Clean Energy Group Webinar

The Economics of Grid Defection

Hosted by

Todd Olinsky-Paul
Resilient Power Project Director

July 1, 2014

Housekeeping

All participants are in "Listen-Only" mode. Select "Use Mic & Speakers" to avoid toll charges and use your computer's VOIP capabilities. Or select "Use Telephone" and enter your PIN onto your phone key pad.

Submit your questions at any time by typing in the Question Box and hitting Send.

This webinar is being recorded.

You will find a recording of this webinar, as well as previous Resilient Power Project webinars, online at:

vimeo.com/channels/resilientpower

About Clean Energy Group (CEG)

Clean Energy Group is a leading national, non-profit advocacy organization working in the US and internationally on innovative technology, finance and policy programs in the area of clean energy and climate change.

About the Resilient Power Project

CEG's Resilient Power Project helps states and municipalities to implement clean resilient power solutions. Through the project, CEG helps states develop new partnerships, supports new public financing tools, connects public officials with private industry, engages federal resources, and works with state and local officials to support greater investment in resilient power deployment.

www.resilient-power.org

Today's Guest Speakers

- **Bodhi Rader**, Electricity Associate, Rocky Mountain Institute
- **Leia Guccione**, Manager, Electricity and Industrial Practices, Rocky Mountain Institute
- **James Mandel**, Manager, Electricity and Industrial Practices, Rocky Mountain Institute

THE ECONOMICS OF GRID DEFECTION

PRESENTATION WITH CEG

1 JULY 2014

ROCKY MOUNTAIN INSTITUTE®

INTRODUCTION TO RMI

WHAT WE DO

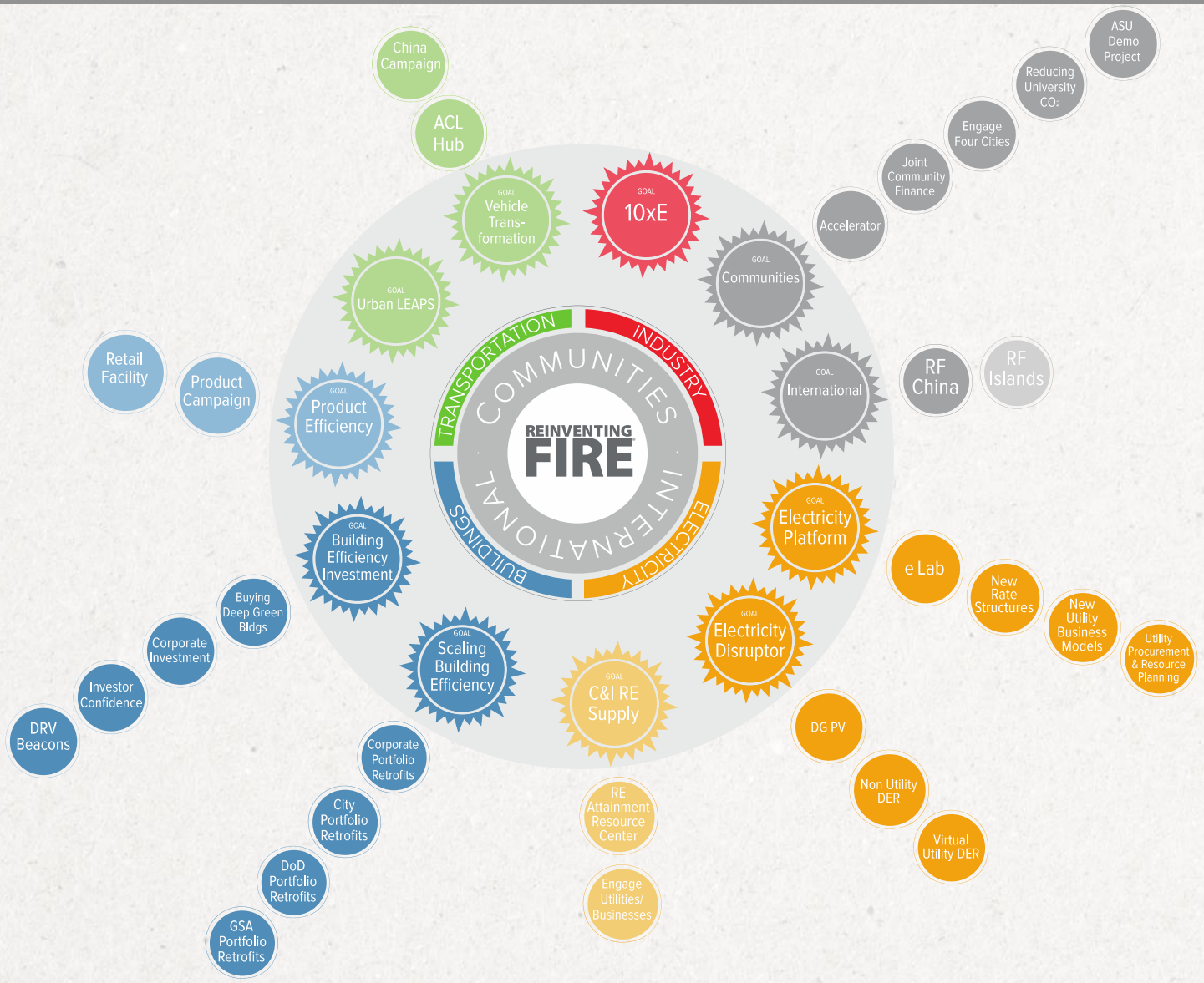
RMI advances market-based solutions that transform global energy use. We engage businesses, communities, and institutions to cost-effectively shift to efficiency and renewables, creating a clean, prosperous, and secure energy future.

WHAT DIFFERENTIATES US

- Our whole-systems expertise unlocks market-based solutions that can be replicated and implemented now.
- As an independent, non-partisan nonprofit, we convene and collaborate with diverse partners—business, government, academic, nonprofit, philanthropic, and military—to accelerate and scale solutions.
- We boldly tackle the toughest long-term problems—challenges often ignored by those held to short-term results.
- We've been a leader in energy efficiency and renewables for more than 30 years.



RMI'S SCOPE OF CURRENT ACTIVITY



PRESENTATION OVERVIEW

- Study Overview
- Highlight Results
- Analysis in Detail
- Ongoing Research

STUDY OVERVIEW

BACKGROUND AND MOTIVATION

01

SPIRALING EFFECTS THAT IMPERIL THE TRADITIONAL UTILITY BUSINESS MODEL

> "…one can imagine a day when battery storage technology or micro turbines could allow customers to be electric grid independent."
>
> *- Peter Kind, Disruptive Challenges report, 2013*

Study Goal: Establish a fact-base for where and when solar plus battery storage hybrid power systems compete with traditional utility service

THESE FACTORS GIVE CUSTOMERS A NEW SPECTRUM OF CHOICE

Focus of our first report: "The Economics of Grid Defection"

On-grid/ Conventional Consumer	Grid-tied/ DG Consumer	Grid-tied/ DG + Storage Consumer	Off-grid/ DG + Storage Consumer

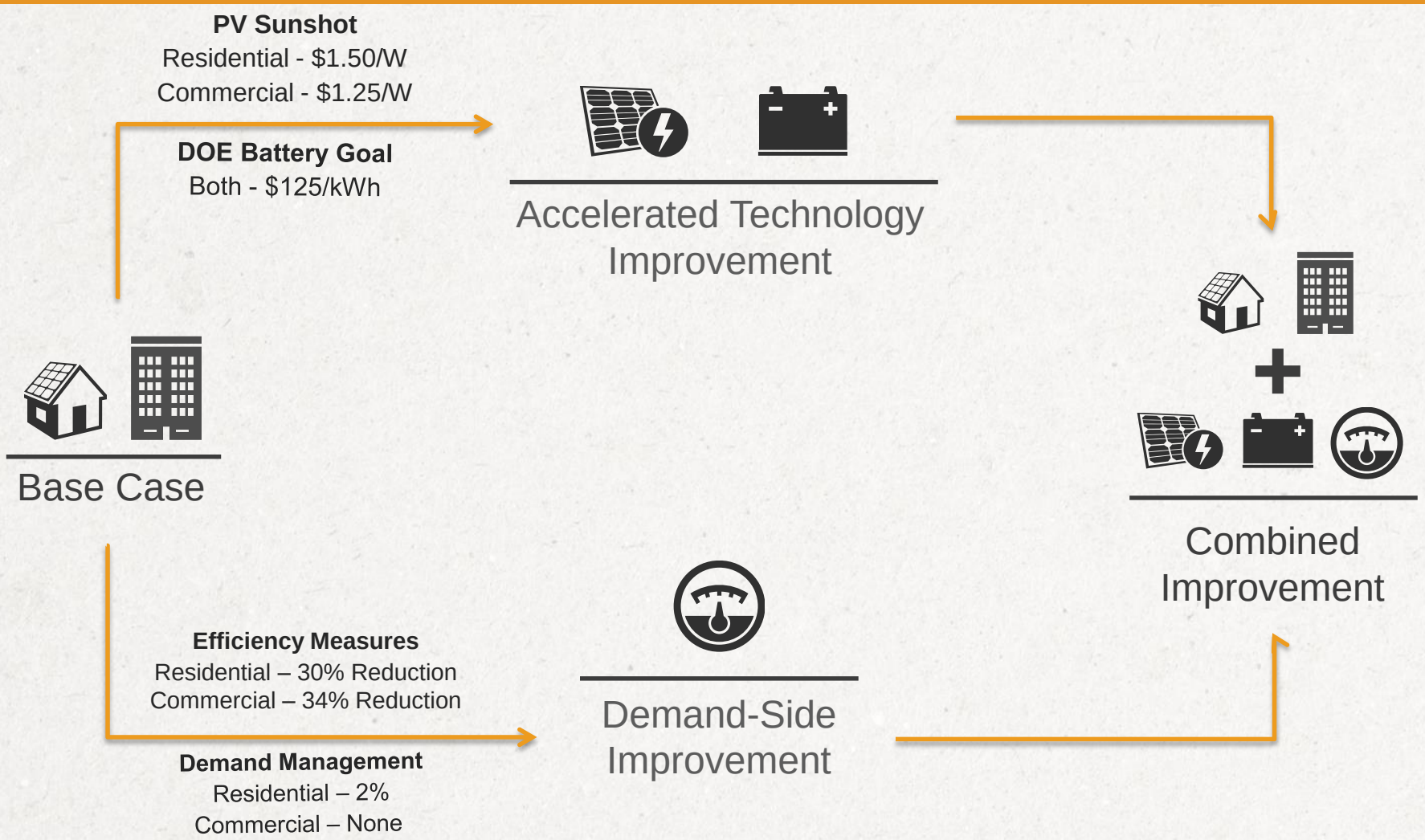
← CONSUMER RELATIONSHIP WITH ELECTRIC SERVICE →

TRADITIONAL — DISRUPTIVE

WHERE WE LOOKED TO SEE IF IT COULD HAPPEN

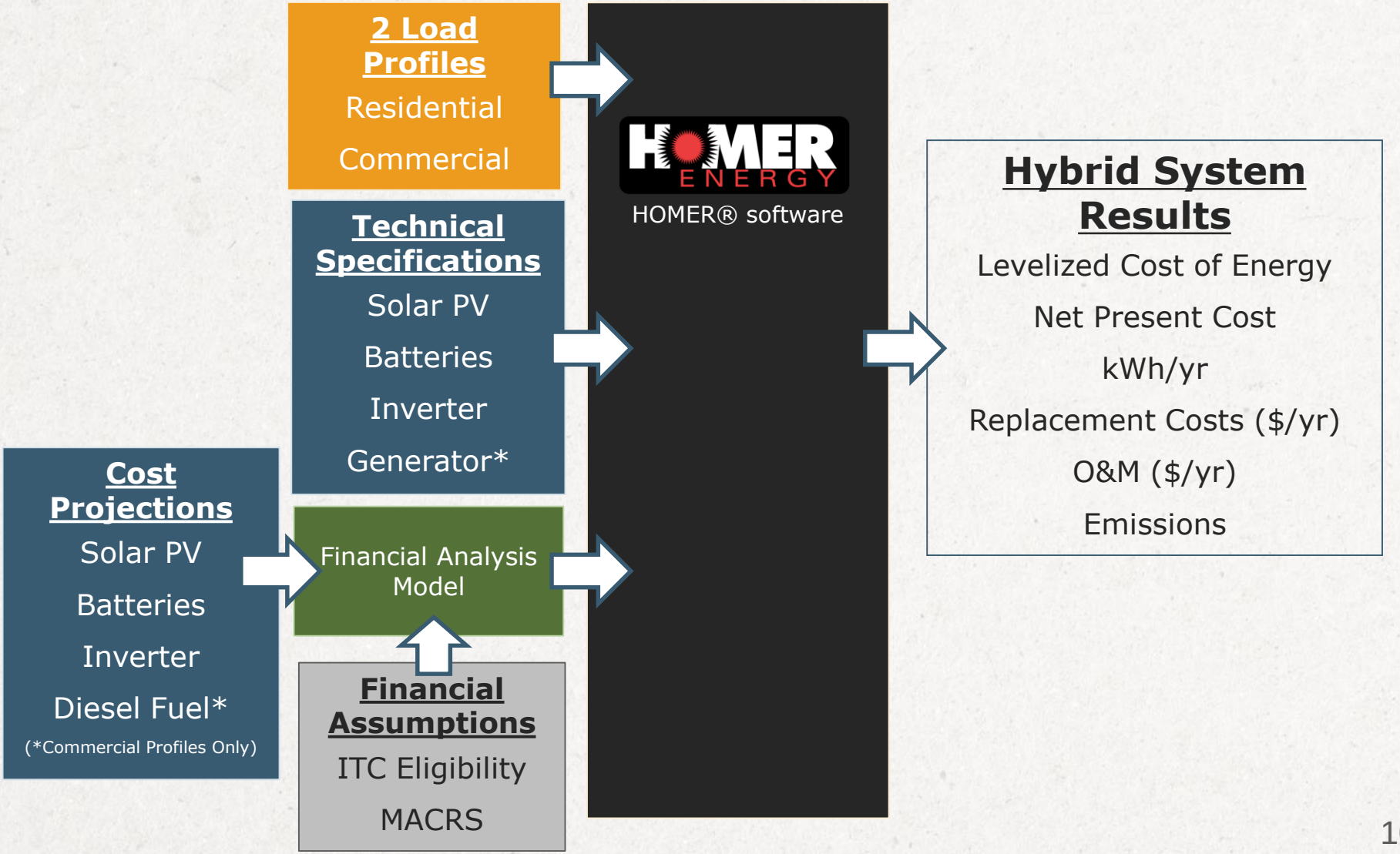
	WESTCHESTER, NY	LOUISVILLE, KY	SAN ANTONIO, TX	LOS ANGELES, CA	HONOLULU, HI
INSOLATION ($kWh/m^2/day$)	4.5 kWh	4.5 kWh	6 kWh	6 kWh	5.5 kWh
2012 AVG RETAIL PRICE ($/kWh)	$0.15–$0.20	$0.06–$0.08	$0.05–$0.09	$0.09–$0.17	$0.34–$0.41
Installed PV (MW)	122.02 MW	2.92 MW	131.16 MW	2074.53 MW	27.33 MW
MARKET STRUCTURE	Deregulated	Regulated	Deregulated	Deregulated	Regulated

WE TESTED THE DISRUPTION THROUGH A VARIETY OF SCENARIOS



- Base Case = Battery and Solar cost trends that are average of analyst estimates
- All scenarios assume 3% real rise in retail electricity rates

HOW WE ARRIVED AT OUR RESULTS



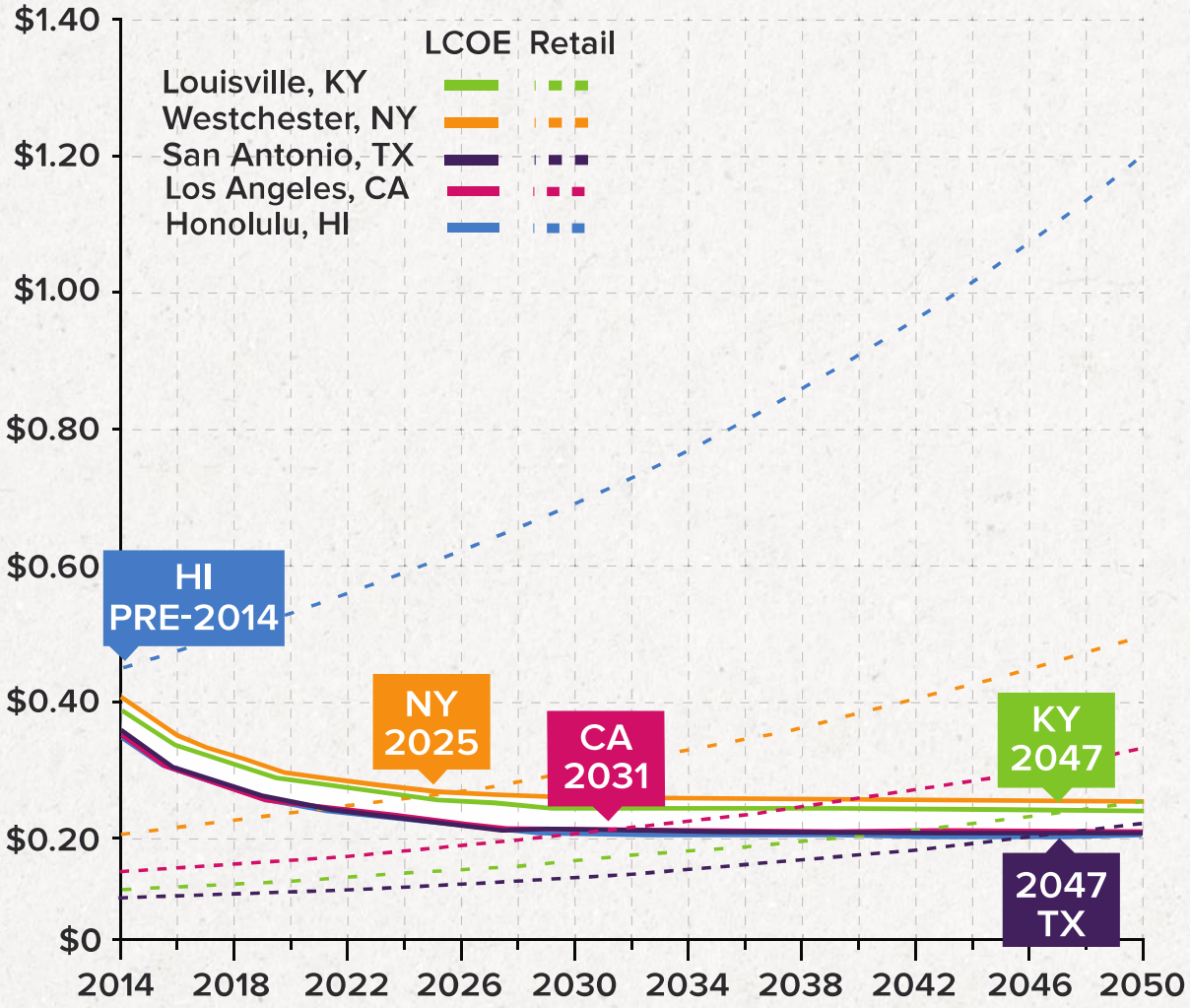
HIGHLIGHT RESULTS

KEY ANALYTIC FINDINGS

02

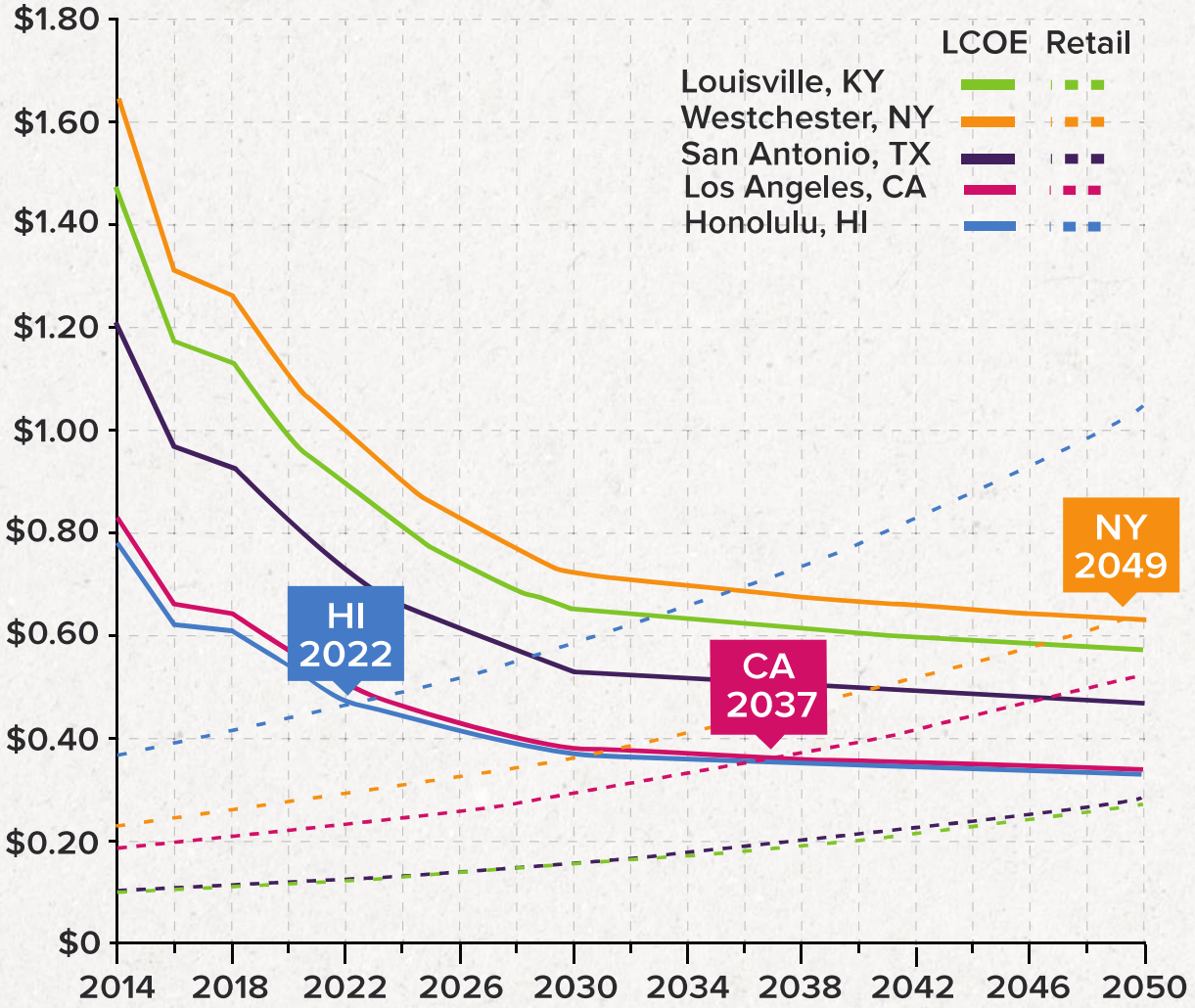
BY 2025 MILLIONS REACH PARITY IN OUR MOST CONSERVATIVE COMMERCIAL SCENARIO

- With projected declines in technology costs parity arrives in ALL of our locations by 2050
- Assuming aggressive price reductions (e.g. DOE Sunshot) or introducing demand management, these dates move forward by nearly a decade



WITHIN A DECADE EVEN LARGE GROUPS OF RESIDENTIAL CUSTOMERS REACH PARITY

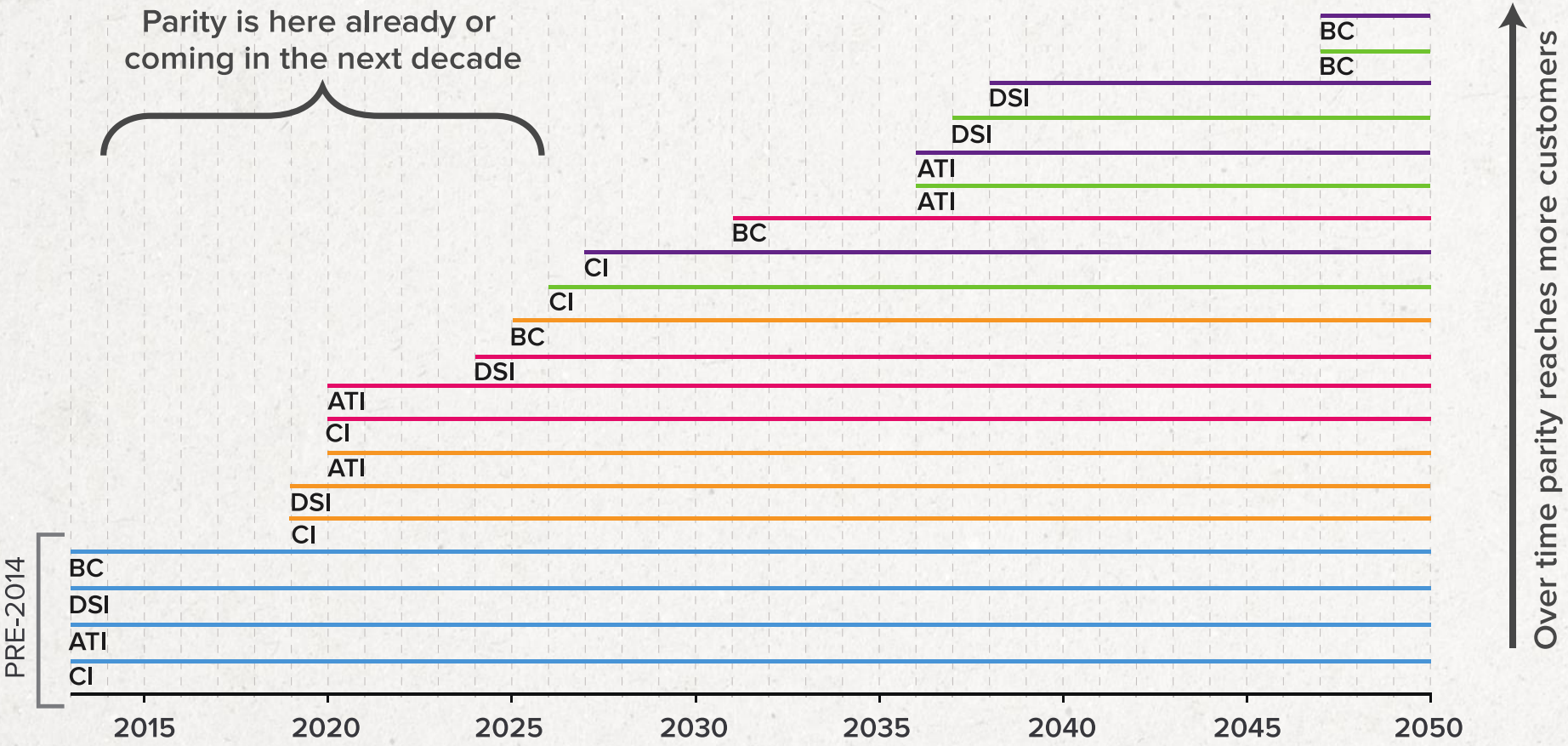
- Despite small systems, residential customers will see grid parity by 2050
- With aggressive technology price reductions or demand management, parity arrives over ten years earlier



THE COMMERCIAL PARITY TIMELINE

BC - Base Case
ATI - Accelerated Technology Improvement
DSI - Demand-Side Improvement
CI - Combined Improvement

Louisville, KY
Westchester, NY
San Antonio, TX
Los Angeles, CA
Honolulu, HI



THE RESIDENTIAL PARITY TIMELINE

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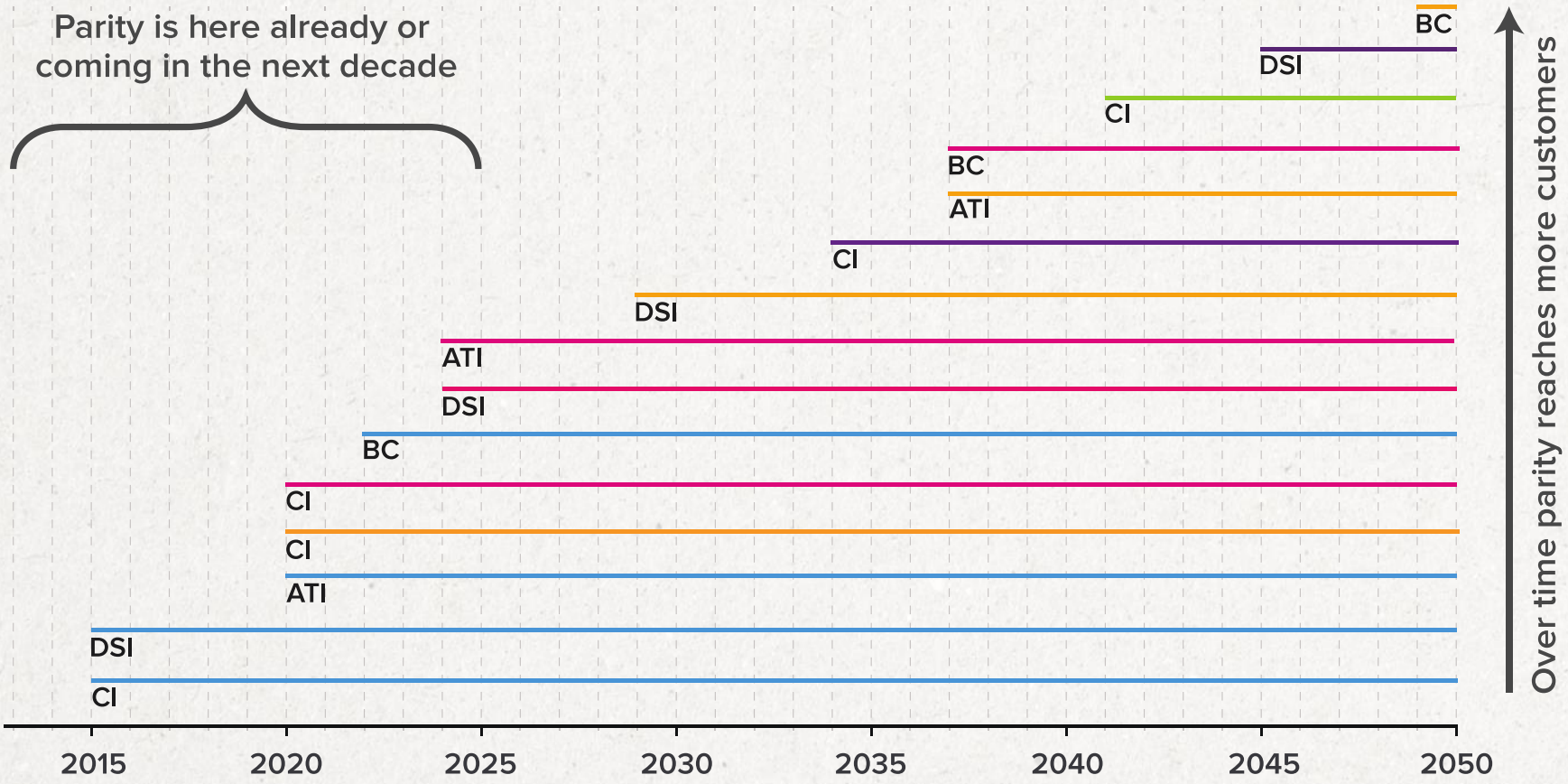
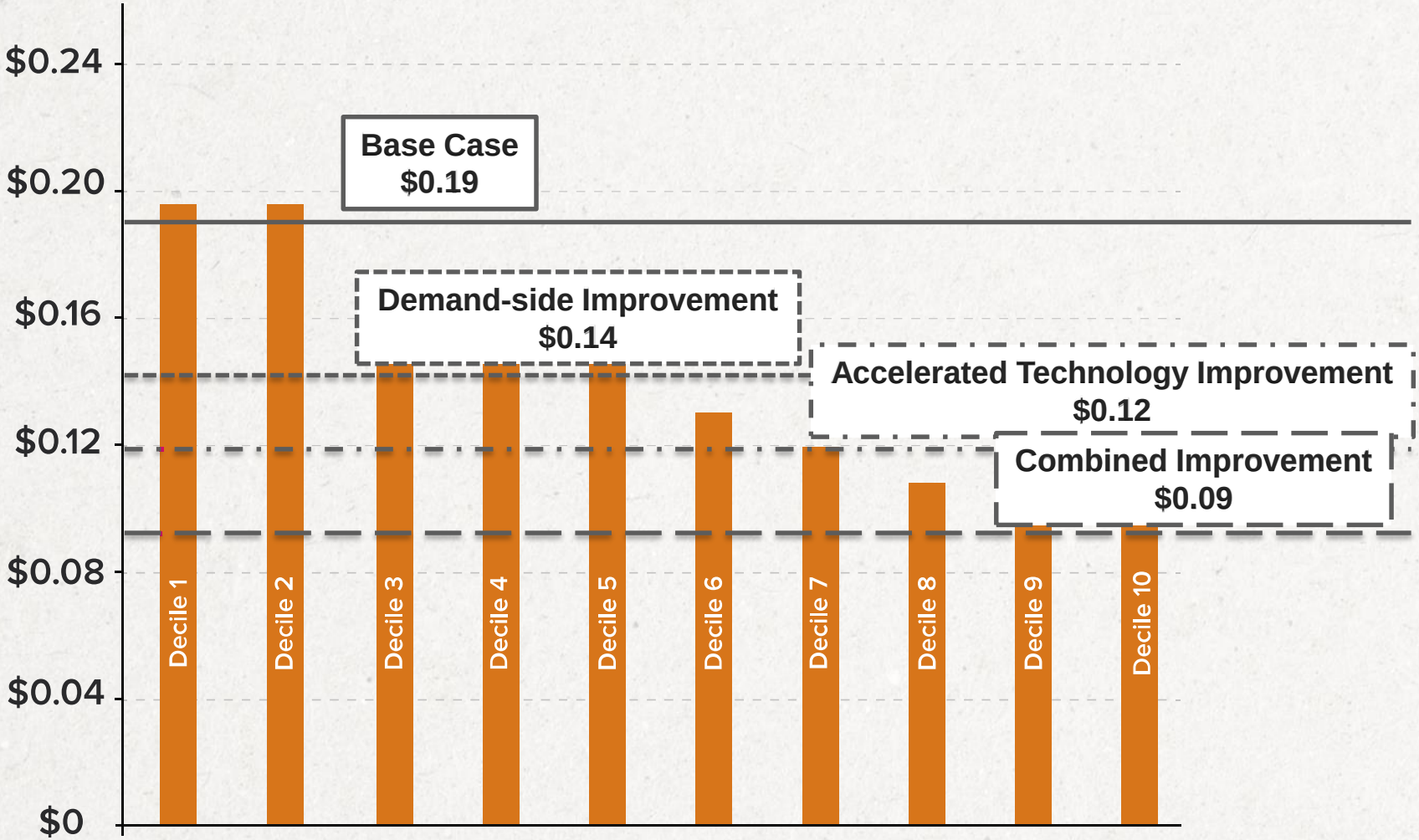
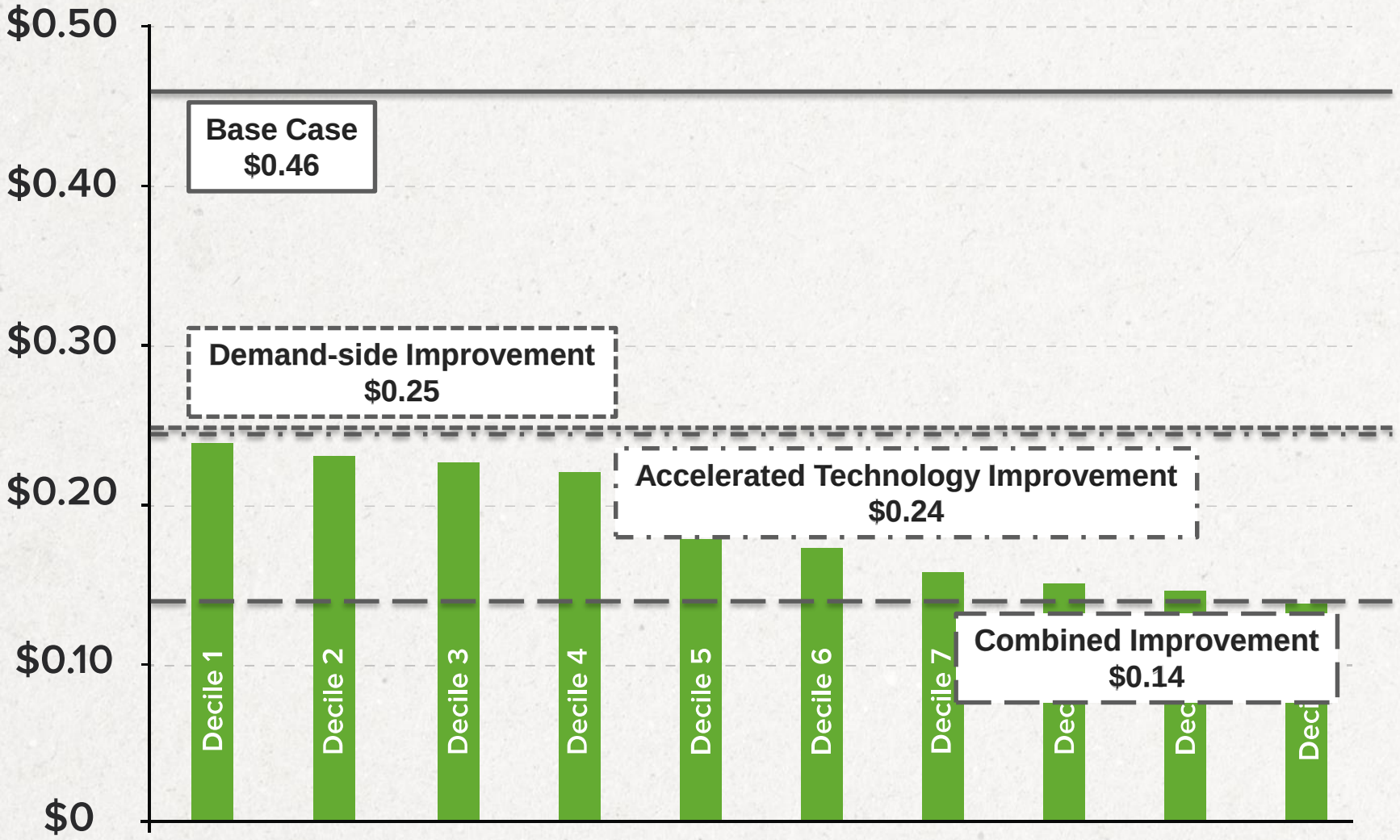


EFFECTS ON CUSTOMERS AND REVENUE IN THE SOUTHWEST BY 2024 (COMMERCIAL)



States included in the Southwest region for this graph: AZ, CA, CO, NM, NV, UT

EFFECTS ON CUSTOMERS AND REVENUE IN THE SOUTHWEST BY 2024 (RESIDENTIAL)



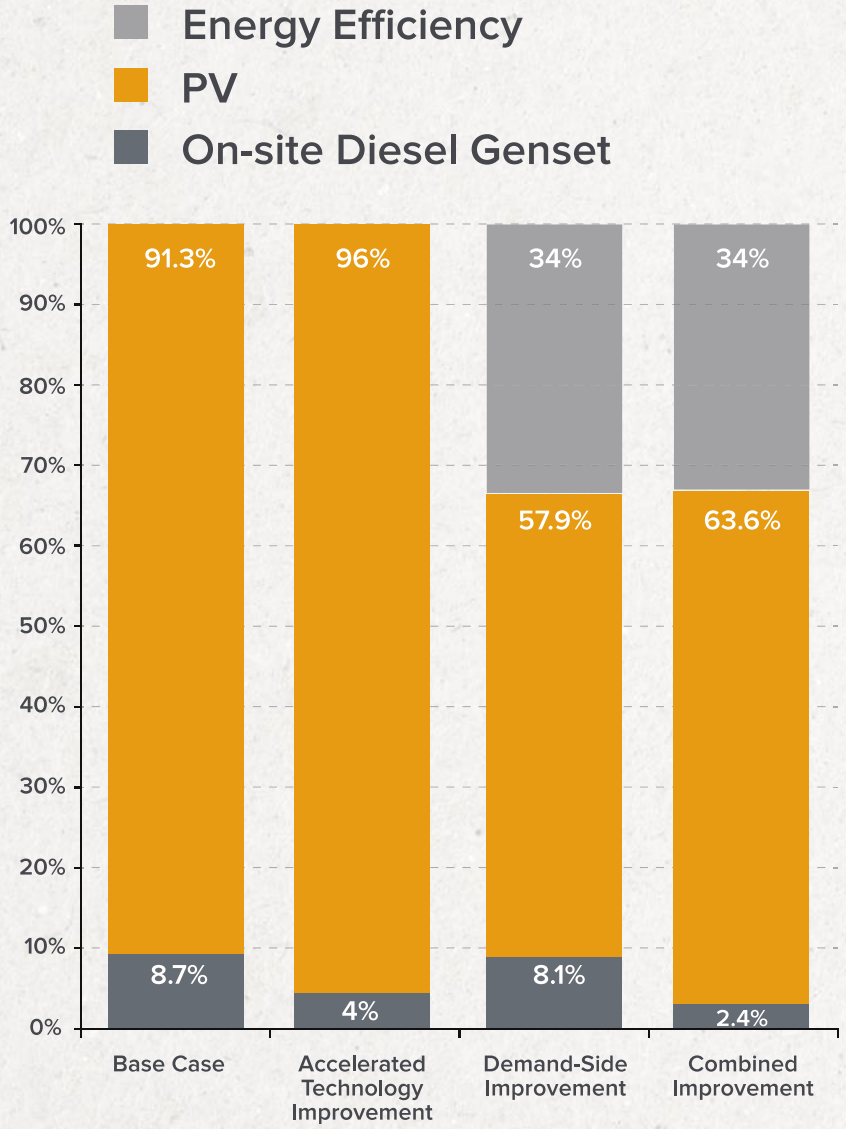
States included in the Southwest region for this graph: AZ, CA, CO, NM, NV, UT

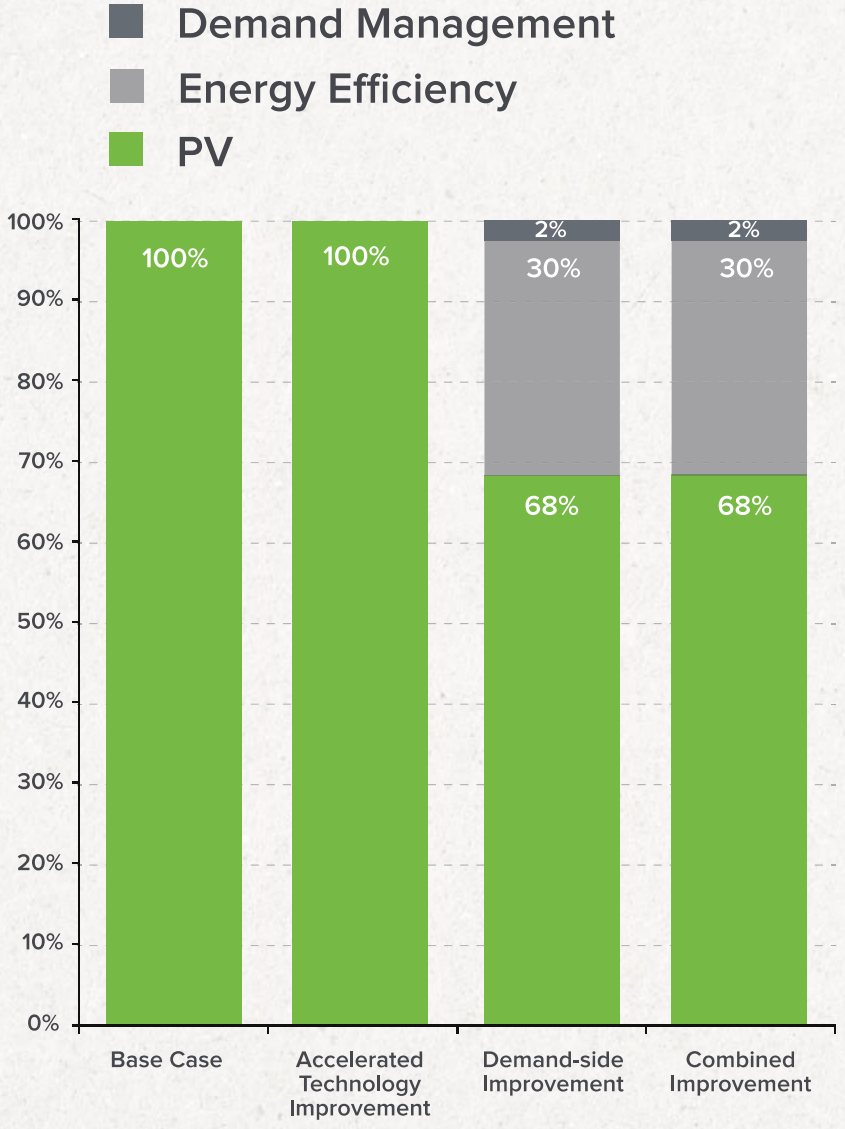
ANALYSIS IN DETAIL

SPECIFIC HIGHLIGHTS FROM OUR RESEARCH

03

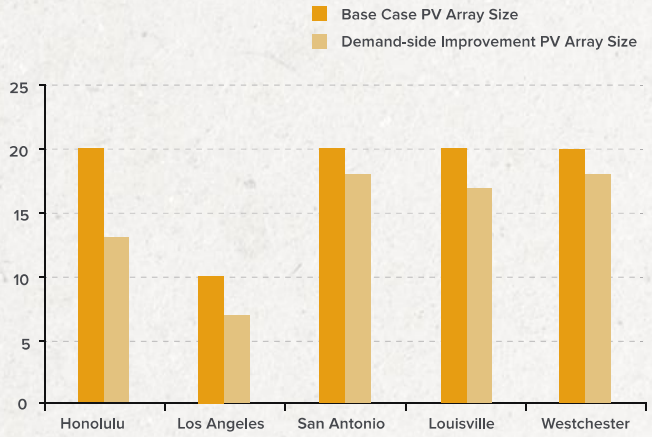
LOS ANGLES GENERATION MIX IN 2024



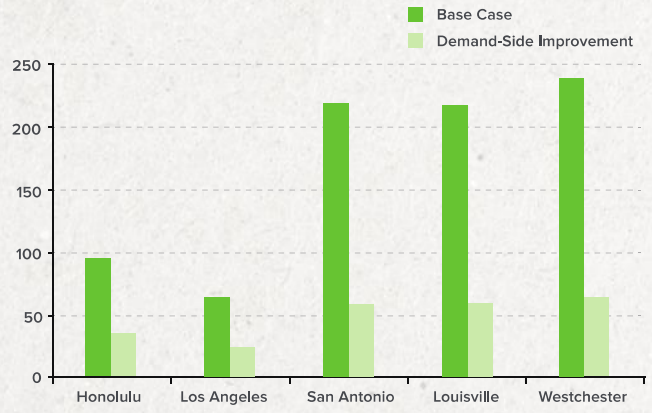


THE VALUE OF DEMAND-SIDE IMPROVEMENTS

2014 RESIDENTIAL PV ARRAY SIZES
[Y-Axis kW]

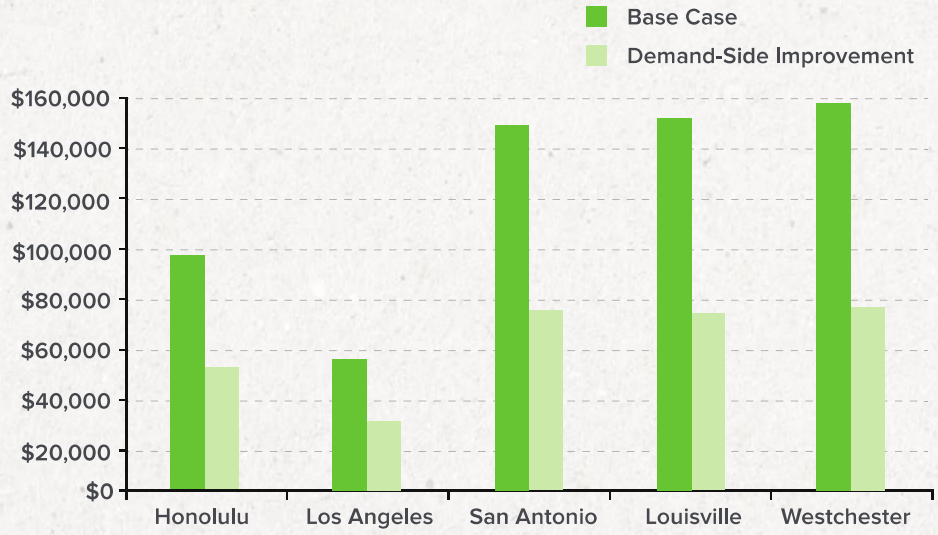


2014 RESIDENTIAL BATTERY SIZES
[Y-Axis kWh]

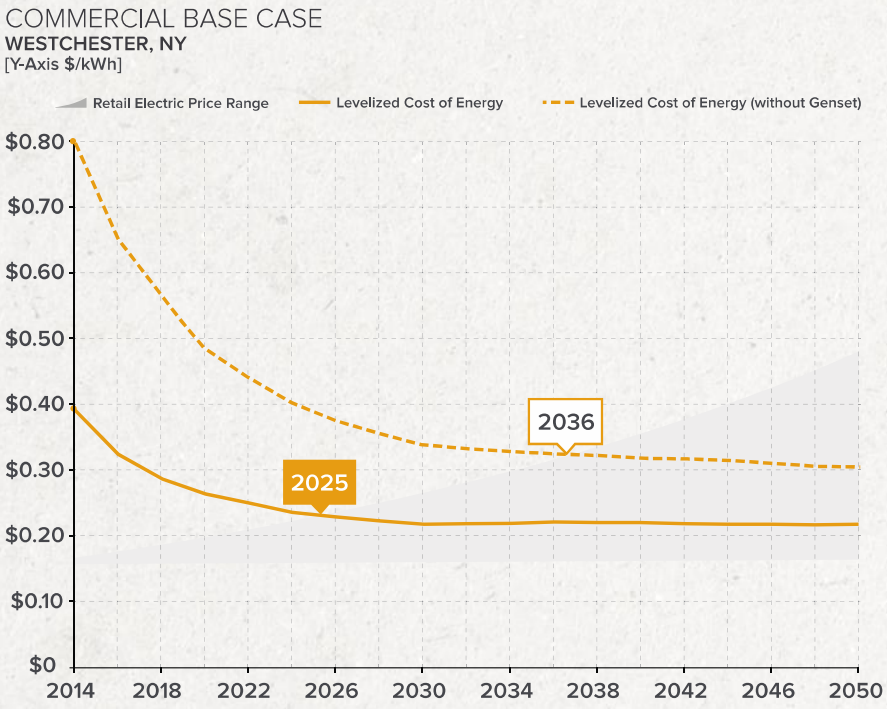


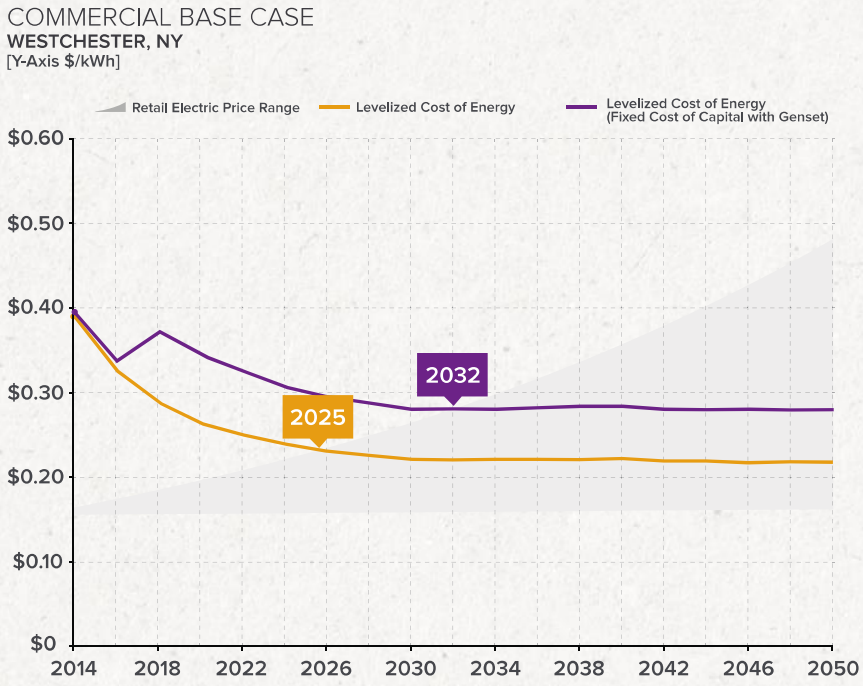
Investing in energy efficiency and allowing for load shifting drastically reduces the necessary battery size, and subsequently total system cost

2014 RESIDENTIAL CAPITAL COSTS
[Y-Axis $U.S.]



THE IMPACT OF LOW COST FINANCING





- Holding cost of capital steady at 9.5% delays parity by 7 years

REPRISE: KEY MESSAGES

1. **Near-term grid parity, and thus defection risk, exists for both commercial and residential customers; we are entering an era of greater customer empowerment**

2. **Grid parity for the majority of US electricity customers arrives within the 30-year economic life of typical utility power assets**

3. **Parity ≠ Defection**

4. **Defection is sub-optimal and can lead to uneconomic and inequitable outcomes**

5. **The speed of disruption in the electricity sector is outpacing regulatory and business model reform; we have <10 years to fix before problems compound significantly and need to make rapid progress**

ONGOING RESEARCH

PLANS FOR COMPANION REPORT

04

TRANSFORMING THE CURRENT RELATIONSHIP WITH ELECTRIC SERVICE

Focus of our forthcoming report

On-grid/ Conventional Consumer	Grid-tied/ DG Consumer	Grid-tied/ DG + Storage Consumer	Off-grid/ DG + Storage Consumer

CONSUMER RELATIONSHIP WITH ELECTRIC SERVICE

TRADITIONAL — DISRUPTIVE

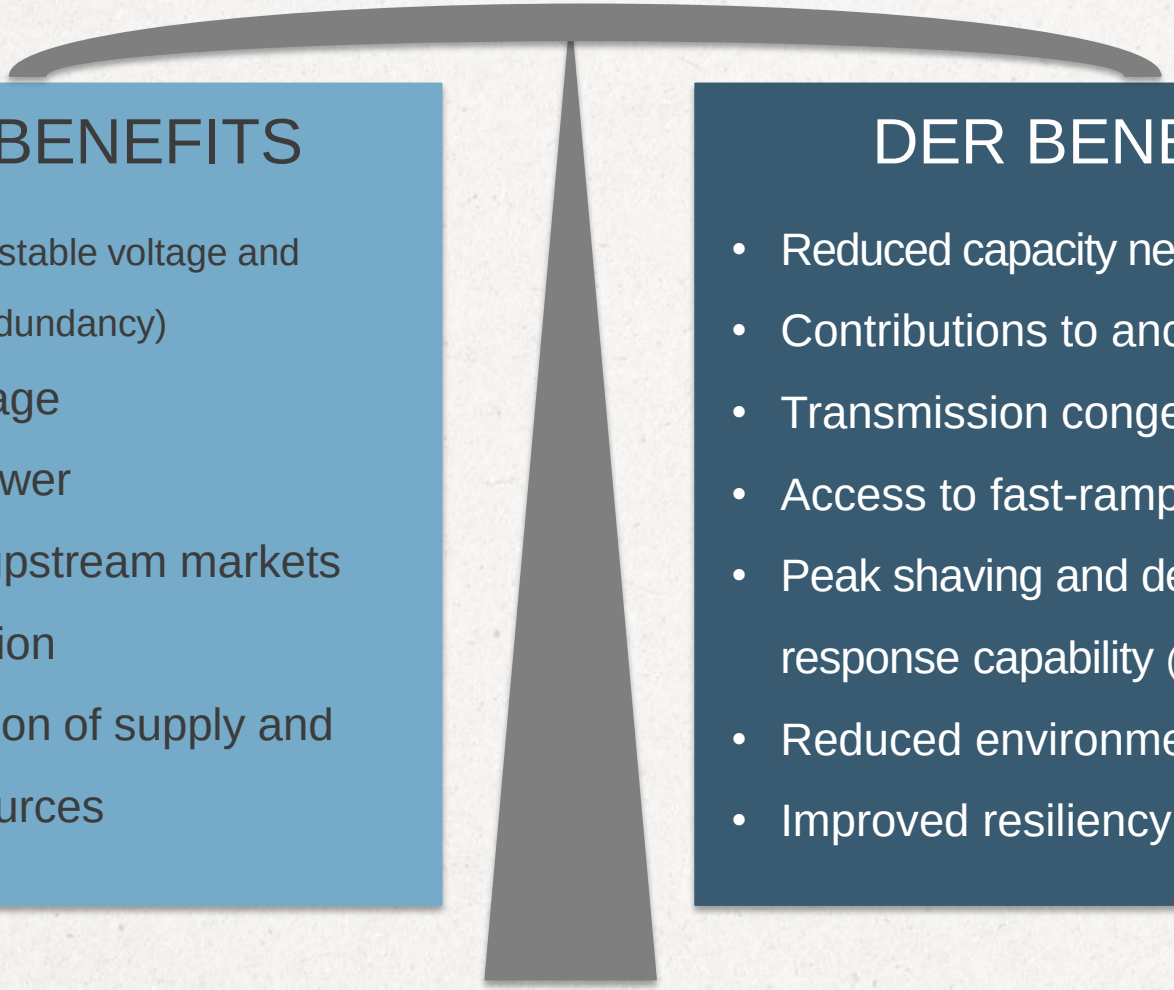
Is complete grid defection an optimal choice?

What can utilities do in advance of these dates to stabilize their business model?

What new interactions and participants might we expect in a transactive grid?

GRID DEFECTION HAS REAL TRADE-OFFS

Distributed resources and the grid can be complementary



GRID BENEFITS

- Reliability (stable voltage and frequency, redundancy)
- Virtual storage
- Start-up Power
- Access to upstream markets
- Risk reduction
- Diversification of supply and demand sources

DER BENEFITS

- Reduced capacity needs on the grid
- Contributions to ancillary services
- Transmission congestion relief
- Access to fast-ramping resources
- Peak shaving and demand response capability (upgrade deferral)
- Reduced environmental impact
- Improved resiliency

THE NEAR AND PRESENT VALUE OF SOLAR AND BATTERIES

GRID SERVICES

FINANCIAL

SECURITY

ENVIRONMENTAL

SOCIAL

ENERGY
- energy
- system losses

CAPACITY
- generation capacity
- transmission & distribution capacity
- DPV installed capacity

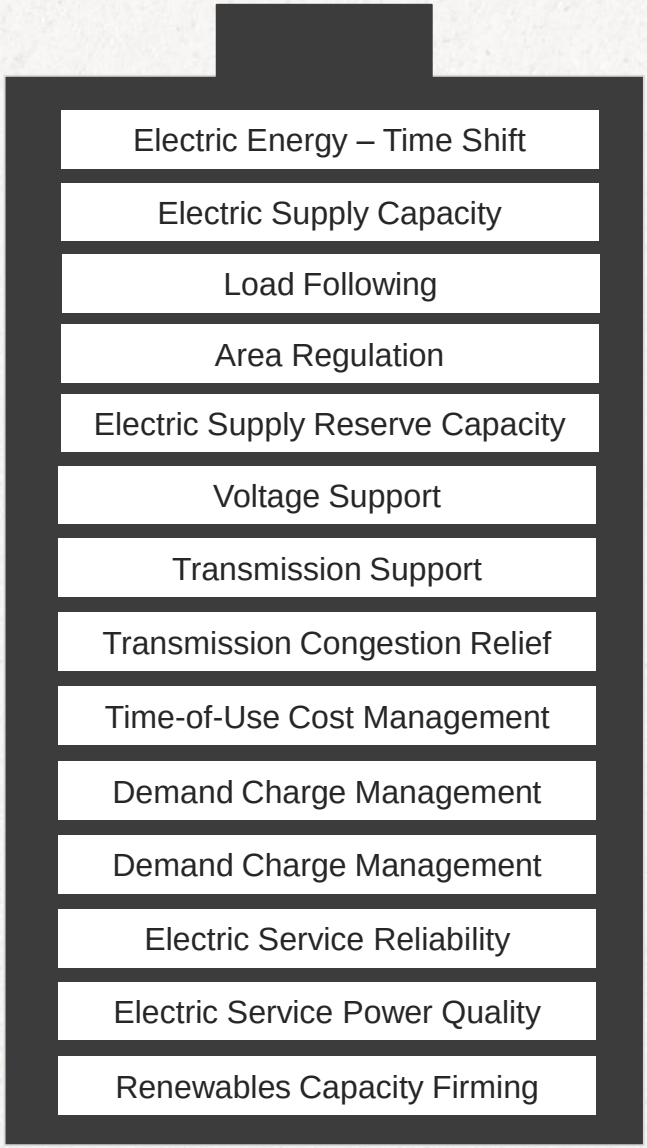
GRID SUPPORT SERVICES
- reactive supply & voltage control
- regulation & frequency response
- energy & generator imbalance
- synchronized & supplemental operating reserves
- scheduling, forecasting, and system control & dispatch

FINANCIAL RISK
- fuel price hedge
- market price response

SECURITY RISK
- reliability & resilience

ENVIRONMENTAL
- carbon emissions
- criteria air pollutants (SO_x, NO_x, PM_{10})
- water
- land

SOCIAL
- Economic development (jobs and tax revenues)



SOME STABLE BUSINESS MODELS ARE EMERGING

In different parts of the U.S., utilities and service providers are already building or offering solar in combination with battery storage. As these projects are still relatively boutique, the landscape of business models is still poorly understood.

A few of the companies we are keeping an eye on for innovative business models

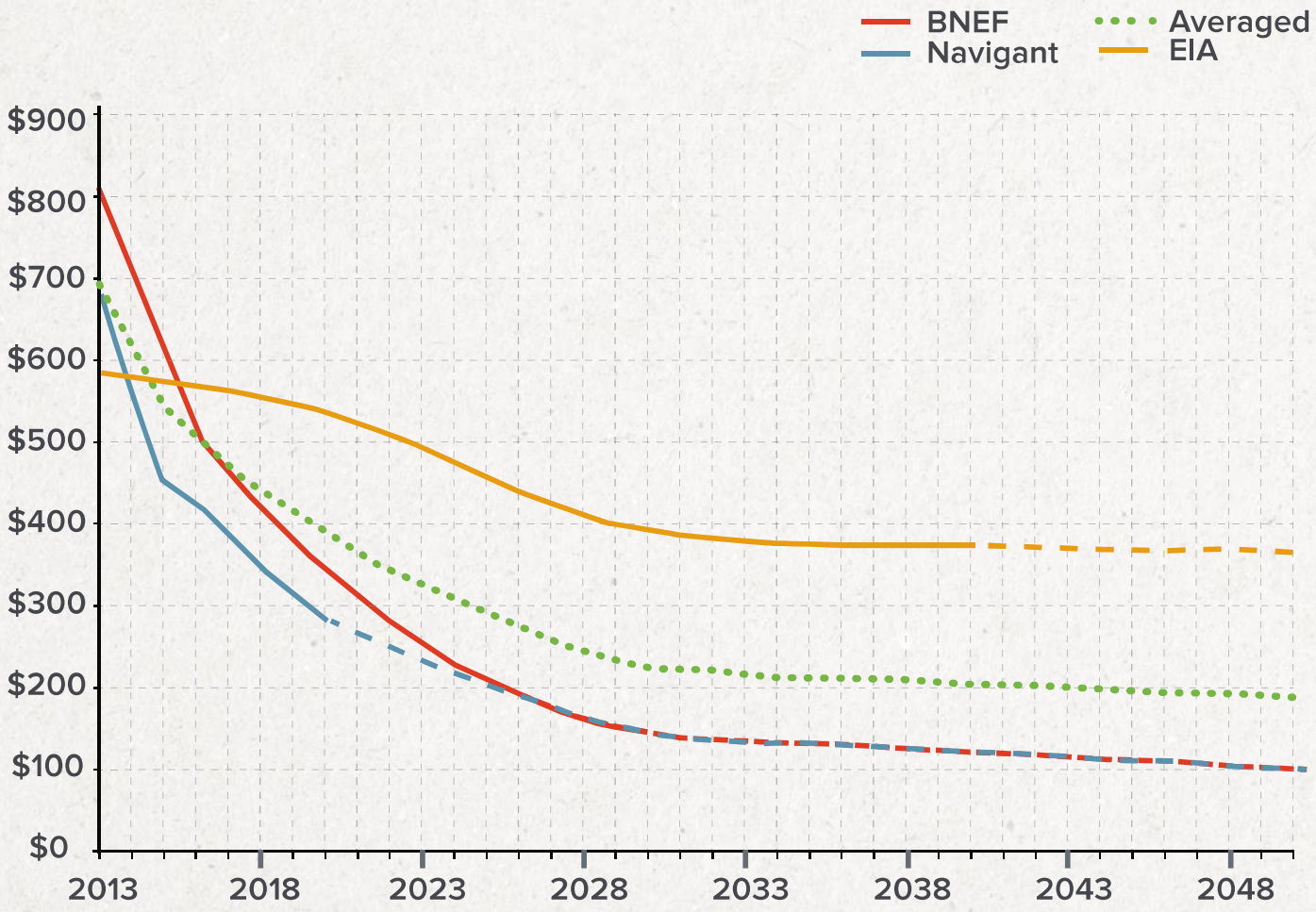
Preliminary

ALL BUSINESS MODELS DEPEND ON REDUCING COSTS (1/2)

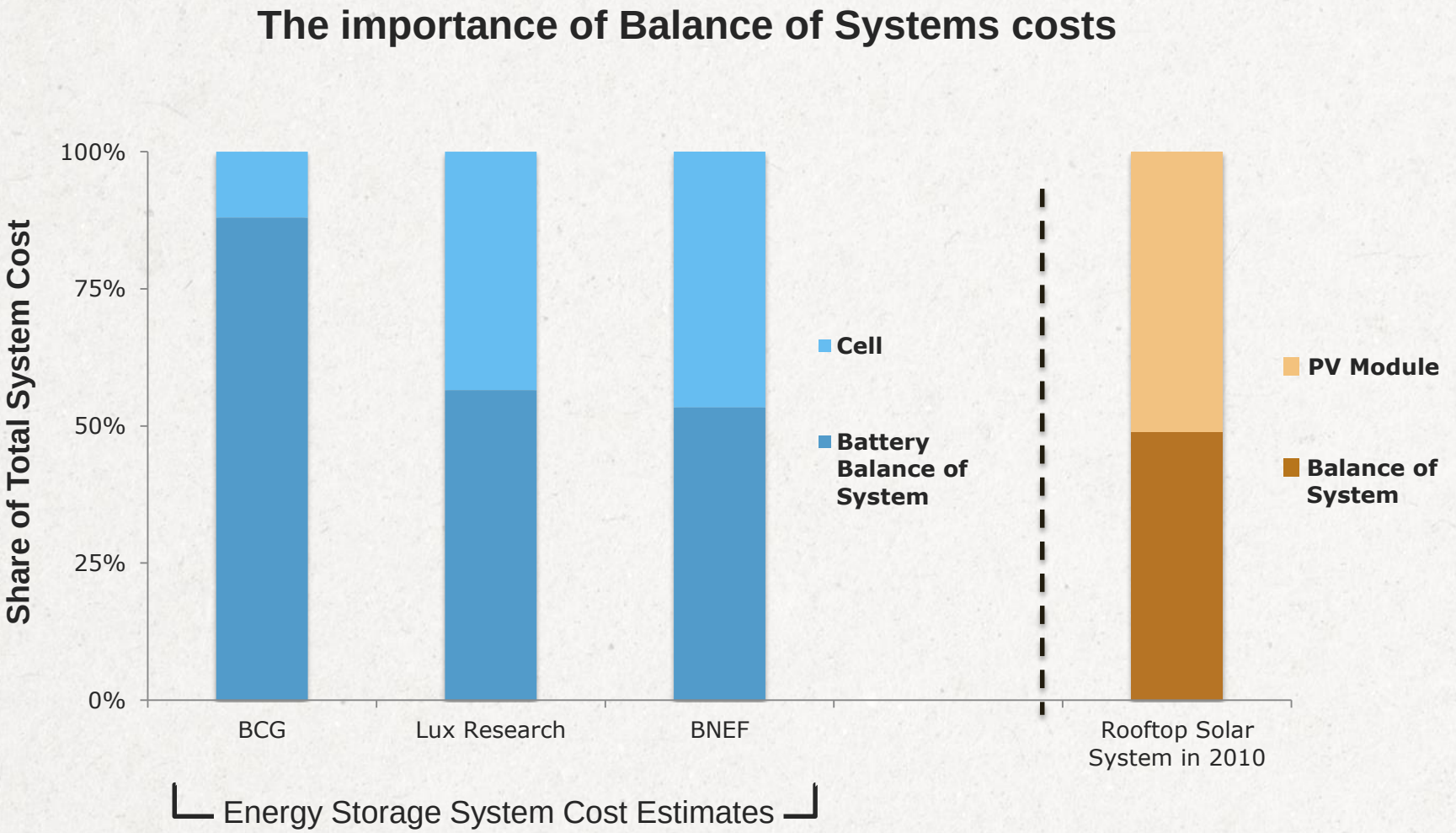
BATTERY PRICE TEAM ANALYSIS PROJECTIONS

[DASHED LINES REPRESENT EXTRAPOLATIONS]

[Y-Axis $/kWh]



ALL BUSINESS MODELS DEPEND ON REDUCING COSTS (2/2)



BCG = Boston Consulting Group BNEF = Bloomberg New Energy Finance

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Thank you for attending our webinar

Todd Olinsky-Paul

Resilient Power Project Director

todd@cleanegroup.org

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