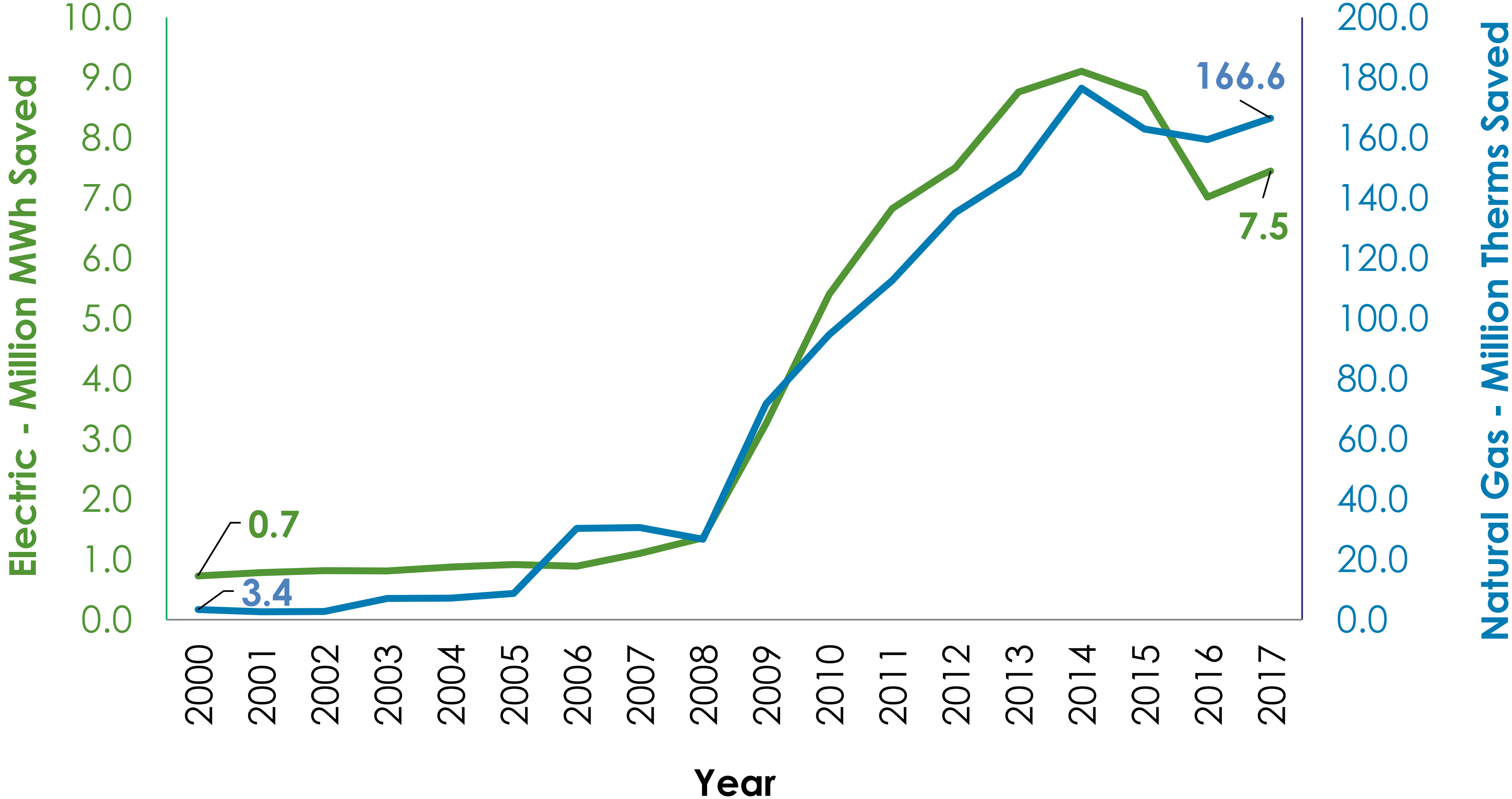
Energy Efficiency Investment & Policies in the Midwest



Timeline of Energy Efficiency Policies in the Midwest

1983	MN	Pilot legislation
1990	IA	Initial legislation
1991	MN	CIP requirement adopted
1996	IA	Legislation updated
1999	WI	Public Benefit Fund adopted (electric & gas)
2007	IL	EERS legislation adopted (electric)
2007	MN	EERS legislation adopted (electric & gas)
2008	MI	EERS legislation adopted (electric & gas)
2008	OH	EERS legislation adopted (electric)
2008	IA	EE mandated by Executive Order (electric & gas)
2009	IL	EERS legislation adopted (gas)
2009	IN	EERS implemented by regulatory order
2009	MO	Voluntary EE standard legislation adopted (electric)
2010	WI	EERS implemented by regulatory order
2011	WI	EERS adjusted by legislation
2014	IN	EERS overturned by legislation
2014	OH	EERS ‘frozen’ by legislation
2016	IL	EERS Updated by legislation
2016	MI	EERS amended, PSC authority increased
2016	OH	EERS freeze extension vetoed, EERS restored

Midwest Energy Savings through Utility Energy Efficiency



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Integrated Resource Planning

Definition

- An **integrated resource plan**, or IRP, is a utility plan for meeting forecasted annual peak and energy demand, plus some established reserve margin, through a combination of supply-side and demand-side resources over a specified future period.

(Regulatory Assistance Project, 2013)

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Integrated Resource Planning

Components

- Modeled Load Scenario Forecasts
- Potential Studies (EE, DR, Markets)
- Supply-side and Demand-side Resources
- System needs and load requirements
- Fuel Prices
- Other state-specific policy priority inputs

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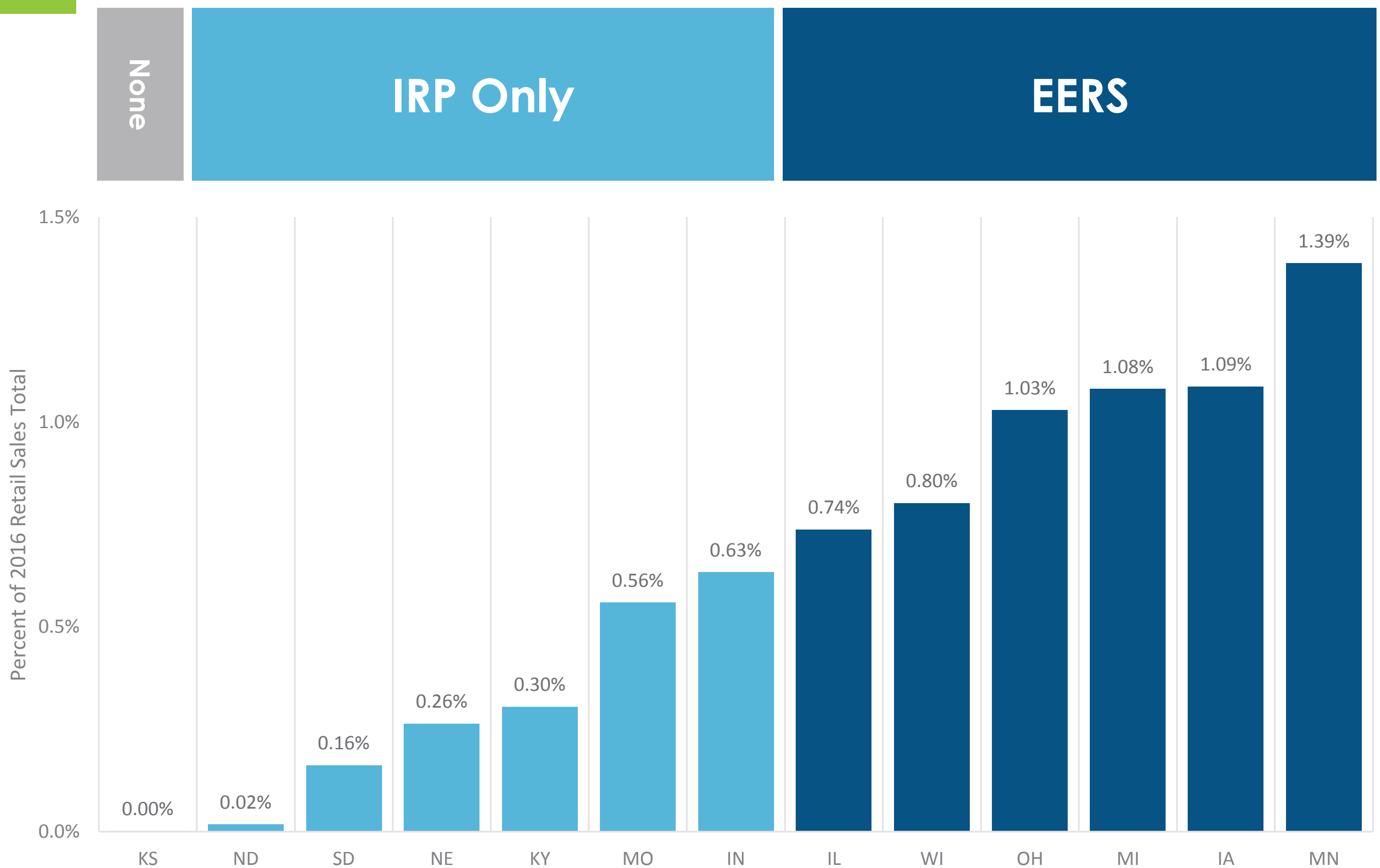
Integrated Resource Planning

Saved Electricity as a % of retail electricity sales, 2016



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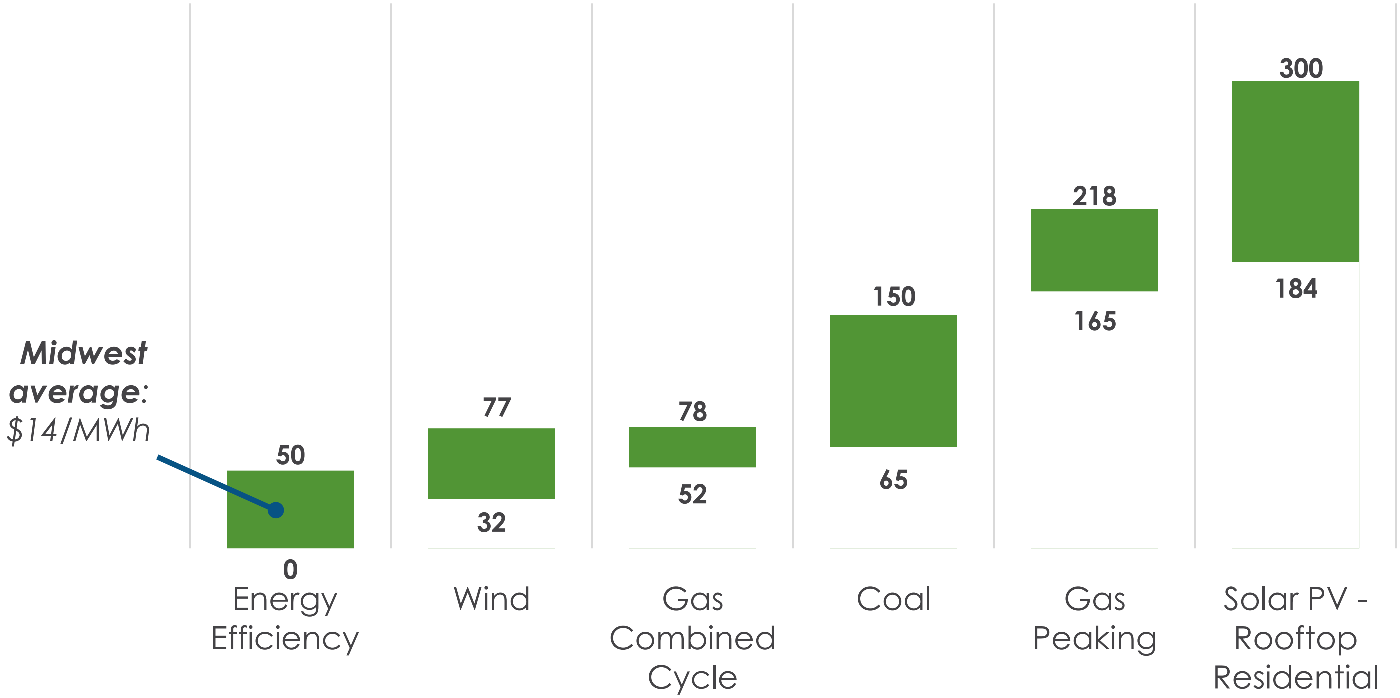
Long-Term Cost of Electricity Resources

$ per Megawatt-hour, 2015



Source: LBNL 2013; Lazard 2016

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Incorporating Energy Efficiency

- Technical, Achievable and Economic Potential Studies
- Determine how to approach benefit-cost screening
- Identify particular sectors in need of specific market potential studies (Industrial, Commercial, Low-Income, Multifamily)
- Evaluate/Model EE at the program level, rather than measure level

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Integrated Resource Planning

Incorporating Energy Efficiency

- Baked in EE
  - In states where an Energy Efficiency Resource Standard (EERS) exists, the resources necessary to satisfy the requirement are modeled as must build resources
- Allowing EE to compete
  - Any EE beyond EERS compete as bundles against other generation/supply-side resources

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How to Incorporate EE

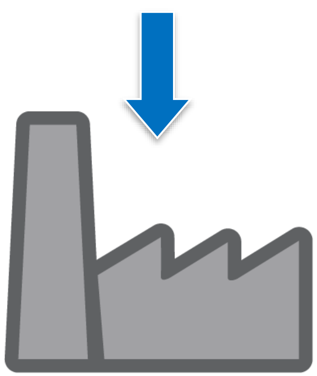
IPL's Bundling Approach

Generation Characteristics:

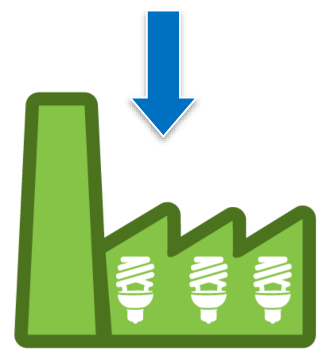
- Fixed cost - $/kW
- Variable cost - $/kWh
- Size (MW)
- Capacity Factor
- Ramp rate

DSM Bundle Characteristics:

- Fixed cost - $/kW-yr
- Variable cost - $/kWh
- Loadshape (8,760 hours)
- Timing for implementation
- Ramp rate
- Disaggregated by measure types and into cost tiers



Peaker Power Plant



DSM Bundle

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Stakeholder Input

- IN - "A **customer or interested party** may comment on an IRP submitted to the commission" and the Commission must "provide an opportunity for **public participation** in a timely manner that **may affect the outcome** of the utility resource planning efforts."
- MN - "**Parties and other interested persons** have until [a date] to review and comment upon the resource plan filings…[which] may include proposed **alternative resource plans**."
- MI - "Before issuing the final modeling scenarios and assumptions each electric utility should include in developing its integrated resource plan, receive **written comments** and **hold hearings to solicit public input** regarding the proposed modeling scenarios and assumptions."

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Other Considerations

- Time-varying value of EE
  - According to LBNL, electric energy efficiency resources save energy and may reduce peak demand.
- Risk and Uncertainty Management
  - IRPs address
    - Load Uncertainty
    - Resource Uncertainty
    - Wholesale Electricity Market Uncertainty
  - EE is better than conventional resources
    - Has value under low market prices
    - Not subject to forced outages
    - Not subject to fuel price risk

Integrated Resource Planning

Minnesota

- Minnesota requires utilities to file IRPs with the Public Utilities Commission that consider all resources to meet future energy needs
- Plans are filed biennially and must include a 15-year forecast of future energy needs.
- Utilities must include the least cost plan for meeting 50 and 75 percent of all new and refurbished capacity needs through a combination of conservation and renewable energy resources.
- Utilities are directed to look at environmental costs, long range emission reduction and there is a preference for renewable energy

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Indiana

- All of Indiana's electric utilities are required to file IRPs
- Plans are filed every 2 years (3 years, soon) and must cover a 20-year forecasted planning period
- IRPs must assess a variety of demand-side management and supply side resources to meet future customer electricity service needs in a cost-effective and reliable manner

Integrated Resource Planning

Michigan

- Public Act 341 requires all rate-regulated utilities to file IRPs with the MPSC by April 20, 2019, and no less than every 5 years thereafter
- The MPSC will set statewide parameters for the IRP filings by December 18, 2017
- 5-, 10- and 15-year load forecasts required
- Financial Incentives to spur EWR
- Existing Energy Efficiency Targets/Goals:
  - 1% for electric; 0.75% Natural Gas
  - Goal of 35% of state's electric needs met through energy waste reduction and renewable energy by 2025

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Michigan

- The MI plans will have to balance:
  - Resource adequacy
  - Compliance with applicable environmental regulations
  - Competitive pricing
  - Reliability
  - Commodity price risks
  - Diversity of generation supply
  - Whether the proposed levels of peak load reduction and energy waste reduction are reasonable and cost effective

Integrated Resource Planning

IRP Goals

- Plan for the provision of reliable, cost-effective long-term energy resources
- Create a nimble system that leans on clean energy and distributed resources to more easily adapt to changing grid, weather, etc. circumstances
- EE as a supply-side and demand-side resource, to target inefficient building stock to better plan for the future at lower cost

Integrated Resource Planning

Midwest Trends

- Increasingly, we are seeing states take steps to develop robust IRP processes, whether or not there is an EERS mandate
  - MN
  - MI
  - IN
  - MO
- EE as a supply-side, demand-side and capacity resource
- Energy savings incentives, and other mechanisms, such as financing opportunities, factor in to increase investment to achieve higher levels of energy savings, in turn increasing adoption rates and economic potential

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Questions?

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http://www.mwalliance.org/initiatives/policy/resource-planning

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