NOVEMBER 2018

LAZARD'S LEVELIZED COST OF STORAGE ANALYSIS—VERSION 4.0

LAZARD

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I Introduction

Introduction

Lazard's Levelized Cost of Storage ("LCOS") analysis(1) addresses the following topics:

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(1) Lazard's LCOS analysis is conducted with support from Enovation Partners, a leading energy consulting firm.

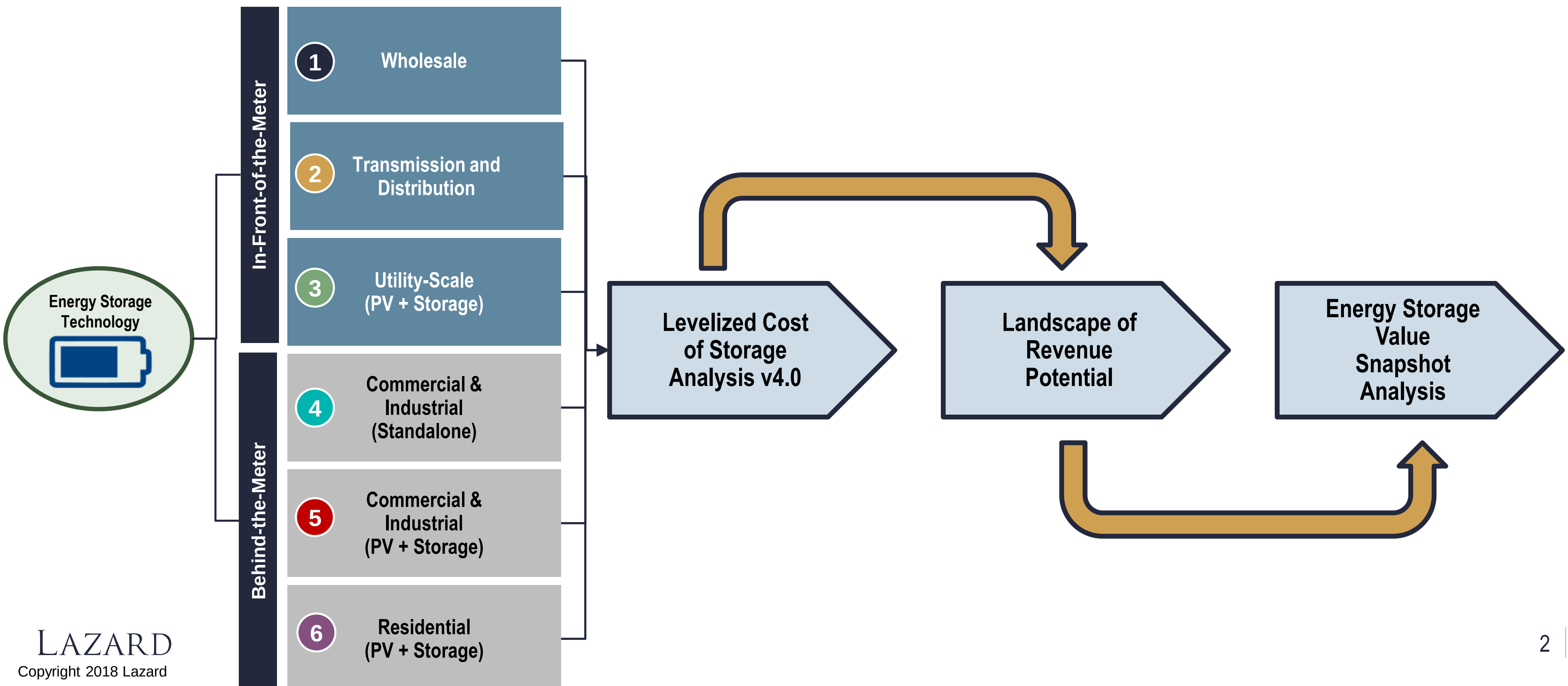
II Executive Summary and Key Findings

What Is Lazard's Levelized Cost of Storage Analysis?

Lazard's LCOS report analyzes the observed costs and revenue streams associated with commercially available energy storage technologies and provides an overview of illustrative project returns. The LCOS aims to provide a robust, empirically based indication of actual cash costs and revenues associated with leading energy storage technologies, which leads to a preliminary view of project feasibility

LCOS Analysis

Selected Use Cases	LCOS Analysis	Potential Revenue	Value Snapshots
Clearly defines a set of use cases in terms of output and operating characteristics (e.g., number of charging cycles, depth of discharge, etc.)	Applies an objective set of financial and operating assumptions provided by Industry participants across a range of commonly employed energy storage technologies to calculate the levelized cost of each	Surveys the range of identifiable revenue streams available to energy storage projects	Applies currently observed costs and revenues associated with existing storage projects, as well as available local and national subsidies, to measure the financial returns realized by a representative set of storage projects



Summary of Key Findings from Lazard's Levelized Cost of Storage v4.0

1 **Continued Decreasing Cost Trends**	• LCOS v4.0 has revealed significant cost declines across most use cases and technologies; however, Industry participants noted rising cost pressures for future deliveries of lithium-ion storage systems due to higher commodity pricing and tightening supply – Sustained cost declines have exceeded expectations for lithium-ion technologies, while cost declines for flow batteries are less significant but still observable – Future declines in the cost of lithium-ion technologies are expected to be mitigated by rising cobalt and lithium carbonate prices as well as delayed battery availability due to high levels of factory utilization • Consistent with prior versions of the LCOS, shorter duration applications (i.e., 4 hours or less) remain the most cost effective for the commercially prominent energy storage technologies analyzed – The underlying costs and performance of commercially available energy storage technologies continue to make them most attractive for applications which improve the grid's ability to respond to momentary or short duration fluctuations in electricity supply and demand (e.g., wholesale services such as frequency regulation and spinning reserves and use cases serving the C&I segment such as demand charge mitigation)
2 **Improving Project Economics**	• Project economics analyzed in the Value Snapshots have revealed a modest improvement year-over-year for the selected use cases, primarily reflecting, among other things, improved costs rather than rising revenues – As costs continue to come down, particularly for shorter duration lithium-ion applications, returns have incrementally improved year-over-year; however, in most geographies, project economics depend heavily on subsidized revenues or related incentives – Among the currently identifiable revenue sources available to energy storage systems, ancillary service products (such as frequency regulation, spinning reserves, etc.), demand response and demand charge mitigation represent potentially attractive revenue opportunities in selected geographies
3 **Solar PV + Storage Viability**	• Project economics analyzed for solar PV + storage systems are attractive for commercial use cases but remain challenged for residential and utility-scale projects – Combining energy storage with solar PV can create value through shared infrastructure (e.g., inverters, interconnection), reducing the need to curtail production by delaying the dispatch of electricity onto the grid and/or by capturing the value of "clipped" solar production (e.g., solar PV output that is in excess of the system inverter) – Energy storage is increasingly being sold with commercial and residential solar PV systems to provide for potentially increased customer reliability benefits and to enable customers to use solar PV production to avoid demand charges – The Value Snapshot analysis suggests commercial use cases for solar PV plus storage provide moderately attractive returns in the markets assessed (e.g., California and Australia) while residential solar PV plus storage and utility-scale solar PV + storage remain modest for those projects analyzed

III Objectives, Scope and Methodology

Key Objectives and Scope of Lazard's Levelized Cost of Storage Analysis

The intent of our LCOS analysis is to provide an objective, transparent methodology for analyzing the cost effectiveness, identifiable revenue potential and underlying value of various energy storage technologies within a range of applications

LCOS Analysis

Key Objectives	Scope
Methodological: • Provide a clear methodology for comparing the cost and performance of the most prominent, commercially available energy storage technologies for a selected subset of illustrative use cases	• Provides a breakdown of costs into components (e.g., capital costs, O&M, charging costs, EPC, augmentation and salvage/removal cost) • Differences in performance and sizing across use cases are reflected in configuration and corresponding costs, reported in \$/MWh and \$/kW-yr. • Intended to provide a basis of comparing costs between commercially available energy storage technologies, across commonly encountered use cases
Cost: • Analyze current cost and performance data for selected energy storage technologies and use cases, sourced from an extensive survey of leading equipment vendors, integrators and developers	• Analyzes costs related to lithium-ion, flow batteries and lead chemistries (excludes mechanical, gravity and thermal technologies) • Cost assumptions are based on 2018 product/component delivery • Capital structure and interest rates are standardized across geographies and use cases to enable comparison • Use cases have been defined to ensure comparability and are intended to represent commercial storage development
Revenue: • Analyze identifiable sources of revenue available to energy storage projects	• Revenue assumptions have been limited to currently identifiable sources of value or savings • The LCOS focuses on those regions of the U.S. and select international geographies (i.e., Australia, Germany and the U.K.) with the most active and transparent markets for energy storage
Value Snapshot: • Provide an overview of illustrative project returns ("Value Snapshots") for selected use cases, based on identifiable revenues (or savings) and costs potentially available in selected markets/geographies	• Regions, mix of revenue sources, applicable subsidies and specific configurations are intended to be reflective of actual market activity • Project economics depicted in the Value Snapshots reflects simulated storage system performance and market rules

Selected Limitations of Lazard's Levelized Cost of Storage Analysis

Our LCOS report analyzes the observed costs and revenue streams associated with the leading energy storage technologies and provides an overview of illustrative project returns; the LCOS is focused on providing a robust, empirically based indication of actual cash costs and revenues associated with leading energy storage technologies

- **Our LCOS does not purport to measure the full set of potential benefits associated with energy storage to Industry participants or society, but merely those demonstrable in the form of strictly financial measures of observable costs and revenues**

What Our LCOS Analysis Does

- ☑ **Defines operational parameters associated with energy storage systems designed for a selected subset of the most prevalent use cases of energy storage**
- ☑ **Aggregates cost and operational data from original equipment manufacturers and energy storage developers, after validation from additional Industry participants/energy storage users**
- ☑ **Analyzes, based on the installed cost, what revenue is required over the indicated project life to achieve certain levelized returns for various technologies, designed for a selected subset of identified use cases**
- ☑ **Provides an "apples-to-apples" comparison among various technologies within a selected subset of identified use cases**
- ☑ **Aggregates robust survey data to define a range of future/expected capital cost decreases by technology**
- ☑ **Surveys currently available revenue streams associated with each use case across selected geographies**
- ☑ **Profiles the economics of typical examples of each use case, located in geographic regions where they are most common, providing a Value Snapshot of the associated financial returns**

What Our LCOS Analysis Does Not Do

- ☒ **Identify the full range of potentially viable energy storage technologies (e.g., mechanical, gravity and thermal)**
- ☒ **Identify the full range of use cases available to energy storage systems**
- ☒ **Provide precise inputs for actual project evaluation or resource planning studies, which would require case-specific system configurations and project/plan-specific procurement and installation costs, among other things**
- ☒ **Authoritatively establish or predict prices or subsidies for energy storage projects/products**
- ☒ **Identify and quantify all potential types of benefits provided by energy storage for power grids or consumers**
- ☒ **Provide a definitive view of project profitability, overall or to specific individuals/entities, for the various use cases across all potential locations and specific circumstances**
- ☒ **Provide an "apples-to-apples" comparison to conventional or Alternative Energy generation**

Levelized Cost of Storage Analysis—Methodology

Our Levelized Cost of Storage analysis consists of creating an energy storage model representing an illustrative project for each relevant technology and solving for the $/MWh figure that results in a levered IRR equal to the assumed cost of equity (see appendix for detailed assumptions by technology)

Peaker Lithium—Low Case Sample Calculations

Year [1]		0	1	2	3	4	5	20
Capacity (MW)	(A)		100	100	100	100	100	100
Total Generation ('000 MWh)[2]	(B)*		140	140	140	140	140	140
Levelized Storage Cost ($/MWh)	***(C)***		***$203.5***	***$203.5***	***$203.5***	***$203.5***	***$203.5***	***$203.5***
Total Revenues	**(B) x (C) = (D)***		**$28.5**	**$28.5**	**$28.5**	**$28.5**	**$28.5**	**$28.5**
Total Charging Cost [3]	(E)		($5.4)	($5.4)	($5.4)	($5.5)	($5.5)	($6.0)
Total O&M[4]	(F)*		(5.7)	(5.8)	(7.3)	(7.3)	(7.3)	(8.0)
Total Operating Costs	**(E) + (F) = (G)**		($11.1)	($11.2)	($12.7)	($12.8)	($12.8)	($14.0)
EBITDA	**(D) - (G) = (H)**		**$17.4**	**$17.3**	**$15.8**	**$15.7**	**$15.6**	**$14.5**
Debt Outstanding - Beginning of Period	(I)		$22.8	$22.3	$21.8	$21.2	$20.5	$2.1
Debt - Interest Expense	(J)		(1.8)	(1.8)	(1.7)	(1.7)	(1.6)	(0.2)
Debt - Principal Payment	(K)		(0.5)	(0.5)	(0.6)	(0.6)	(0.7)	(2.1)
Levelized Debt Service	(J) + (K) = (L)		(2.3)	(2.3)	(2.3)	(2.3)	(2.3)	(2.3)
EBITDA	**(H)**		$17.4	$17.3	$15.8	$15.7	$15.6	$14.5
Depreciation (7-yr MACRS)	(M)		(27.9)	(19.9)	(14.2)	(10.2)	(10.2)	0.0
Interest Expense	(J)		(1.8)	(1.8)	(1.7)	(1.7)	(1.6)	(0.2)
Taxable Income	**(H) + (M) + (J) = (N)**		**($12.3)**	**($4.4)**	**($0.2)**	**$3.8**	**$3.8**	**$14.4**
Tax Benefit (Liability)	**(N) x (Tax Rate) = (O)**		**$4.9**	**$1.8**	**$0.1**	**($1.5)**	**($1.5)**	**($5.7)**
After-Tax Net Equity Cash Flow	**(H) + (L) + (O) = (P)**	**($91.2)**[7]	**$20.0**	**$16.8**	**$13.5**	**$11.8**	**$11.8**	**$6.5**

IRR For Equity Investors	**12.0%**

Key Assumptions [5]	
Power Rating (MW)	100
Duration (Hours)	4
Usable Energy (MWh)	400
100% Depth of Discharge Cycles/Day	1
Operating Days/Year	350
Capital Structure	
Debt	20.0%
Cost of Debt	8.0%
Equity	80.0%
Cost of Equity	12.0%
Taxes	
Combined Tax Rate	40.0%
Contract Term / Project Life (years)	20
MACRS Depreciation Schedule	7 Years
Total Initial Installed Cost ($/MWh)[6]	$814
O&M, Warranty & Augmentation Cost ($/MWh)	$43
Charging Cost ($/kWh)	$0.033
Charging Cost Escalator (%)	0.55%
Efficiency (%)	87%

Technology-dependent

Levelized

Source: *Lazard and Enovation Partners estimates.*

Note: Wholesale Lithium—Low LCOS case presented for illustrative purposes only. Assumptions specific to Wholesale Lithium Low Case.

* Denotes unit conversion.

(1) Assumes half-year convention for discounting purposes.

(2) Total Generation reflects (Cycles) x (Capacity) x (Depth of Discharge) x (1 – Fade). Note for the purpose of this analysis, Lazard accounts for Fade in Augmentation costs (included in O&M).

(3) Charging Cost reflects (Total Generation) / [(Efficiency) x (Charging Cost) x (1 + Charging Cost Escalator)].

(4) O&M costs include general O&M (1.3% of BESS equipment and 1.7% of PCS equipment, yearly at 2.5%), augmentation costs (4.2% of ESS equipment) and warranty costs (1.5% of BESS equipment and 2.0% of PCS equipment, starting in year 3).

(5) Reflects a "key" subset of all assumptions for methodology illustration purposes only. Does not reflect all assumptions.

(6) Initial Installed Cost includes Inverter cost of $49/kW, Module cost of $205/kWh, Balance of System cost of $27/kWh and a 16.7% engineering procurement and construction ("EPC") cost.

(7) Reflects initial cash outflow from equity sponsor.

Illustrative Value Snapshots—Methodology

Our Value Snapshot analysis consists of creating a financial model representing an illustrative energy storage project designed for a specific use case and analyzing the financial viability of such project assuming commercially available revenue streams and system costs

Value Snapshot Methodology

Selected Use Cases	Illustrative Revenue Sources	Optimization Analysis[1]	Illustrative Project Returns
This study analyzes six use cases which represent an application of energy storage that market participants are utilizing now or will be utilizing in the near future	The scope of revenue sources analyzed in this study are limited to those that are applied in existing or soon-to-be commissioned projects, and that are quantifiable and identifiable	The project's optimal combination of revenue sources is calculated using simulation analysis	Detailed cash flow statements for each project are calculated and project returns are calculated on a 20-year levered post-tax IRR basis

Location/ Owner

Energy Storage

Selected Use Cases

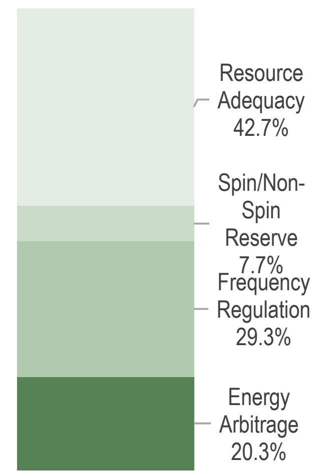
1. Wholesale
2. Transmission and Distribution
3. Utility-Scale (PV + Storage)
4. Commercial & Industrial (Standalone)
5. Commercial & Industrial (PV + Storage)
6. Residential (PV + Storage)

Illustrative Revenue Sources

- Energy Arbitrage
- Frequency Regulation
- Spinning/Non-Spinning Reserves
- Resource Adequacy
- Distribution Deferral
- Demand Response—Wholesale
- Demand Response—Utility
- Bill Management
- Local Incentive Payments

Illustrative Project Returns

Wholesale (CAISO)



Revenue Sources
(-) Operating Costs
(-) Debt Service
(-) Taxes
(-) Capital Costs

Levered IRR = ~16.7%[2]

(1) The Value Snapshots analyze project economics of selected energy storage applications by simulating locally available revenue streams, given the energy storage system's performance constraints, applicable contractual rules and assuming perfect foresight with respect to future prices and load.
(2) Cash flow waterfall is simplified for illustrative purposes only. See appendix for full valuation details.

Evolution of Lazard's Levelized Cost of Storage Analysis

As the energy storage Industry continues to mature, Lazard continues to make incremental improvements to the LCOS analysis; however, we remain cognizant that changes between versions need to balance the requirement of accurately depicting current commercial practices with a desire to enable year-over-year comparisons of observed costs, identifiable revenue potential and underlying value of various energy storage technologies within a range of applications

LCOS v1.0 (2015)

- Launched ongoing cost survey analogous to Lazard's LCOE to chart evolution of energy storage cost and performance

LCOS v2.0 (2016)

- Reported results for expanded and more detailed set of storage technologies
- Narrowed LCOS ranges
- Introduced "Value Snapshots" to profile project economics

LCOS v3.0 (2017)

- Narrowed scope of energy storage technologies and use cases surveyed to more accurately reflect current commercial opportunities
- Introduced and included survey of identifiable revenue streams available for energy storage projects in the U.S.
- Revised Value Snapshots to illustrate typical project returns for each use case
- Updated methodology for reflecting storage system replacement costs/degradation through augmentation costs

LCOS v4.0 (2018)

- Added utility-scale, C&I and residential solar PV plus storage uses cases
- O&M and warranty costs are treated as independent parameters (vs. a function of equipment costs)
- Preventative maintenance, scheduled inspection and scheduled replacement included in O&M expense (excluded capacity and warranty-covered maintenance)
- Extension of general OEM warranty with scheduled capacity reduction included in warranty expense (excluded shipping and changes to original warranty)
- Included residual value (or net remediation cost)
- Included in augmentation costs are periodic upgrades needed to maintain DC equipment capacity, amortized as a time series of equipment upgrade expenses needed to maintain the original energy storage capacity for the lifetime of the project (excluded any repair that maintains capacity through standard O&M or warranty)
- Added international geographies to each Value Snapshot use case

2015 | 2016 | 2017 | 2018

IV Lazard's Levelized Cost of Storage Analysis v4.0

A Overview of Selected Use Cases

Energy Storage Use Cases—Overview

Numerous potential applications for energy storage technologies have been identified and piloted; for the purposes of this assessment, we have chosen to focus on a subset of use cases that are the most identifiable and common. Lazard's LCOS examines the cost of energy storage in the context of its specific applications on the grid and behind-the-meter; each use case analyzed herein, and presented below, represents an application of energy storage that market participants are utilizing now or will be utilizing in the near future

		Use Case Description	Technologies Assessed
In-Front-of-the-Meter	1 Wholesale	• Large-scale energy storage system designed to replace peaking gas turbine facilities; brought online quickly to meet rapidly increasing demand for power at peak; can be quickly taken offline as power demand diminishes	• Lithium-Ion • Flow Battery-Vanadium • Flow Battery-Zinc Bromide
In-Front-of-the-Meter	2 Transmission and Distribution	• Energy storage system designed to defer transmission and/or distribution upgrades, typically placed at substations or distribution feeder controlled by utilities to provide flexible capacity while also maintaining grid stability	• Lithium-Ion • Flow Battery-Vanadium • Flow Battery-Zinc Bromide
In-Front-of-the-Meter	3 Utility-Scale (PV + Storage)	• Energy storage system designed to be paired with large solar PV facilities to improve the market price of solar generation, reduce solar curtailment and provide grid support when not supporting solar objectives	• Lithium-Ion • Flow Battery-Vanadium • Flow Battery-Zinc Bromide
Behind-the-Meter	4 Commercial & Industrial (Standalone)	• Energy storage system designed for behind-the-meter peak shaving and demand charge reduction services for commercial energy users – Units typically sized to have sufficient power/energy to support multiple commercial energy management strategies and provide the option of the system to provide grid services to a utility or the wholesale market	• Lithium-Ion • Lead-Acid • Advanced Lead (Lead Carbon)
Behind-the-Meter	5 Commercial & Industrial (PV + Storage)	• Energy storage system designed for behind-the-meter peak shaving and demand charge reduction services for commercial energy users – Units typically sized to have sufficient power/energy to support multiple commercial energy management strategies and provide the option of the system to provide grid services to a utility or the wholesale market	• Lithium-Ion • Lead-Acid • Advanced Lead (Lead Carbon)
Behind-the-Meter	6 Residential (PV + Storage)	• Energy storage system designed for behind-the-meter residential home use—provides backup power, power quality improvements and extends usefulness of self-generation (e.g., "solar PV + storage") – Regulates the power supply and smooths the quantity of electricity sold back to the grid from distributed PV applications	• Lithium-Ion • Lead-Acid • Advanced Lead (Lead Carbon)

Energy Storage Use Cases—Operational Parameters

For comparison purposes, this study assumes and quantitatively operationalizes six use cases for energy storage; while there may be alternative or combined/"stacked" use cases available to energy storage systems, the six use cases below represent illustrative current and contemplated energy storage applications and are derived from Industry survey data

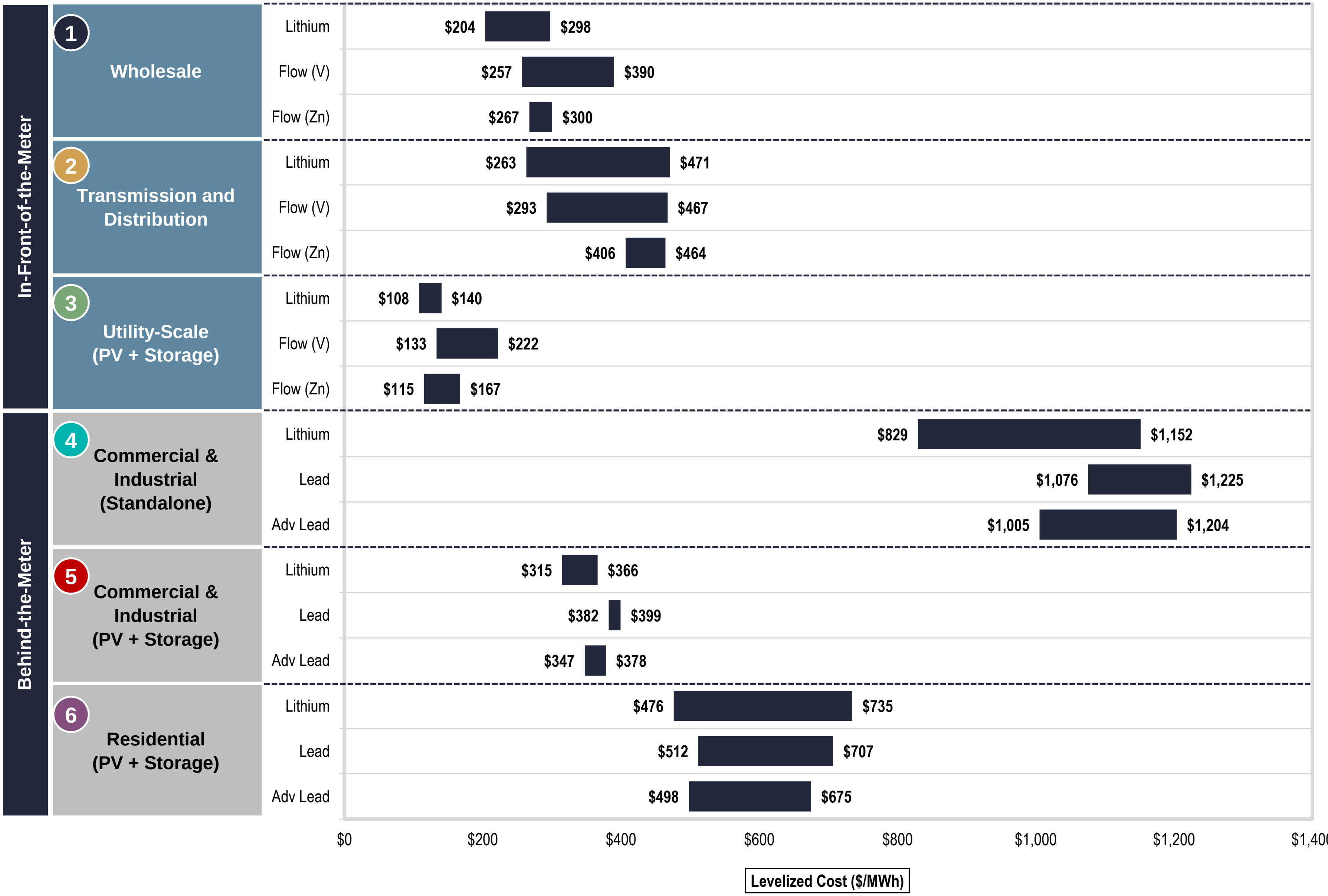
[ ] = "Usable Energy"(1)

		Project Life (Years)	Storage MW(2)	Solar PV MW	MWh of Capacity(3)	100% DOD Cycles/ Day(4)	Days/ Year(5)	Annual MWh	Project MWh
In-Front-of-the-Meter	1 Wholesale	20	100	--	400	1	350	140,000	2,800,000
In-Front-of-the-Meter	2 Transmission and Distribution	20	10	--	60	1	250	15,000	300,000
In-Front-of-the-Meter	3 Utility-Scale (PV + Storage)	20	20	40	80	1	350	28,000	560,000
Behind-the-Meter	4 Commercial & Industrial (Standalone)	10	1	--	2	1	250	500	5,000
Behind-the-Meter	5 Commercial & Industrial (PV + Storage)	20	0.50	1	2	1	350	700	14,000
Behind-the-Meter	6 Residential (PV + Storage)	20	0.01	0.02	0.04	1	350	14	280

(1) Usable energy indicates energy stored and able to be dispatched from system.
(2) Indicates power rating of system (i.e., system size).
(3) Indicates total battery energy content on a single, 100% charge, or "usable energy." Usable energy divided by power rating (in MW) reflects hourly duration of system.
(4) "DOD" denotes depth of battery discharge (i.e., the percent of the battery's energy content that is discharged). Depth of discharge of 100% indicates that a fully charged battery discharges all of its energy. For example, a battery that cycles 48 times per day with a 10% depth of discharge would be rated at 4.8 100% DOD Cycles per Day.
(5) Indicates number of days of system operation per calendar year.

B Lazard's Levelized Cost of Storage Analysis v4.0

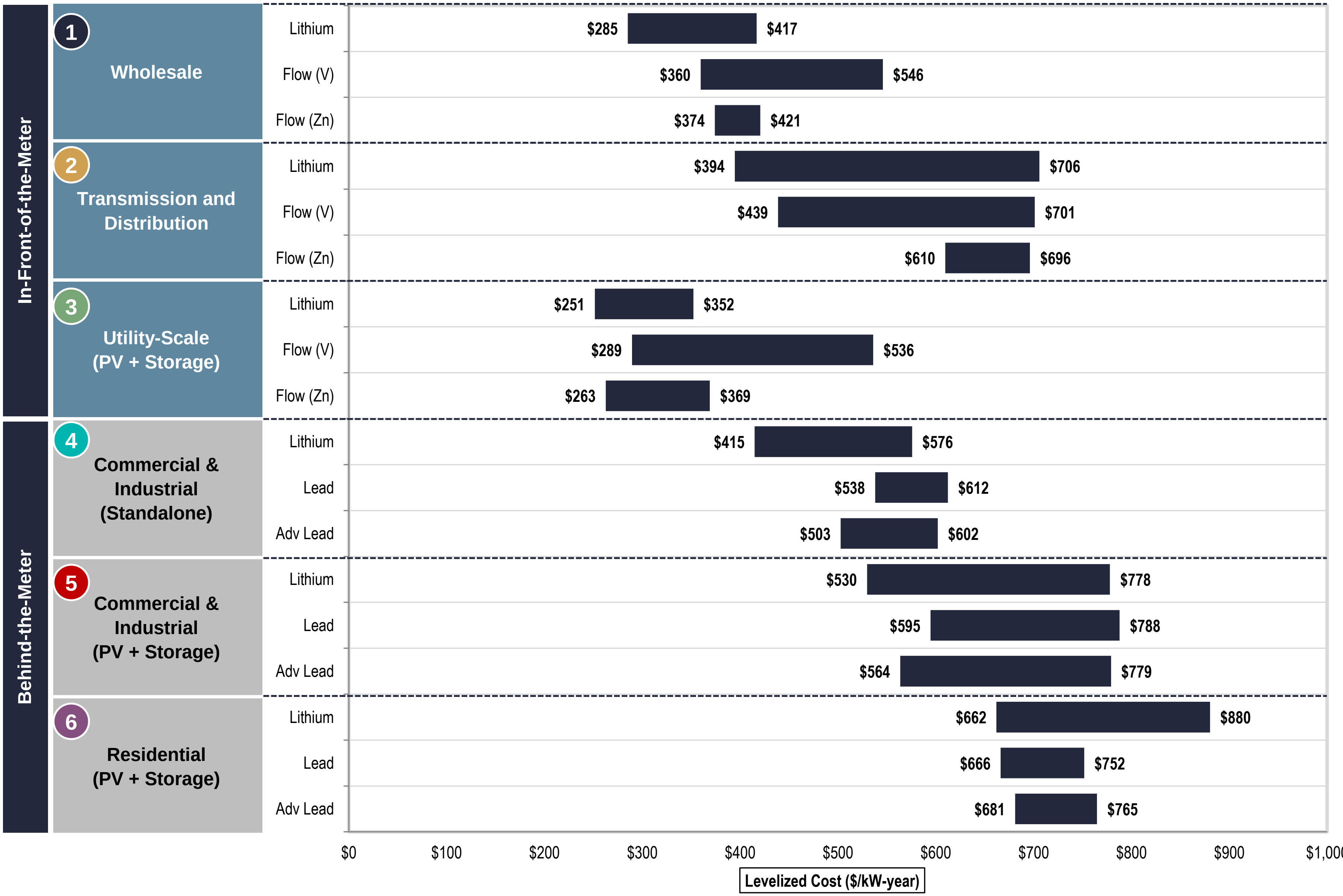
Unsubsidized Levelized Cost of Storage Comparison—$/MWh



Source: Lazard and Enovation Partners estimates.

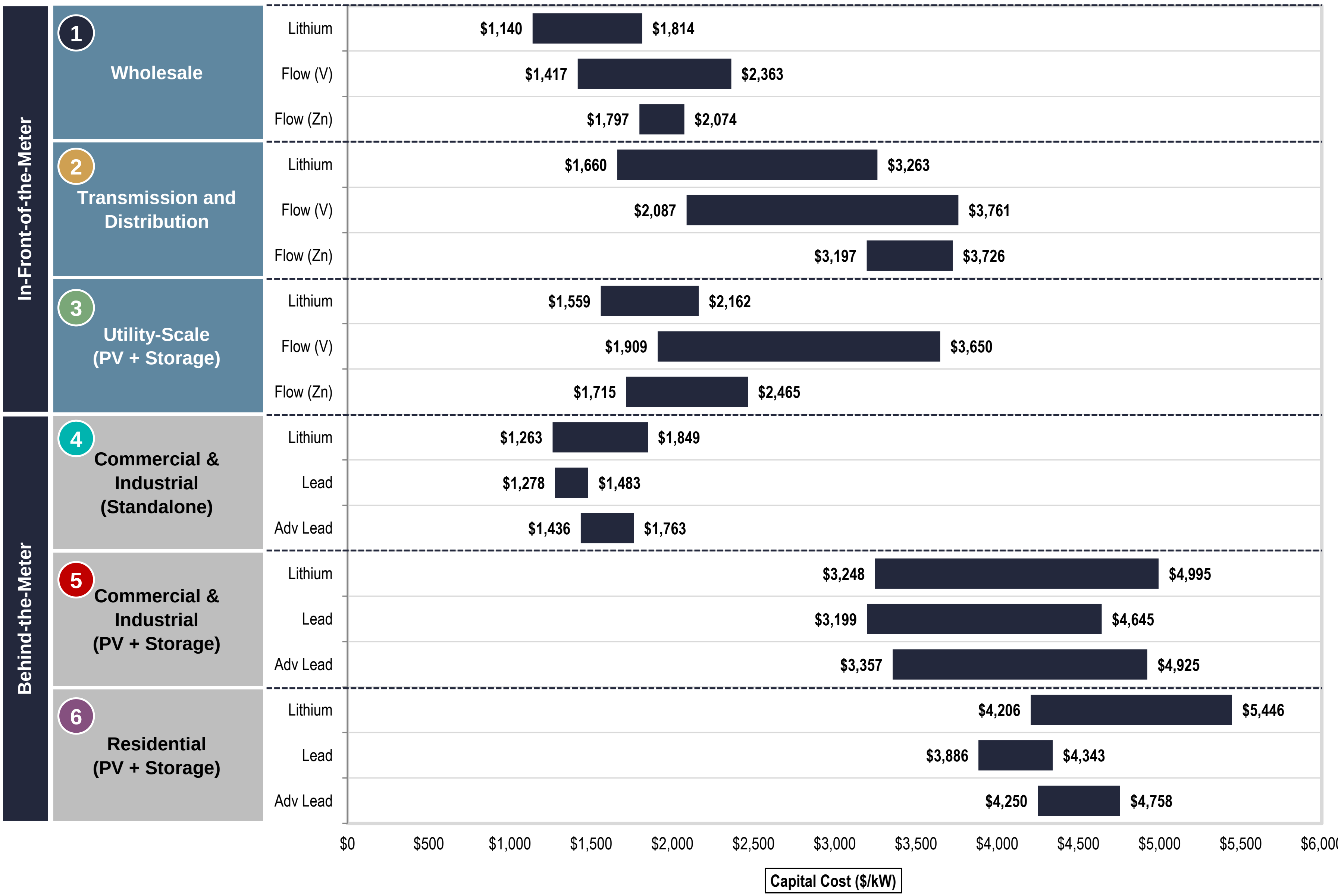
Note: Here and throughout this presentation, unless otherwise indicated, analysis assumes 20% debt at an 8% interest rate and 80% equity at a 12% cost of equity. Flow Battery Vanadium and Flow Battery Zinc Bromide denoted in this report as Flow (V) and Flow (Zn), respectively.

Unsubsidized Levelized Cost of Storage Comparison—$/kW-year



Source: *Lazard and Enovation Partners estimates.*
Note: Here and throughout this presentation, unless otherwise indicated, analysis assumes 20% debt at an 8% interest rate and 80% equity at a 12% cost of equity. Flow Battery Vanadium and Flow Battery Zinc Bromide denoted in this report as Flow (V) and Flow (Zn), respectively.

Capital Cost Comparison—$/kW

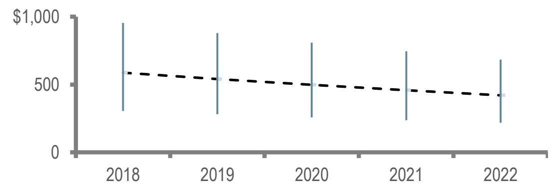
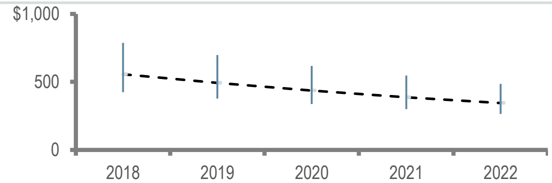
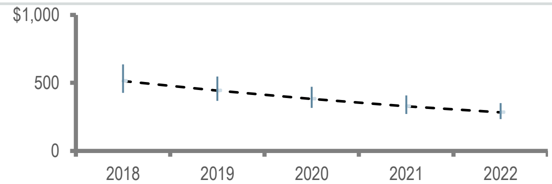
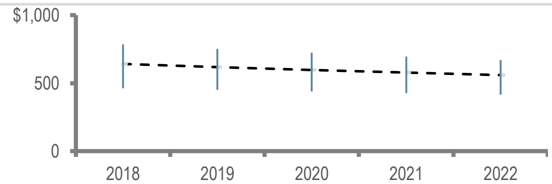
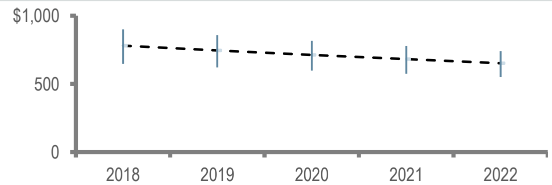


Source: *Lazard and Enovation Partners estimates.*

Note: Capital costs represent costs of equipment only. This excludes augmentation costs that represent the energy storage capacity required to maintain the full usable energy storage capacity (MWh) over the life of the unit. These augmentation costs vary due to different usage profiles and lifespans. Capital cost units are the total investment divided by the greater of solar PV nameplate capacity or low-end battery capacity. This excludes considerations for additional value provided by avoiding curtailment on the solar PV component of the system (where applicable).

Capital Cost Outlook by Technology

The average capital cost outlook accounts for the relative commercial maturity of different offerings (i.e., more mature offerings influence the cost declines per technology)

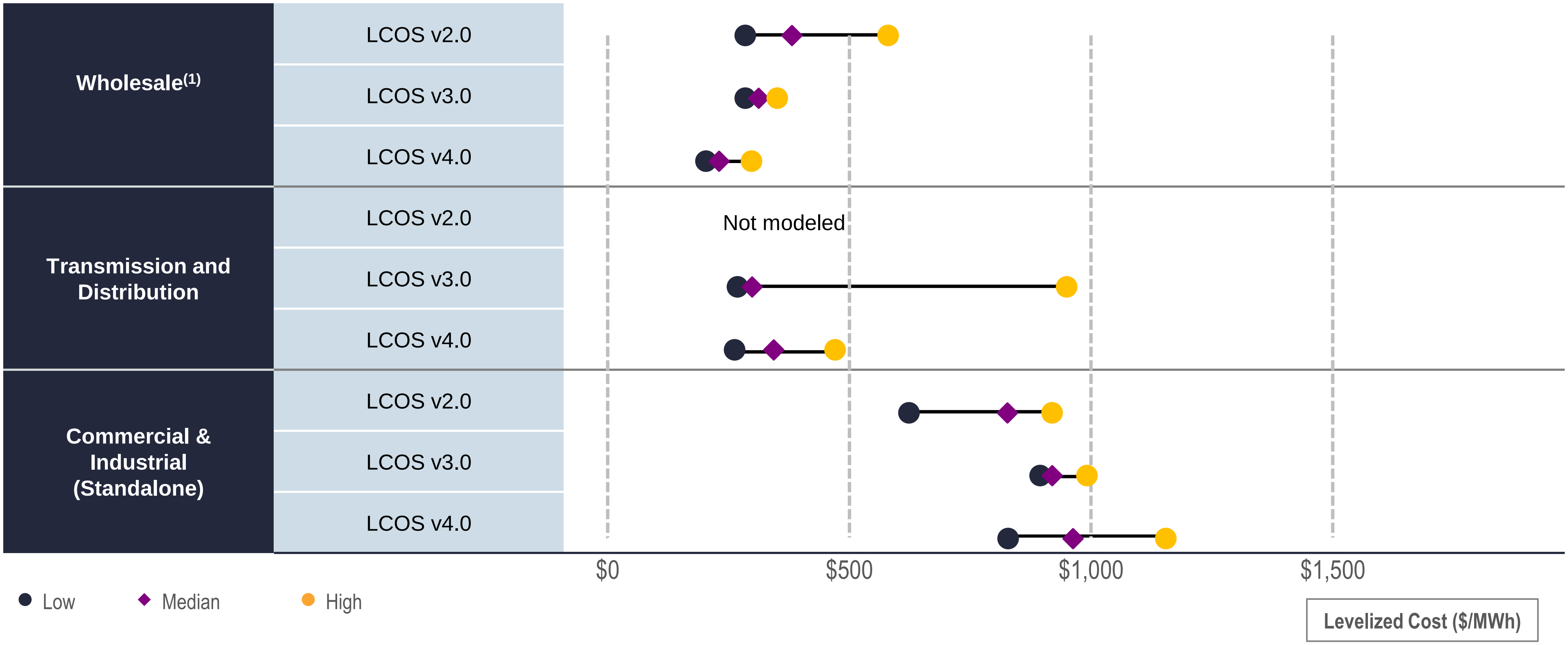
	Capital Cost ($/kWh)		Average	Technology Trends & Opportunities
Lithium-Ion		**CAGR** **5-Year**	(8%) (28%)	• Increased variation in magnitude of cost declines going forward • Battery OEMs reduce proportion of cobalt to mitigate higher raw material • Potential volatility from near-term capacity tightness, followed by multiple new production lines and price-based competition from new entrants • Slower cost declines in BOS, EPC and PCS costs, which represent increasing share of total system cost
Flow Battery–Vanadium		**CAGR** **5-Year**	(11%) (38%)	• Cost declines through increased manufacturing scale and energy densities • Long-term contracts with vanadium providers to make costs more predictable • Focus on providing plug and play (e.g., turnkey) units to keep EPC costs down
Flow Battery–Zinc Bromide		**CAGR** **5-Year**	(14%) (45%)	• Cost declines through increased manufacturing scale and increased densities (e.g., thicker zinc plating) • Reduced cost through more widely available components (e.g., pumps and valves) • Expectations of reductions in EPC and PCS costs
Lead		**CAGR** **5-Year**	(3%) (13%)	• Limited usability and performance translates into high levelized cost • Limited cost improvement expected
Advanced Lead		**CAGR** **5-Year**	(4%) (17%)	• Greater performance than typical lead-acid options • Cost reduction and performance improvements expected to continue • OEMs looking to use this class to address larger commercial systems not typically served by lead acid

Note: Capital costs reported are based on year 1 costs for systems designed for all LCOS use cases. Capital cost units are the total investment divided by the storage equipment's energy capacity (kWh rating) and inverter rating (kW rating). Capital cost outlook represents average expected cost reductions across use cases.

Historical LCOS Declines—Lithium-Ion Technologies

Lithium-ion equipment cost declines contend with system scale, installation and operating realities

- **Lithium-ion equipment costs continue to decline based on product design improvements (including continued progress on energy density, cell life, reduced BOS costs, etc.), scale and learning curve improvements**
- **Industry concerns over rising commodity prices (i.e., lithium and, in particular, cobalt), tariffs and product availability are not fully reflected in LCOS v4.0, primarily because a majority of 2018 deliveries were contracted and priced during the previous two years, which was prior to recent cost pressures**
- **Generally tighter ranges in LCOS values are observable as the Industry matures, supplemented by a more accurate representation of price differences due to location, bargaining power of buyer, etc.**



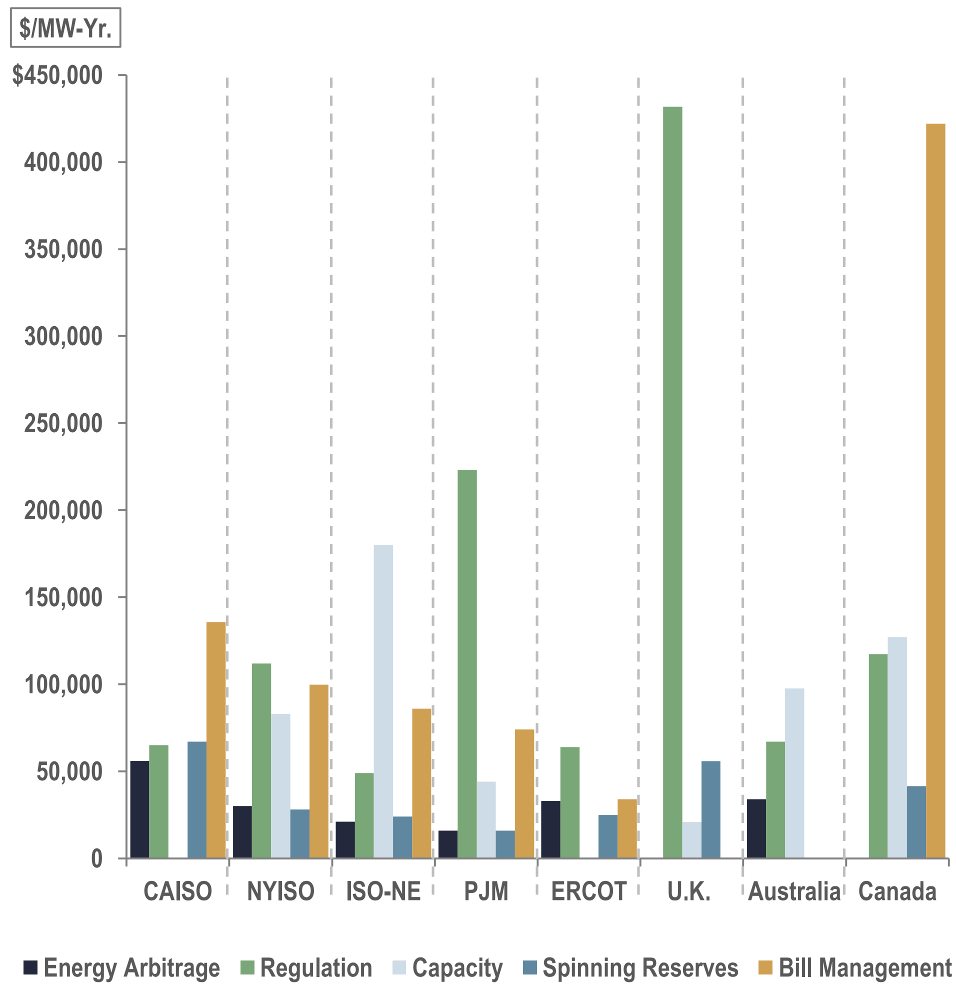
(1) "Wholesale" was termed "Peaker Replacement" in earlier versions of the LCOS.

V Landscape of Energy Storage Revenue Potential

Overview of Energy Storage Revenue Streams

As the energy storage market continues to evolve, several forms of potential revenue streams have emerged in select U.S. and other markets; Lazard's LCOS analyzes only those revenue streams that are quantifiable from currently deployed energy storage systems

Energy Storage Revenue Streams by Market & Use Case (2017)



What Determines Available Revenues for Energy Storage?

- **Enabling policies:** Include explicit targets and/or state goals incentivizing procurement of energy storage
  - Example—California energy storage procurement targets (e.g., AB2514) requires 1,325 MW by 2020
- **Incentives:** Upfront or performance-based incentive payments to subsidize initial capital requirements
  - Example—California Self-Generation Incentive Programs ("SGIP"): $450 million budget available to behind-the-meter storage
- **Market fundamentals:** Endogenous market conditions resulting in higher revenue potential and/or increased opportunity to participate in wholesale markets
  - Example—Daily volatility in energy prices lead to arbitrage opportunities worth ~$56/kW and $33/kW in CAISO and ERCOT respectively
  - Example—Constrained conditions resulted in capacity price of $180/kW in ISO-NE for new resources
- **Favorable wholesale/utility program rules:** Accessible revenue sources with operational requirements favoring fast-responding assets
  - Example—PJM regulation: average prices of $16.78/eff. MW in 2017, with significant revenue upside for performance for storage under RegD signal
  - Example—U.K. utilities required to procure enhanced frequency reserves for fast response assets under 4-year contracts. Short contract term requires asset to be amortized for fewer years, driving prices up
- **High Peak and/or Demand Charges:** Opportunities to avoid utility charges through peak load management during specified periods or system peak hours
  - Example—SDG&E demand charge of $49/kW, one of the highest in the U.S.

Source: Lazard and Enovation Partners estimates.
Note: All figures presented in USD using the following exchange rates: AUD/USD 1.38, CAD/USD 1.29, EUR/USD 0.85 and GBP/USD 0.76.

Landscape of Energy Storage Revenue Potential

Numerous potential sources of revenue available to energy storage systems reflect system and customer benefits provided by projects

- **The scope of revenue sources is limited to those actually applied in existing or soon-to-be commissioned projects. Revenue sources that are not identifiable or without publicly available price data are not analyzed**

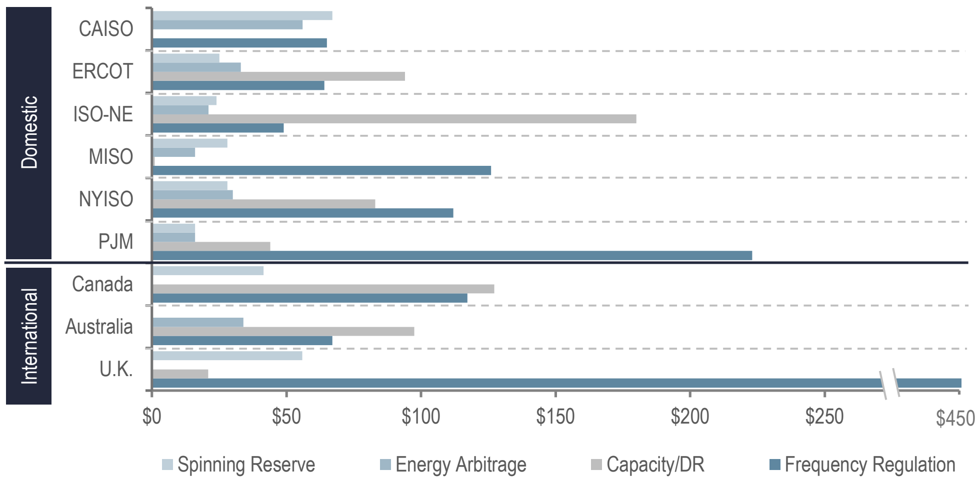
		Description	Use Cases[1]: Wholesale	T&D	Utility (PV + S)	Commercial (Standalone)	Commercial (PV + S)	Residential (PV + S)
A Wholesale	Demand Response–Wholesale	• Manages high wholesale price or emergency conditions on the grid by calling on users to reduce or shift electricity demand				✓	✓	✓
	Energy Arbitrage	• Allows storage of inexpensive electricity to sell at a higher price later (includes only wholesale electricity purchase)	✓	✓	✓			
	Frequency Regulation	• Provides immediate (4-second) power to maintain generation-load balance and prevent frequency fluctuations	✓	✓	✓	✓	✓	
	Resource Adequacy	• Provides capacity to meet generation requirements at peak loading in a region with limited generation and/or transmission capacity	✓	✓	✓	✓	✓	
	Spinning/ Non-Spinning Reserves	• Maintains electricity output during unexpected contingency event (e.g., an outage) immediately (spinning reserve) or within a short period (non-spinning reserve)	✓	✓	✓	✓	✓	
B Utility	Distribution Deferral	• Provide extra capacity to meet projected load growth for the purpose of delaying, reducing or avoiding distribution system investment in a region		✓				
	Transmission Deferral	• Provide extra capacity to meet projected load growth for the purpose of delaying, reducing or avoiding transmission system investment		✓				
	Demand Response–Utility	• Manages high wholesale price or emergency conditions on the grid by calling on users to reduce or shift electricity demand				✓	✓	✓
C Customer	Bill Management	• Allows reduction of demand charge using battery discharge and the daily storage of electricity for use when time of use rates are highest				✓	✓	✓
	Backup Power	• Supplies power reserve for use by Residential and Commercial users when the grid is down				✓	✓	✓

(1) Represents the universe of potential revenue streams available to the various use cases. Does not represent the use cases analyzed in the Value Snapshots.

A Wholesale Market Revenue Streams

Availability and value of wholesale market products to energy storage varies based on ISO rules and project specifications

2017 Wholesale Revenue Streams ($/kW-year)



Resource Adequacy ("RA") Revenue Streams

- **CAISO: Distributed resources in CAISO can access resource adequacy payments through one of two auction programs run by the IOUs**
  - Local Capacity Resource ("LCR") Auction
    - IOUs acquire RA and DR-like capabilities from bidders in a pay-as-bid 10-year contract auction
    - Focused on providing capacity to constrained zones
  - Demand Response Auction Mechanism ("DRAM") Pilot
    - IOUs acquire RA for 1 – 2 years and Distributed Energy Resources ("DERs") assets are given a type of must-bid responsibility in the wholesale markets
    - Focused on creating new opportunities for DERs to participate in wholesale markets
  - Estimate of $35/kW-year – $60/kW-year
- **MISO: Energy storage can qualify in MISO as behind-the-meter generation and participate alongside all conventional resources in public Planning Resource Auction ("PRA")**
  - Estimate of $0.55/kW-year based on the notably poor 2017 auction

Assumptions Employed

Energy Markets	• Assumed perfect foresight • Daily charging at the minimum price, discharge at maximum
Frequency Regulation	• Assumed participation in day ahead market(s) and fast response, energy neutral and continuous market where available • Assumed either 90% performance factor or ISO-wide average performance if reported • Assumed system average mileage ratio (fast resources where available)
Spinning Reserves	• Assumed capable to participate in spinning reserve market • Self scheduled/price taker in the day ahead market
Capacity/ Demand Response	• Revenue estimates are based on direct or DR program-enabled participation in the capacity markets (NYISO, PJM, ISO-NE, Canada and U.K.), responsive reserve service (ERCOT), planning resource auction (MISO) and reserve capacity mechanism (Australia)

Technical Factors Impacting Value/Availability of Wholesale Revenue

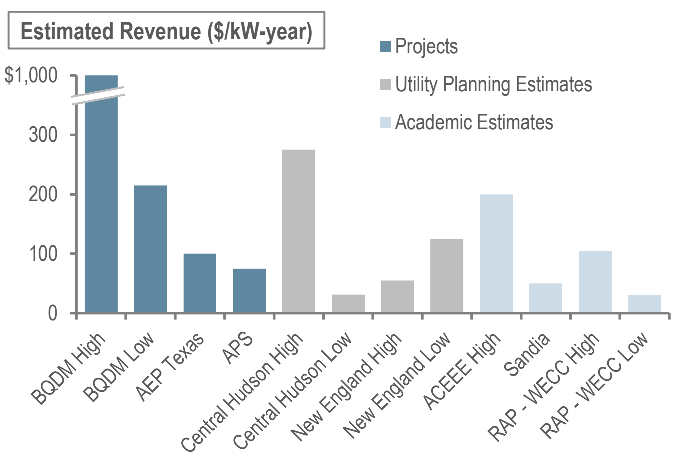
Minimum Size	• There is a minimum size to qualify as a generator, under which the asset must qualify through an ISO DR program or by aggregation	All
Energy Neutrality	• Some ISOs provide FR signals that are energy neutral over a set time period and thus allow energy storage assets to perform better	Frequency Regulation
Performance	• The ability to accurately follow the AGC signal and the energy to meet performance standards throughout the course of an hour will have a strong impact on payment from the FR market	Frequency Regulation
Qualification Method	• If an energy storage asset qualifies for the wholesale markets through a DR program, there may be limitations placed on the asset or additional revenues sources available (beyond capacity)	DR Programs
Congestion Constraints	• The Locational Based Marginal Pricing ("LBMP") for an energy storage asset will be different from the system-wide energy price (used here), as will the spread between daily high and daily low price	Energy Arbitrage

Source: Lazard and Enovation Partners estimates.
Note: All figures presented in USD using the following exchange rates: AUD/USD 1.38, CAD/USD 1.29, EUR/USD 0.85 and GBP/USD 0.76.

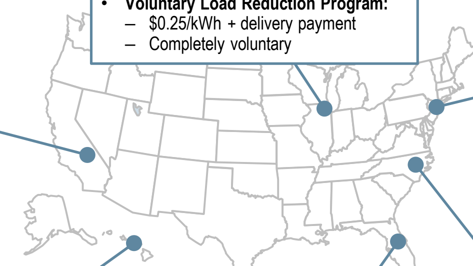
B Utility Revenue Streams

Utilities provide valuable revenue sources in exchange for location-based grid services, with most common applications being in utility DR programs and T&D deferral applications

Value of Deferral



Utility Funded Demand Response Programs—Selected Examples



CA IOUs

- **Capacity Bidding Program ("CBP"):**
  - PG&E: ~$10.3/kW-month, 6 months
  - SCE: ~$6.32/kW-month, 12 months
  - SDG&E: Varies on notice, from $10.8 – $14.7/kW-month, 6 months
- **Base Interruptible Program ("BIP"):**
  - PG&E: $8 – $9/kW-month, 12 months
  - SCE: $18 – $23/kW-month, 6 months
  - SDG&E: $10.8/kW-month summer, $1.8/kW-month winter
- **Demand Bidding Program**
  - $0.50/kWh during events

Com Edison

- **Voluntary Load Reduction Program:**
  - $0.25/kWh + delivery payment
  - Completely voluntary

ConEd

- **Commercial System Relief Program ("CSRP"):**
  - $6 – $18/kW-month, depending on location
  - 5 month period, $1/kWh
- **Distribution Load Reduction Program (DLRP):**
  - $18 – $25/kW-month, depending on location
  - 5 month period, $1/kWh

Hawaiian Electric

- **Fast DR Pilot Program:**
  - $5-10/kW-month, 12 months
  - $0.50/kWh during events

FPL

- **Commercial Demand Reduction Program:**
  - $8.20/kW-month
  - FPL controls the asset during events

Duke Energy Progress

- **Demand Response Automation ("DRA") Program:**
  - $3.25/kW-month + $50/kW for 1st & 2nd event + $6/kW at each event

Selected Observations

- Jurisdictional and regulatory concerns have limited deployment thus far
- Transacted values do not typically equal price; in most installations value substantially exceeds price
- Assets are typically transacted as a capital purchase by utilities
- Asset value is highly location dependent
- Deferral length varies based on factors independent of the battery
- Projects are rarely transacted in absence of other revenue streams

Selected Observations

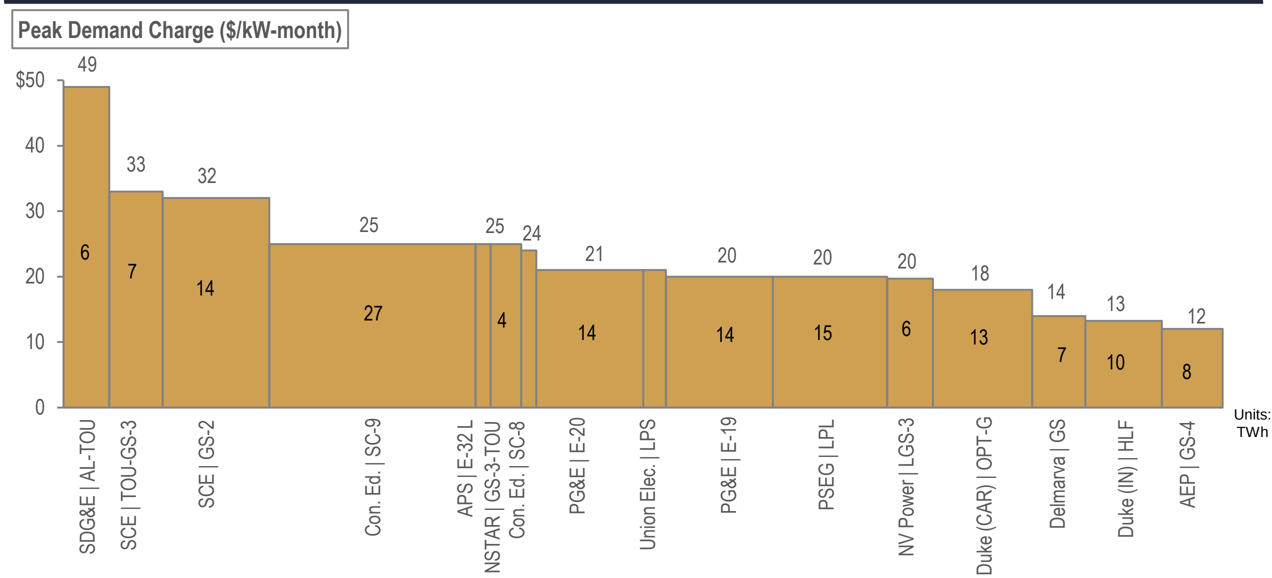
Capacity Type Programs	– Paid a substantial standby payment to be available on a monthly or seasonal basis – Paid a comparatively lower rate per energy reduced when called – Calls are typically mandatory – Tend to have harsher penalties for underperformance
Energy Type Programs	– Paid only based on energy reduced – No capacity payment, often DR calls are not mandatory – Penalties are rare and when they do exist, tend to be less severe than in capacity type programs
Common Issues to DR Programs	– Length of notice – Payment size and ratio of capacity to energy payments – Frequency of calls – Call trigger (supply economics or emergency situation) – Severity of penalty – Baseline methodology (how the demand reduction is calculated based on prior energy usage)

Source: Utility Dive, GTM, AEP Central Hudson and ISO NE regulatory filings, ACEEE, Sandia and WECC.

C Customer Revenue Streams

Utility bill management is a key driver of returns for behind-the-meter energy storage projects; project-specific needs for reliability and microgrid integration can be significant, but are rarely monetized

Representative Utility Demand Charges & Reported Volumes (2017)(1)(2)



Utility Demand Charges

United States	• Demand charges are widely used in the U.S. for C&I customers. (See chart to left for examples)
Australia	• Demand charges are common in Australia and vary widely by utility and region (surveyed demand charges range from $6.3 – $131.5/kW-month)
Other International	• Demand charges are a not common part of utility bills in most countries

Additional Avoidable Retail Electricity Charges

Type	Example	Description	Charge (2017 $/kW-yr.)(3)
Capacity	PJM GENCAP	• Applied to average load usage during PJM's 5 noncoincident peak; referred to as 5CP hours	• RTO: 59 • EMAAC: 80
Transmission	ERCOT 4CP	• Applied to average load during system coincidental peaks occurring in June, July, August and September	• CNP: 8 • Oncor: 18 • TNMP: 18
Other	Ontario/IESO Global Adjustment	• Annual determination of coincident peak demand specifies share of GA costs	• Class A: 422

Reliability Benefits

- Behind-the-meter reliability
  - Behind-the-meter energy storage installations designed to provide outage protection are challenged by the high overall reliability of the grid
  - Storage units sized to provide other benefits (e.g. demand charge reduction) often are too small to provide long-term reliability
  - Best example of payment for long-term reliability is from Texas, priced at $8 – $10/kW-month

Source: FERC Form 1 Filings, PUC of TX, PJM RPM, utility tariffs, OpenEI, Lazard and Enovation Partners estimates.

(1) Demand charges are fixed, monthly costs typically limited to commercial customers. The rate is typically a function of a customer's peak demand as measured over a predefined period. Energy storage can enable customers to save money through reducing peak consumption, lowering their demand charge.

(2) Non-exhaustive list based on FERC Form 1 total reported TWh by tariff, sorted by highest total demand charges during peak periods.

(3) Values based on PJM 17/18 DY Reliability Pricing Model results & Transmission Cost Recovery Factors for customers with >5kVA demand in ERCOT.

VI Energy Storage Value Snapshot Analysis

Illustrative Value Snapshots—Introduction

In addition to the LCOS methodology, which provides a cost focused "apples-to-apples" comparison between use cases, Lazard has included several illustrative "Value Snapshots" that reflect typical economics associated with merchant behind-the-meter and in-front-of-the-meter storage applications across various geographies in the U.S. and internationally

Configurations	• Value Snapshot configurations are based on illustrative energy storage applications that have been designed to capture value streams available in a number of ISOs/RTOs and international markets, including: – Serving RTO markets (i.e., energy arbitrage, frequency regulation, spinning/non-spinning reserves and demand response) – Serving utilities (i.e., demand response, transmission deferral and distribution deferral) – Serving customers (i.e., bill management and backup power) • Behind-the-Meter load profiles are based on a U.S. DOE medium/large-sized commercial building profile and an illustrative residential profile • Specific tariff rates reflect medium or large commercial power with peak load floors and caps of 10 kW and 100 kW, respectively; applies demand charges ranging from $4 – $53 per peak kW, depending on jurisdiction and customer type • Combined/stacked revenue streams are based on optimal combination of available options, given the energy storage system's performance constraints, applicable contractual rules and assuming perfect foresight with respect to future prices and load • Analysis assumes state-level, non-tax-oriented incentive payments (e.g., LCR/SGIP in California) are treated as taxable income for federal income tax purposes(1)
Cost Estimates	• Cost estimates(2) are based on the LCOS framework (i.e., assumptions regarding O&M, warranties, etc.) but sized to reflect the system configuration described above • System size and performance adjusted to capture multiple value streams and to reflect estimated regional differences in installation costs(3) • System costs are based on individual component (lithium-ion battery, inverter, etc.) sizing and are based on the needs determined in the analysis • Operational performance specifications required to serve various modeled revenue streams, based on lithium-ion systems in the LCOS (cycling life, depth of discharge, etc.)
Results	• System economic viability is illustrated by a levered IRR(4)

Note: All Value Snapshots assume lithium-ion batteries.
(1) Based on discussions with developers of merchant storage projects in New York and California.
(2) Costs for illustrative Value Snapshots denote actual cost-oriented line items, not "LCOS" costs (i.e., $/MWh required to satisfy assumed equity cost of capital).
(3) Based on survey data and proprietary Enovation Partners case experience.
(4) This report does not attempt to determine "base" or "typical" IRRs associated with a given market or region. Results and viability are purely illustrative and may differ from actual project results.

Illustrative Value Snapshots—Overview

Our Value Snapshots analyze the financial viability of illustrative energy storage systems designed for selected use cases. The geographic locations, assumed installed and operating costs and associated revenue streams reflect current energy storage market activity

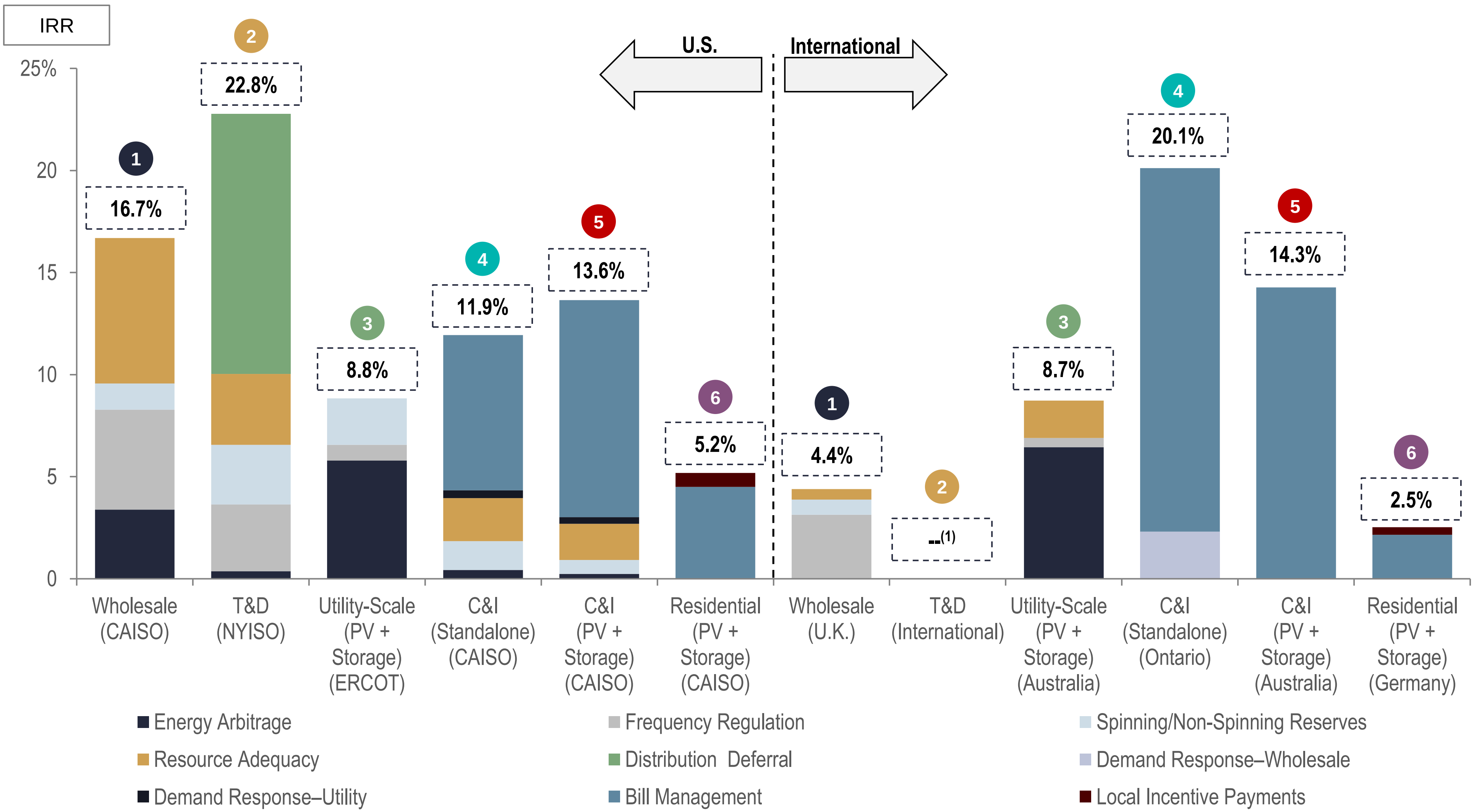
- **Actual project returns may vary due to differences in location-specific costs, revenue streams and owner/developer risk preferences**

	Use Case	U.S. Location	International Location	Owner	Revenue Streams
1	Wholesale	CAISO (SP-15)	U.K.	• IPP in a competitive wholesale market	• Wholesale market settlement • Local capacity resource programs
2	Transmission and Distribution	NYISO (New York City)	--(1)	• Wires utility in a competitive wholesale market	• Capital recovery in regulated rates, avoided cost to wires utility, avoided cost incentives
3	Utility-Scale (PV + Storage)	ERCOT (West Texas)	Australia	• IPP in a competitive wholesale market	• Wholesale market settlement
4	Commercial & Industrial (Standalone)	CAISO (San Francisco)	Ontario	• Customer or financier in a competitive wholesale area	• Wholesale market settlement, tariff settlement, DR participation, avoided costs to commercial customer, local capacity resource programs
5	Commercial & Industrial (PV + Storage)	CAISO (San Francisco)	Australia	• Customer or financier in a competitive wholesale area	• Wholesale market settlement, tariff settlement, DR participation, avoided costs to commercial customer, local capacity resource programs
6	Residential (PV + Storage)	CAISO (Los Angeles)	Germany	• Customer or financier	• DR participation, tariff settlement, avoided costs to residential customer and incentives

(1) Lazard's Value Snapshot analysis intentionally excluded a Transmission and Distribution use case from its international analysis.

Illustrative Value Snapshots—Summary Results

Project economics analyzed in the Value Snapshots have revealed a modest improvement year-over-year for the selected use cases, primarily reflecting, among other things, improved costs rather than rising revenues



Source: Lazard and Enovation Partners estimates.
(1) Lazard's Value Snapshot analysis intentionally excluded a Transmission and Distribution use case from its international analysis.

Illustrative U.S. Value Snapshots—Detailed Results

	1 Wholesale	2 Transmission and Distribution	3 Utility-Scale (PV + Storage)	4 Commercial & Industrial (Standalone)	5 Commercial & Industrial (PV + Storage)	6 Residential (PV + Storage)
Region	CAISO	NYISO	ERCOT	CAISO	CAISO	CAISO
Revenue Sources						
Energy Arbitrage	20.3%	1.6%	65.6%	3.5%	1.7%	--
Frequency Regulation	29.3%	14.3%	8.7%	--	--	--
Spinning/Non-Spinning Reserves	7.7%	12.8%	25.7%	11.8%	5.0%	--
Resource Adequacy	42.7%	15.3%	--	17.7%	13.0%	--
Distribution Deferral	--	55.9%	--	--	--	--
Demand Response–Wholesale	--	--	--	--	--	--
Demand Response–Utility	--	--	--	3.2%	2.4%	--
Bill Management	--	--	--	63.7%	77.9%	86.8%
Local Incentive Payments	--	--	--	--	--	13.2%
Energy Storage Configuration						
Battery Size (MWh)	400	60	80	2	2	0.04
Inverter Size (MW)	100	10	20	1	0.5	0.01
C-Rating	C/4	C/6	C/4	C/2	C/4	C/4
IRR	16.7%	22.8%	8.8%	11.9%	13.6%	5.2%

Source: Lazard and Enovation Partners estimates.
Note: Percentages represent allocation of battery's useful life dedicated to each revenue stream.

Illustrative International Value Snapshots—Detailed Results

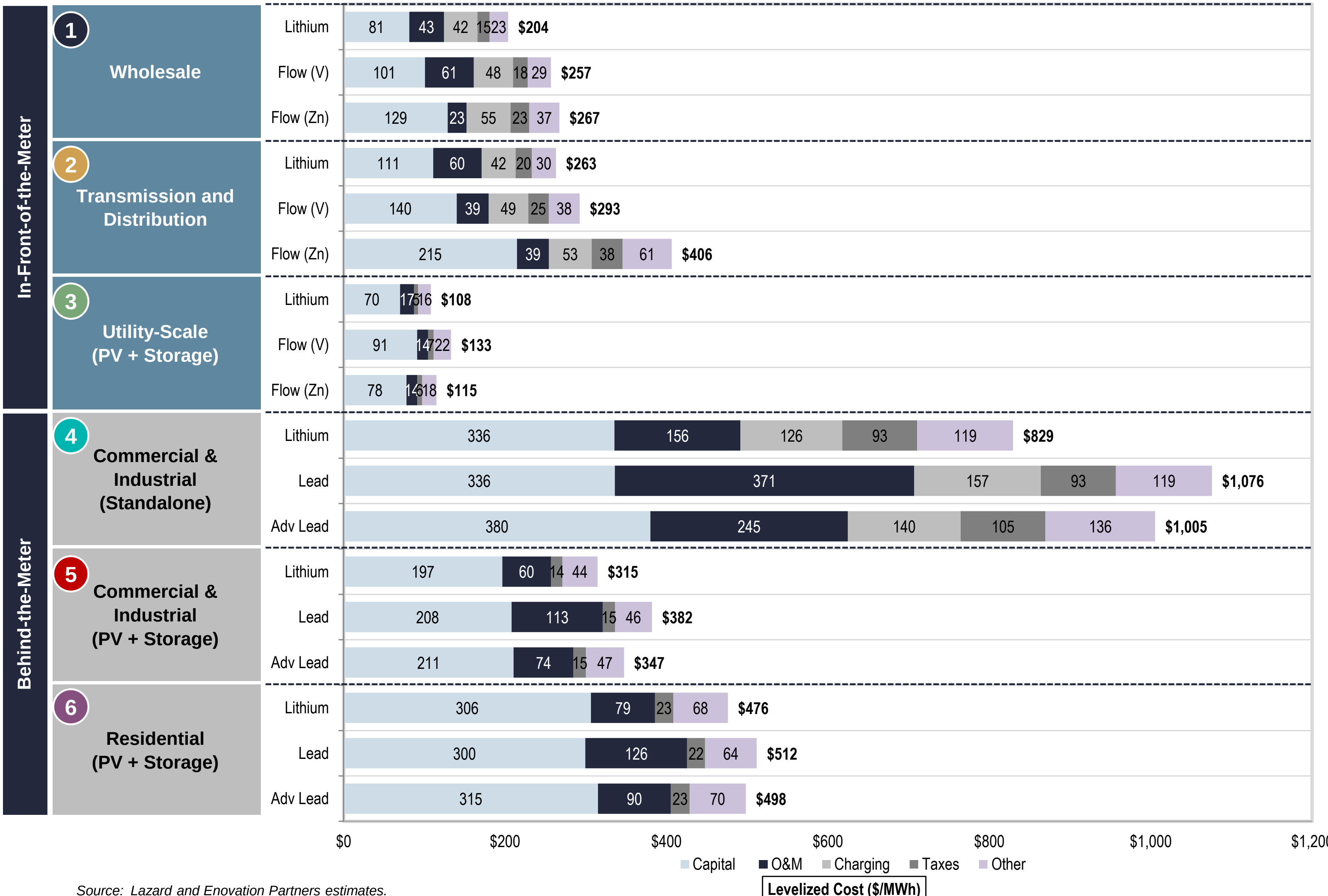
	1 Wholesale	2 Transmission and Distribution[1]	3 Utility-Scale (PV + Storage)	4 Commercial & Industrial (Standalone)	5 Commercial & Industrial (PV + Storage)	6 Residential (PV + Storage)
Region	U.K.	--	Australia	Ontario	Australia	Germany
Revenue Sources						
Energy Arbitrage	--	--	73.8%	--	--	--
Frequency Regulation	71.3%	--	5.2%	--	--	--
Spinning/Non-Spinning Reserves	16.9%	--	--	--	--	--
Resource Adequacy	11.8%	--	21.0%	--	--	--
Distribution Deferral	--	--	--	--	--	--
Demand Response–Wholesale	--	--	--	11.5%	--	--
Demand Response–Utility	--	--	--	--	--	--
Bill Management	--	--	--	88.5%	100.0%	85.2%
Local Incentive Payments	--	--	--	--	--	14.8%
Energy Storage Configuration						
Battery Size (MWh)	400	--	80	2	2	0.04
Inverter Size (MW)	100	--	20	1	0.5	0.01
C-Rating	C/4	--	C/4	C/2	C/4	C/4
IRR	4.4%	--	8.7%	20.1%	14.3%	2.5%

Source: Lazard and Enovation Partners estimates.
Note: Percentages represent allocation of battery's useful life dedicated to each revenue stream.
(1) Lazard's Value Snapshot analysis intentionally excluded a Transmission and Distribution use case from its international analysis.

Appendix

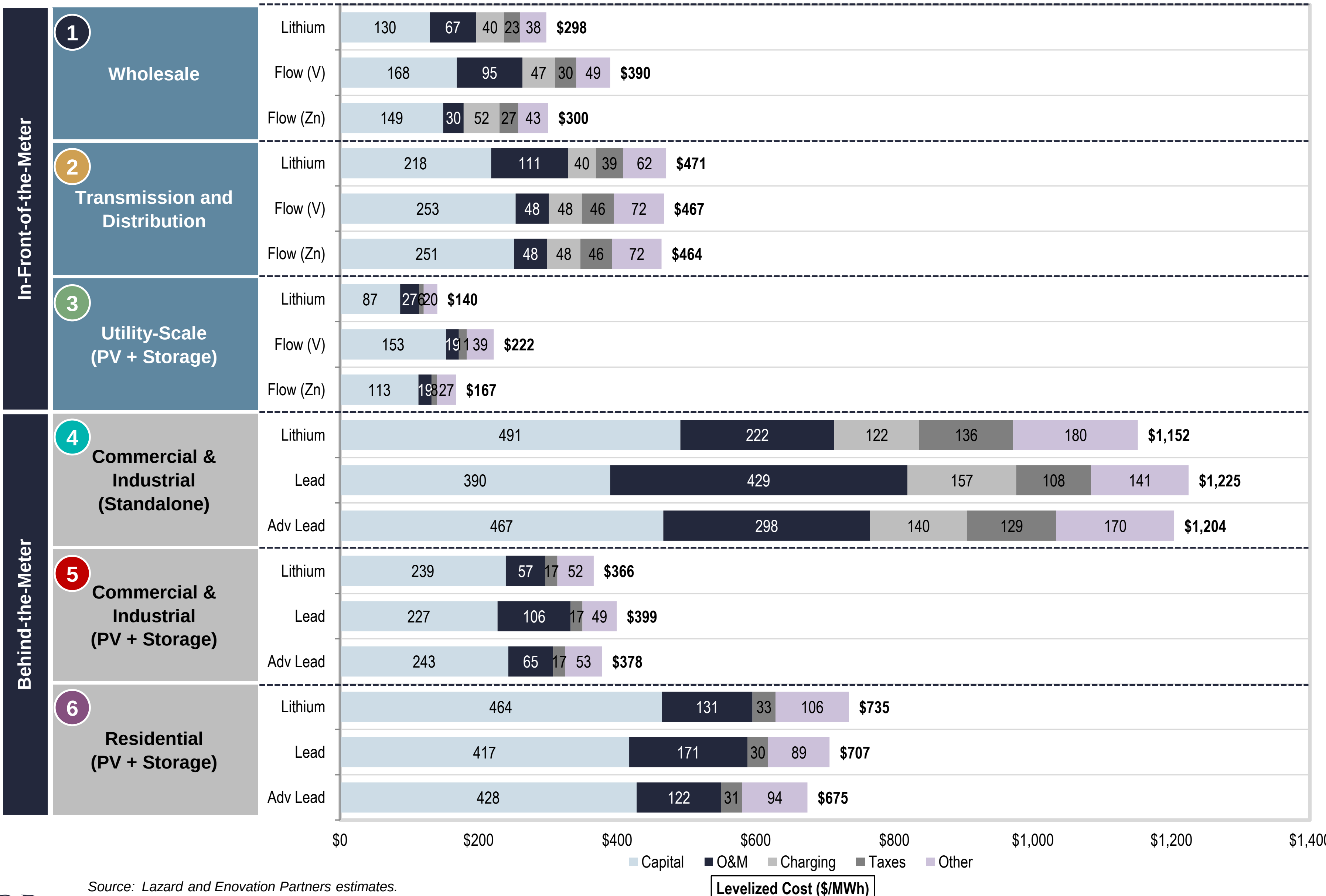
A Supplementary LCOS Analysis Materials

Levelized Cost of Storage Components—Low



Source: *Lazard and Enovation Partners estimates.*
Note: O&M costs include augmentation costs.

Levelized Cost of Storage Components—High



Source: *Lazard and Enovation Partners estimates.*
Note: O&M costs include augmentation costs.

Levelized Cost of Storage—Key Assumptions

		Wholesale			Transmission & Distribution			Utility-Scale (PV + Storage)		
	Units	Lithium	Flow Battery-Vanadium	Flow Battery-Zinc Bromide	Lithium	Flow Battery-Vanadium	Flow Battery-Zinc Bromide	Lithium	Flow Battery-Vanadium	Flow Battery-Zinc Bromide
Power Rating	MW	100 – 100	100 – 100	100 – 100	10 – 10	10 – 10	10 – 10	20 – 20	20 – 20	20 – 20
Duration	Hours	4 – 4	4 – 4	4 – 4	6 – 6	6 – 6	6 – 6	4 – 4	4 – 4	4 – 4
Usable Energy	MWh	400 – 400	400 – 400	400 – 400	60 – 60	60 – 60	60 – 60	80 – 80	80 – 80	80 – 80
100% Depth of Discharge Cycles/Day		1 – 1	1 – 1	1 – 1	1 – 1	1 – 1	1 – 1	1 – 1	1 – 1	1 – 1
Operating Days/Year		350 – 350	350 – 350	350 – 350	250 – 250	250 – 250	250 – 250	350 – 350	350 – 350	350 – 350
Solar PV Capacity	MW	0.00 – 0.00	0.00 – 0.00	0.00 – 0.00	0.00 – 0.00	0.00 – 0.00	0.00 – 0.00	40.00 – 40.00	40.00 – 40.00	40.00 – 40.00
Annual Solar PV Generation	MWh	0 – 0	0 – 0	0 – 0	0 – 0	0 – 0	0 – 0	119,136 – 80,592	119,136 – 80,592	119,136 – 80,592
Project Life	Years	20 – 20	20 – 20	20 – 20	20 – 20	20 – 20	20 – 20	20 – 20	20 – 20	20 – 20
Memo: Annual Used Energy	*MWh*	*140,000 – 140,000*	*140,000 – 140,000*	*140,000 – 140,000*	*15,000 – 15,000*	*15,000 – 15,000*	*15,000 – 15,000*	*28,000 – 28,000*	*28,000 – 28,000*	*28,000 – 28,000*
Memo: Project Used Energy	*MWh*	*2,800,000 – 2,800,000*	*2,800,000 – 2,800,000*	*2,800,000 – 2,800,000*	*300,000 – 300,000*	*300,000 – 300,000*	*300,000 – 300,000*	*560,000 – 560,000*	*560,000 – 560,000*	*560,000 – 560,000*
Initial Capital Cost—DC	$/kWh	$232 – $398	$314 – $550	$409 – $478	$190 – $442	$271 – $550	$456 – $544	$293 – $265	$550 – $819	$381 – $456
Initial Capital Cost—AC	$/kW	$49 – $61	$0 – $0	$0 – $0	$60 – $151	$0 – $0	$0 – $0	$79 – $33	$0 – $0	$0 – $0
EPC Costs	$	$16 – $16	$16 – $16	$16 – $16	$5 – $5	$5 – $5	$5 – $5	$5 – $5	$5 – $5	$5 – $5
Solar PV Capital Cost	$/kW	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$1,250 – $950	$1,250 – $950	$1,250 – $950
Total Initial Installed Cost	$	$114 – $181	$142 – $236	$180 – $207	$17 – $33	$21 – $38	$32 – $37	$80 – $65	$99 – $109	$86 – $80
O&M % of BESS	%	1.28% – 0.76%	1.01% – 0.58%	0.78% – 0.67%	2.29% – 0.98%	1.72% – 0.85%	1.02% – 0.86%	2.00% – 2.31%	1.16% – 0.78%	1.67% – 1.40%
O&M % of PCS	%	1.71% – 1.01%	1.35% – 0.77%	1.04% – 0.89%	3.05% – 1.31%	2.29% – 1.13%	1.36% – 1.14%	2.66% – 3.08%	1.54% – 1.04%	2.23% – 1.86%
Extended Warranty Start	Year	3 – 3	3 – 3	3 – 3	3 – 3	3 – 3	3 – 3	3 – 3	3 – 3	3 – 3
Warranty Expense % of BESS	%	1.50% – 1.50%	1.50% – 1.50%	1.50% – 1.50%	1.50% – 1.50%	1.50% – 1.50%	1.50% – 1.50%	1.50% – 1.50%	1.50% – 1.50%	1.50% – 1.50%
Warranty Expense % of PCS	%	2.00% – 2.00%	2.00% – 2.00%	2.00% – 2.00%	2.00% – 2.00%	2.00% – 2.00%	2.00% – 2.00%	2.00% – 2.00%	2.00% – 2.00%	2.00% – 2.00%
Investment Tax Credit	%	0.0% – 0.0%	0.0% – 0.0%	0.0% – 0.0%	0.0% – 0.0%	0.0% – 0.0%	0.0% – 0.0%	0.0% – 0.0%	0.0% – 0.0%	0.0% – 0.0%
Production Tax Credit	$/MWh	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0
Charging Cost	$/MWh	$33 – $33	$33 – $33	$33 – $33	$33 – $33	$33 – $33	$33 – $33	$0 – $0	$0 – $0	$0 – $0
Charging Cost Escalator	%	0.55% – 0.55%	0.55% – 0.55%	0.55% – 0.55%	0.55% – 0.55%	0.55% – 0.55%	0.55% – 0.55%	0.00% – 0.00%	0.00% – 0.00%	0.00% – 0.00%
Efficiency of Storage Technology	%	87% – 90%	74% – 77%	67% – 70%	86% – 90%	74% – 77%	69% – 76%	90% – 84%	72% – 72%	76% – 69%
Levelized Cost of Storage	$/MWh	$204 – $298	$257 – $390	$267 – $300	$263 – $471	$293 – $467	$406 – $464	$108 – $140	$133 – $222	$115 – $167

Source: *Lazard and Enovation Partners estimates.*

Note: Assumed capital structure of 80% equity (with a 12% cost of equity) and 20% debt (with an 8% cost of debt). Capital cost units are the total investment divided by the storage equipment's energy capacity (kWh rating) and inverter rating (kW rating). Wholesale and Transmission & Distribution charging costs use the EIA's "2017 Wholesale price $/MWh - Wtd Avg Low" price estimate of $33.48/MWh. Escalation is derived from the EIA's "AEO 2018 Energy Source–Electric Price Forecast (10-year CAGR)" and is 0.55%. Systems with PV do not charge from the grid.

Levelized Cost of Storage—Key Assumptions (cont'd)

		Commercial & Industrial (Standalone)			Commercial & Industrial (PV + Storage)			Residential (PV + Storage)		
	Units	Lithium	Lead	Advanced Lead	Lithium	Lead	Advanced Lead	Lithium	Lead	Advanced Lead
Power Rating	MW	1 – 1	1 – 1	1 – 1	0.5 – 0.5	0.5 – 0.5	0.5 – 0.5	0.01 – 0.01	0.01 – 0.01	0.01 – 0.01
Duration	Hours	2 – 2	2 – 2	2 – 2	4 – 4	4 – 4	4 – 4	4 – 4	4 – 4	4 – 4
Usable Energy	MWh	2 – 2	2 – 2	2 – 2	2 – 2	2 – 2	2 – 2	0.04 – 0.04	0.04 – 0.04	0.04 – 0.04
100% Depth of Discharge Cycles/Day		1 – 1	1 – 1	1 – 1	1 – 1	1 – 1	1 – 1	1 – 1	1 – 1	1 – 1
Operating Days/Year		250 – 250	250 – 250	250 – 250	350 – 350	350 – 350	350 – 350	350 – 350	350 – 350	350 – 350
Solar PV Capacity	MW	0.00 – 0.00	0.00 – 0.00	0.00 – 0.00	1.00 – 1.00	1.00 – 1.00	1.00 – 1.00	0.02 – 0.02	0.02 – 0.02	0.02 – 0.02
Annual Solar PV Generation	MWh	0 – 0	0 – 0	0 – 0	1,752 – 2,190	1,752 – 1,971	1,752 – 2,190	33 – 23	33 – 23	33 – 23
Project Life	Years	10 – 10	10 – 10	10 – 10	20 – 20	20 – 20	20 – 20	20 – 20	20 – 20	20 – 20
Memo: Annual Used Energy	*MWh*	*500 – 500*	*500 – 500*	*500 – 500*	*700 – 700*	*700 – 700*	*700 – 700*	*14 – 14*	*14 – 14*	*14 – 14*
Memo: Project Used Energy	*MWh*	*5,000 – 5,000*	*5,000 – 5,000*	*5,000 – 5,000*	*14,000 – 14,000*	*14,000 – 14,000*	*14,000 – 14,000*	*280 – 280*	*280 – 280*	*280 – 280*
Initial Capital Cost—DC	$/kWh	$335 – $580	$343 – $397	$422 – $537	$409 – $572	$384 – $417	$463 – $537	$639 – $780	$409 – $340	$616 – $522
Initial Capital Cost—AC	$/kW	$158 – $254	$158 – $254	$158 – $254	$191 – $292	$191 – $255	$191 – $292	$130 – $174	$205 – $182	$205 – $182
EPC Costs	$	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0
Solar PV Capital Cost	$/kW	$0 – $0	$0 – $0	$0 – $0	$1,900 – $3,270	$1,900 – $2,585	$1,900 – $3,270	$3,270 – $2,961	$3,270 – $2,961	$3,270 – $2,961
Total Initial Installed Cost	$	$1 – $2	$1 – $1	$1 – $2	$3 – $5	$3 – $4	$3 – $5	$0 – $0	$0 – $0	$0 – $0
O&M % of BESS	%	3.98% – 2.34%	3.91% – 3.09%	3.32% – 2.48%	3.70% – 2.61%	3.91% – 3.49%	3.32% – 2.76%	2.20% – 1.79%	3.14% – 3.74%	2.19% – 2.57%
O&M % of PCS	%	5.30% – 3.11%	5.21% – 4.12%	4.43% – 3.30%	4.94% – 3.49%	5.21% – 4.65%	4.43% – 3.68%	2.93% – 2.39%	4.19% – 4.99%	2.92% – 3.43%
Extended Warranty Start	Year	3 – 3	3 – 3	3 – 3	3 – 3	3 – 3	3 – 3	3 – 3	3 – 3	3 – 3
Warranty Expense % of BESS	%	1.50% – 1.50%	1.50% – 1.50%	1.50% – 1.50%	1.50% – 1.50%	1.50% – 1.50%	1.50% – 1.50%	1.50% – 1.50%	1.50% – 1.50%	1.50% – 1.50%
Warranty Expense % of PCS	%	2.00% – 2.00%	2.00% – 2.00%	2.00% – 2.00%	2.00% – 2.00%	2.00% – 2.00%	2.00% – 2.00%	2.00% – 2.00%	2.00% – 2.00%	2.00% – 2.00%
Investment Tax Credit	%	0.0% – 0.0%	0.0% – 0.0%	0.0% – 0.0%	0.0% – 0.0%	0.0% – 0.0%	0.0% – 0.0%	0.0% – 0.0%	0.0% – 0.0%	0.0% – 0.0%
Production Tax Credit	$/MWh	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0
Charging Cost	$/MWh	$107 – $107	$107 – $107	$107 – $107	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0	$0 – $0
Charging Cost Escalator	%	0.50% – 0.50%	0.50% – 0.50%	0.50% – 0.50%	0.00% – 0.00%	0.00% – 0.00%	0.00% – 0.00%	0.00% – 0.00%	0.00% – 0.00%	0.00% – 0.00%
Efficiency of Storage Technology	%	91% – 94%	72% – 72%	82% – 82%	90% – 91%	72% – 72%	82% – 82%	89% – 86%	72% – 72%	82% – 82%
Levelized Cost of Storage	$/MWh	$829 – $1,152	$1,076 – $1,225	$1,005 – $1,204	$315 – $366	$382 – $399	$347 – $378	$476 – $735	$512 – $707	$498 – $675

Source: *Lazard and Enovation Partners estimates.*
Note: Assumed capital structure of 80% equity (with a 12% cost of equity) and 20% debt (with an 8% cost of debt). Capital cost units are the total investment divided by the storage equipment's energy capacity (kWh rating) and inverter rating (kW rating). C&I charging costs use the EIA's "EIA Average Commercial Retail Price 2017" price estimate of $106.80/MWh. Escalation is derived from the EIA's "AEO 2018 Commercial Electric Price Forecast (10-year CAGR)" and is 0.50%. Systems with PV do not charge from the grid.

B Supplementary Value Snapshot Materials

Illustrative U.S. Value Snapshots—Assumptions

	Revenue Source	Description	Modeled Price	Annual Rev. ($/kW-year)	Cost Assumptions
1 Wholesale	Energy Arbitrage	• Energy prices based on 2017 CAISO SP-15 real-time • Annual escalation of 1.8%	Hourly LMP	$56.28	• AC system: $16/kWh • DC system: $283/kWh • EPC: 14% • Efficiency: 87% • Augmentation Costs: 4.2% of ESS
	Frequency Regulation	• Includes Reg-Up and Reg-Down products; participation based on hourly price and battery state of charge	Reg Up: $9.71/MWh Reg Down: $5.49/MWh	$80.76	
	Resource Adequacy	• Assumes participation in SCE Local Capacity Resource programs • Reliability ($/kW-month) payment amounts vary by contract and are not publicly available • Estimates assume a modified Net CONE methodology based on assumed technology costs and other available revenue sources	$11.87/kW-month	$142.50	
2 Transmission and Distribution	Frequency Regulation	• Includes combined regulation product; participation based on hourly price and battery state of charge	$5.19/MWh	$66.74	• AC system: $19/kWh • DC system: $284/kWh • EPC: 25% • Efficiency: 87% • Augmentation Costs: 4.1% of ESS
	Capacity	• NYC Zone J ICAP annual estimates	Summer: $8.5/kW-month Winter: $3.5/kW-month	$71.25	
	Brooklyn-Queens Demand Management (BQDM)	• Program based on deferred $1.2 billion substation upgrade, driven by contracts for demand reductions and distributed resource investments • Estimates based on program expense and capacity • 10 year contract modeled	$4,545.45/kW(1)	$431.82	
3 Utility-Scale (PV + Storage)	Energy Arbitrage	• Energy prices based on 2017 ERCOT (West) real-time • Annual escalation of 2.0%	Hourly LMP	PV: $75.89 Storage: $73.87	• AC system: $26/kWh • DC system: $296/kWh • EPC: 20% • Efficiency: 87% • Augmentation Costs: 4.3% of ESS
	Frequency Regulation	• Includes Reg-Up and Reg-Down products; participation based on hourly price and battery state of charge	Reg Up: $7.65/MWh Reg Down: $6.10/MWh	$29.92	
	Spinning Reserve	• ERCOT responsive reserve product; participation based on hourly price and battery state of charge	$9.58/MWh	$95.69	

Source: ISO/RTO markets, DOE, Lazard and Enovation Partners estimates.
Note: Capital cost units are the total investment divided by the storage equipment's energy capacity (kWh rating) and inverter rating (kW rating).
(1) Represents lifetime costs.

Illustrative U.S. Value Snapshots—Assumptions (cont'd)

	Revenue Source	Description	Modeled Price	Annual Rev. ($/kW-year)	Cost Assumptions
4 Commercial & Industrial (Standalone)	**Local Capacity Resources**	• IOUs acquire RA from bidders in a pay-as-bid contract auction • Focused on providing capacity to constrained zones • Discounted because of duration of battery	$75kW-year	$71.25	• AC system: $108/kWh • DC system: $437/kWh • EPC: 40% • Efficiency: 91% • Augmentation Costs: 5.0% of ESS
	Demand Bidding Program ("DBP")	• Year-round, event-based program; credited for 50% – 200% of event performance; no underperformance penalties	$0.5/kWh	$13.00	
	Bill Management	• Reduction of demand and energy charges through time shifting • Modeled PG&E E-19 TOU rate • Annual escalation of 2.5%	PG&E E-19 TOU Tariff	$219.32	
5 Commercial & Industrial (PV + Storage)	**Local Capacity Resources**	• IOUs acquire RA from bidders in a pay-as-bid contract auction • Focused on providing capacity to constrained zones	$150kW-year	$142.50	• AC system: $64/kWh • DC system: $510/kWh • EPC: 38% • Efficiency: 91% • Augmentation Costs: 4.9% of ESS
	Demand Bidding Program ("DBP")	• Year-round, event-based program; credited for 50% – 200% of event performance; no underperformance penalties	$0.5/kWh	$26.00	
	Bill Management	• Reduction of demand and energy charges through time shifting • Modeled PG&E E-19 TOU rate • Annual escalation of 2.5%	PG&E E-19 TOU Tariff	$363.40*	
6 Residential (PV + Storage)	**Self-Generation Incentive Program**	• Provides incentives to support DER projects via performance-based rebates for qualifying distributed energy systems • System under 30 kW receives entire incentive upfront	$0.35/Wh	$997.50	• AC system: $49/kWh • DC system: $743/kWh • EPC: 10% • Efficiency: 88% • Augmentation Costs: 4.9% of ESS
	Bill Management	• Reduction of energy charges through time shifting • Modeled SCE TOU-D (Option 4-9 PM) rate • Annual escalation of 2.5%	SCE TOU-D (Option 4-9 PM) Tariff	$355.65*	

Source: ISO/RTO markets, DOE, Lazard and Enovation Partners estimates.
Note: Capital cost units are the total investment divided by the storage equipment's energy capacity (kWh rating) and inverter rating (kW rating).
* Calculated based on size of the solar system.

Illustrative International Value Snapshots—Assumptions

		Revenue Source	Description	Modeled Price	Annual Rev. ($/kW-year)	Cost Assumptions
1	Wholesale (U.K.)	Frequency Regulation	• Four-year enhanced frequency reserve contract for fast response assets • Contract does not renew after expiration in year 4	$447.81/kW-year	$447.81	• AC system: $16/kWh • DC system: $283/kWh • EPC: 14% • Efficiency: 87% • Augmentation Costs: 4.2% of ESS
		Spinning Reserve	• Short-term operating reserve payment • Value stream isn't captured until year 5, after expiration of enhanced frequency reserve contract • Annual escalation of 2.0%	$61.67/kW-year (starting in year 5)	$61.67	
		Capacity	• Participation in U.K. capacity market auction • Annual escalation of 3.0%	$19.74/kW-year	$19.74	
2	Transmission and Distribution(1)	--	--	--	--	--
3	Utility-Scale (PV + Storage) (Australia)	Energy Arbitrage	• Energy prices based on 2017/2018 Queensland region • Assume discharge of battery in top 4 hours of each day • Annual escalation of 3.0%	Hourly LMP	$164.62*	• AC system: $26/kWh • DC system: $296/kWh • EPC: 20% • Efficiency: 87% • Augmentation Costs: 4.3% of ESS
		Ancillary Services	• Participation in Queensland ancillaries (Lower & Raise, 6sec, 5min, Reg, Restart, Reactive)	$10.56/MW	$22.78	
		Capacity	• Benchmark Reserve Capacity Price from AEMO	$91.42/kW-year	$91.42	
4	Commercial & Industrial (Standalone) (Ontario)	Demand Response	• DR-3 program from Ontario Power Authority	$56/kW-year	$56.45	• AC system: $108/kWh • DC system: $437/kWh • EPC: 40% • Efficiency: 91% • Augmentation Costs: 5.0% of ESS
		Bill Management	• Ontario/IESO "Class A" Global Adjustment charge • Annual escalation of 3.0%	$433kW-year	$433.03	
5	Commercial & Industrial (PV + Storage) (Australia)	Bill Management	• Ausnet utility in Victoria, AU • Reduction of demand and energy charges through time shifting • Modeled NSP56 rate	Ausnet NSP56 Tariff	$621.56*	• AC system: $64/kWh • DC system: $510/kWh • EPC: 38% • Efficiency: 91% • Augmentation Costs: 4.9% of ESS
6	Residential (PV + Storage) (Germany)	Local Incentive Program	• German Development Bank, KfW Incentive program	13% of Capex	$1,261.80	• AC system: $49/kWh • DC system: $743/kWh • EPC: 10% • Efficiency: 88% • Augmentation Costs: 4.9% of ESS
		Bill Management	• Reduction of energy charges through time shifting • Survey respondent estimated German residential rate • Annual escalation of 3.0%	Retail Electric Rate: $0.36 kWh	$377.31*	

Source: *Lazard and Enovation Partners estimates.*
Note: Capital cost units are the total investment divided by the storage equipment's energy capacity (kWh rating) and inverter rating (kW rating). All figures presented in USD using the following exchange rates: AUD/USD 1.38, CAD/USD 1.29, EUR/USD 0.85, GBP/USD 0.76.
* Calculated based on size of the solar system.
(1) Lazard's Value Snapshot analysis intentionally excluded a Transmission and Distribution use case from its international analysis.

1

Illustrative Value Snapshot—Wholesale (CAISO)

($ in thousands, unless otherwise noted)

California	2018	2019	2020	2021	2022	2023	2028*	2033*	2038*
Total Revenue	**$ -**	**$ 30,084.1**	**$ 30,966.4**	**$ 32,423.6**	**$ 32,774.7**	**$ 32,850.5**	**$ 34,536.1**	**$ 36,078.6**	**$ 37,510.2**
Energy Arbitrage	-	5,628.2	5,908.4	6,345.5	6,507.5	6,604.3	7,195.1	7,763.9	8,258.5
Frequency Regulation	-	8,076.2	8,553.9	9,359.1	9,509.8	9,493.2	10,357.8	11,129.4	11,869.8
Spinning/Non-Spinning Reserves	-	2,129.7	2,254.2	2,469.0	2,507.4	2,503.0	2,733.2	2,935.4	3,132.0
Resource Adequacy	-	14,250.0	14,250.0	14,250.0	14,250.0	14,250.0	14,250.0	14,250.0	14,250.0
Distribution Deferral	-	-	-	-	-	-	-	-	-
Demand Response–Wholesale	-	-	-	-	-	-	-	-	-
Demand Response–Utility	-	-	-	-	-	-	-	-	-
Bill Management	-	-	-	-	-	-	-	-	-
Local Incentive Payments	-	-	-	-	-	-	-	-	-
Total Operating Costs	**$ -**	**$ (8,553.5)**	**$ (8,678.3)**	**$ (10,633.0)**	**$ (10,767.1)**	**$ (10,906.2)**	**$ (11,336.2)**	**$ (11,787.6)**	**$ (12,219.0)**
Storage O&M	-	(1,312.2)	(1,345.0)	(1,378.7)	(1,413.1)	(1,448.5)	(1,638.8)	(1,854.1)	(2,097.8)
Storage Warranty	-	-	-	(1,825.3)	(1,825.3)	(1,825.3)	(1,825.3)	(1,825.3)	(1,825.3)
Storage Augmentation Costs	-	(4,984.6)	(4,984.6)	(4,984.6)	(4,984.6)	(4,984.6)	(4,984.6)	(4,984.6)	(4,984.6)
Solar O&M	-	-	-	-	-	-	-	-	-
Storage Charging	-	(2,256.7)	(2,348.7)	(2,444.5)	(2,544.2)	(2,647.9)	(2,887.5)	(3,123.6)	(3,311.4)
EBITDA	**$ -**	**$ 21,530.6**	**$ 22,288.1**	**$ 21,790.6**	**$ 22,007.6**	**$ 21,944.3**	**$ 23,199.9**	**$ 24,291.0**	**$ 25,291.2**
Less: MACRS D&A	-	(137,275.1)	-	-	-	-	-	-	-
EBIT	**$ -**	**$ (115,744.5)**	**$ 22,288.1**	**$ 21,790.6**	**$ 22,007.6**	**$ 21,944.3**	**$ 23,199.9**	**$ 24,291.0**	**$ 25,291.2**
Less: Interest Expense	-	(2,196.4)	(2,148.4)	(2,096.6)	(2,040.6)	(1,980.1)	(1,597.0)	(1,034.2)	(207.1)
Less: Cash Taxes	-	-	-	-	-	-	(6,045.3)	(6,508.1)	(7,019.4)
Tax Net Income	**$ -**	**$ (117,940.9)**	**$ 20,139.7**	**$ 19,694.0**	**$ 19,967.0**	**$ 19,964.2**	**$ 15,557.6**	**$ 16,748.7**	**$ 18,064.6**
MACRS D&A	-	137,275.1	-	-	-	-	-	-	-
EPC	(17,748.5)	-	-	-	-	-	-	-	-
Storage Module Capital	(96,693.3)	-	-	-	-	-	-	-	-
Inverter / AC System Capital	(6,479.5)	-	-	-	-	-	-	-	-
Balance of System Capital	(16,353.8)	-	-	-	-	-	-	-	-
Solar Capital	-	-	-	-	-	-	-	-	-
ITC	-	-	-	-	-	-	-	-	-
Debt	27,455.0	-	-	-	-	-	-	-	-
Principal	-	(600.0)	(647.9)	(699.8)	(755.8)	(816.2)	(1,199.3)	(1,762.2)	(2,589.2)
After-Tax Levered Cash Flow	**$ (109,820.1)**	**$ 18,734.2**	**$ 19,491.7**	**$ 18,994.3**	**$ 19,211.2**	**$ 19,148.0**	**$ 14,358.3**	**$ 14,986.5**	**$ 15,475.4**
Levered Project IRR	16.7%								
Levered Project NPV	34,326,697								

Model Assumptions							
Storage Size (MW)	100.000	Storage Extended Warranty (%)	1.5%	Debt	20%	Combined Tax Rate	28%
Storage Capacity (MWh)	400.000	Storage EPC Cost (%)	15.7%	Cost of Debt	8%	Charging Cost Escalation	1%
Solar Sizing (MW)	0.000	Storage O&M Cost (%)	1.1%	Equity	80%	O&M Escalation	2.5%
Full DOD Cycles Per Year	244	Storage Efficiency (% RT)	87.4%	Cost of Equity	12%	Regional EPC Scalar	1.09
Depth of Discharge (%)	100%	Solar Fixed O&M ($/kW-yr.)	$0.00	WACC	11%	Useful Life (years)	20

Source: *Lazard and Enovation Partners estimates.*

Note: *Extended warranty costs represent coverage provided beyond the initial two-year product warranty (included in equipment capital costs); charging costs are based on real-time SP-15 price forecasts; 100% of 7 year MACRS taken in the first year; regional EPC scalars are adjustment factors for the national averages, determined by Bloomberg estimates and Labor Department statistics.*

2

Illustrative Value Snapshot—Transmission and Distribution (NYISO)

($ in thousands, unless otherwise noted)

New York	2018	2019	2020	2021	2022	2023	2028*	2033*	2038*
Total Revenue	**$ -**	**$ 6,369.6**	**$ 6,438.7**	**$ 6,644.9**	**$ 6,729.7**	**$ 6,760.0**	**$ 7,098.5**	**$ 2,844.4**	**$ 3,037.2**
Energy Arbitrage	-	75.2	81.1	81.9	85.9	93.0	98.3	107.4	116.9
Frequency Regulation	-	667.4	684.5	779.2	831.9	824.0	858.0	933.7	1,035.6
Spinning/Non-Spinning Reserves	-	596.3	613.9	696.2	743.3	736.3	769.5	834.3	925.3
Resource Adequacy	-	712.5	741.0	769.5	750.5	788.5	1,054.5	969.0	959.5
Distribution Deferral	-	4,318.2	4,318.2	4,318.2	4,318.2	4,318.2	4,318.2	-	-
Demand Response–Wholesale	-	-	-	-	-	-	-	-	-
Demand Response–Utility	-	-	-	-	-	-	-	-	-
Bill Management	-	-	-	-	-	-	-	-	-
Local Incentive Payments	-	-	-	-	-	-	-	-	-
Total Operating Costs	**$ -**	**$ (1,147.1)**	**$ (1,160.1)**	**$ (1,452.3)**	**$ (1,466.3)**	**$ (1,480.8)**	**$ (1,528.5)**	**$ (1,589.6)**	**$ (1,657.5)**
Storage O&M	-	(289.0)	(296.2)	(303.6)	(311.2)	(318.9)	(360.9)	(408.3)	(461.9)
Storage Warranty	-	-	-	(278.7)	(278.7)	(278.7)	(278.7)	(278.7)	(278.7)
Storage Augmentation Costs	-	(751.9)	(751.9)	(751.9)	(751.9)	(751.9)	(751.9)	(751.9)	(751.9)
Solar O&M	-	-	-	-	-	-	-	-	-
Storage Charging	-	(106.2)	(112.0)	(118.1)	(124.5)	(131.3)	(137.1)	(150.7)	(165.0)
EBITDA	**$ -**	**$ 5,222.5**	**$ 5,278.7**	**$ 5,192.7**	**$ 5,263.5**	**$ 5,279.2**	**$ 5,570.0**	**$ 1,254.8**	**$ 1,379.7**
Less: MACRS D&A	-	(23,966.1)	-	-	-	-	-	-	-
EBIT	**$ -**	**$ (18,743.6)**	**$ 5,278.7**	**$ 5,192.7**	**$ 5,263.5**	**$ 5,279.2**	**$ 5,570.0**	**$ 1,254.8**	**$ 1,379.7**
Less: Interest Expense	-	(383.5)	(375.1)	(366.0)	(356.3)	(345.7)	(278.8)	(180.6)	(36.2)
Less: Cash Taxes	-	-	-	-	-	(116.0)	(1,382.8)	(280.7)	(351.1)
Tax Net Income	**$ -**	**$ (19,127.1)**	**$ 4,903.6**	**$ 4,826.7**	**$ 4,907.2**	**$ 4,817.5**	**$ 3,908.3**	**$ 793.5**	**$ 992.4**
MACRS D&A	-	23,966.1	-	-	-	-	-	-	-
EPC	(5,768.6)	-	-	-	-	-	-	-	-
Storage Module Capital	(14,685.1)	-	-	-	-	-	-	-	-
Inverter / AC System Capital	(1,144.3)	-	-	-	-	-	-	-	-
Balance of System Capital	(2,368.0)	-	-	-	-	-	-	-	-
Solar Capital	-	-	-	-	-	-	-	-	-
ITC	-	-	-	-	-	-	-	-	-
Debt	4,793.2	-	-	-	-	-	-	-	-
Principal	-	(104.7)	(113.1)	(122.2)	(131.9)	(142.5)	(209.4)	(307.6)	(452.0)
After-Tax Levered Cash Flow	**$ (19,172.9)**	**$ 4,734.3**	**$ 4,790.5**	**$ 4,704.5**	**$ 4,775.3**	**$ 4,675.0**	**$ 3,698.9**	**$ 485.8**	**$ 540.4**
Levered Project IRR	22.8%								
Levered Project NPV	8,679,758								

Model Assumptions							
Storage Size (MW)	10.000	Storage Extended Warranty (%)	1.5%	Debt	20%	Combined Tax Rate	26%
Storage Capacity (MWh)	60.000	Storage EPC Cost (%)	33.8%	Cost of Debt	8%	Charging Cost Escalation	1%
Solar Sizing (MW)	0.000	Storage O&M Cost (%)	1.5%	Equity	80%	O&M Escalation	2.5%
Full DOD Cycles Per Year	78	Storage Efficiency (% RT)	87.5%	Cost of Equity	12%	Regional EPC Scalar	1.25
Depth of Discharge (%)	100%	Solar Fixed O&M ($/kW-yr.)	$0.00	WACC	11%	Useful Life (years)	20

Source: *Lazard and Enovation Partners estimates.*
Note: *Extended warranty costs represent coverage provided beyond the initial two-year product warranty (included in equipment capital costs); charging costs are based on real-time NYISO Zone J price forecasts; 100% of 7 year MACRS taken in the first year; regional EPC scalars are adjustment factors for the national averages, determined by Bloomberg estimates and Labor Department statistics.*

3

Illustrative Value Snapshot—Utility-Scale (PV + Storage) (ERCOT)

($ in thousands, unless otherwise noted)

Texas	2018	2019	2020	2021	2022	2023	2028*	2033*	2038*
Total Revenue	**$ -**	**$ 6,878.7**	**$ 7,016.5**	**$ 7,157.0**	**$ 7,300.2**	**$ 7,446.2**	**$ 8,221.2**	**$ 9,076.9**	**$ 10,021.6**
Energy Arbitrage	-	4,513.1	4,603.4	4,695.4	4,789.3	4,885.1	5,393.6	5,955.0	6,574.8
Frequency Regulation	-	598.5	610.2	622.1	634.5	647.2	714.6	789.0	871.1
Spinning/Non-Spinning Reserves	-	1,767.1	1,802.9	1,839.5	1,876.3	1,913.9	2,113.0	2,332.9	2,575.7
Resource Adequacy	-	-	-	-	-	-	-	-	-
Distribution Deferral	-	-	-	-	-	-	-	-	-
Demand Response–Wholesale	-	-	-	-	-	-	-	-	-
Demand Response–Utility	-	-	-	-	-	-	-	-	-
Bill Management	-	-	-	-	-	-	-	-	-
Local Incentive Payments	-	-	-	-	-	-	-	-	-
Total Operating Costs	**$ -**	**$ (1,956.6)**	**$ (1,980.1)**	**$ (2,365.5)**	**$ (2,390.3)**	**$ (2,415.6)**	**$ (2,552.3)**	**$ (2,707.0)**	**$ (2,882.0)**
Storage O&M	-	(522.4)	(535.5)	(548.9)	(562.6)	(576.7)	(652.5)	(738.2)	(835.2)
Storage Warranty	-	-	-	(361.2)	(361.2)	(361.2)	(361.2)	(361.2)	(361.2)
Storage Augmentation Costs	-	(1,014.1)	(1,014.1)	(1,014.1)	(1,014.1)	(1,014.1)	(1,014.1)	(1,014.1)	(1,014.1)
Solar O&M	-	(420.0)	(430.5)	(441.3)	(452.3)	(463.6)	(524.5)	(593.4)	(671.4)
Storage Charging	-	-	-	-	-	-	-	-	-
EBITDA	**$ -**	**$ 4,922.1**	**$ 5,036.4**	**$ 4,791.5**	**$ 4,909.9**	**$ 5,030.6**	**$ 5,668.9**	**$ 6,369.9**	**$ 7,139.6**
Less: MACRS D&A	-	(50,472.7)	-	-	-	-	-	-	-
EBIT	**$ -**	**$ (45,550.6)**	**$ 5,036.4**	**$ 4,791.5**	**$ 4,909.9**	**$ 5,030.6**	**$ 5,668.9**	**$ 6,369.9**	**$ 7,139.6**
Less: Interest Expense	-	(1,153.7)	(1,128.5)	(1,101.2)	(1,071.8)	(1,040.1)	(838.9)	(543.2)	(108.8)
Less: Cash Taxes	-	-	-	-	-	-	-	(1,223.6)	(1,476.5)
Tax Net Income	**$ -**	**$ (46,704.3)**	**$ 3,907.9**	**$ 3,690.3**	**$ 3,838.1**	**$ 3,990.5**	**$ 4,830.0**	**$ 4,603.1**	**$ 5,554.3**
MACRS D&A	-	50,472.7	-	-	-	-	-	-	-
EPC	(4,443.6)	-	-	-	-	-	-	-	-
Storage Module Capital	(20,266.0)	-	-	-	-	-	-	-	-
Inverter / AC System Capital	(1,265.1)	-	-	-	-	-	-	-	-
Balance of System Capital	(2,129.2)	-	-	-	-	-	-	-	-
Solar Capital	(44,000.0)	-	-	-	-	-	-	-	-
ITC	21,631.2	-	-	-	-	-	-	-	-
Debt	14,420.8	-	-	-	-	-	-	-	-
Principal	-	(315.1)	(340.3)	(367.6)	(397.0)	(428.7)	(629.9)	(925.6)	(1,360.0)
After-Tax Levered Cash Flow	**$ (36,052.0)**	**$ 3,453.3**	**$ 3,567.6**	**$ 3,322.8**	**$ 3,441.1**	**$ 3,561.8**	**$ 4,200.1**	**$ 3,677.5**	**$ 4,194.3**
Levered Project IRR	8.8%								
Levered Project NPV	(5,240,060)								

Model Assumptions							
Storage Size (MW)	20.000	Storage Extended Warranty (%)	1.5%	Debt	20%	Combined Tax Rate	21%
Storage Capacity (MWh)	80.000	Storage EPC Cost (%)	19.8%	Cost of Debt	8%	Charging Cost Escalation	0%
Solar Sizing (MW)	40.000	Storage O&M Cost (%)	2.2%	Equity	80%	O&M Escalation	2.5%
Full DOD Cycles Per Year	43	Storage Efficiency (% RT)	87.2%	Cost of Equity	12%	Regional EPC Scalar	0.95
Depth of Discharge (%)	100%	Solar Fixed O&M ($/kW-yr.)	$10.50	WACC	11%	Useful Life (years)	20

Source: Lazard and Enovation Partners estimates.

Note: Incentives include ITC (30% of capital); extended warranty costs represent coverage provided beyond the initial two-year product warranty (included in equipment capital costs); charging costs are zero with all energy self-generated by the PV portion of the system; 100% of 5 year MACRS taken in the first year; regional EPC scalars are adjustment factors for the national averages, determined by Bloomberg estimates and Labor Department statistics.

4

Illustrative Value Snapshot—Commercial & Industrial (Standalone) (CAISO)

($ in thousands, unless otherwise noted)

California	2018	2019	2020	2021	2022	2023	2028*	2033*	2038*
Total Revenue	**$ -**	**$ 353.5**	**$ 361.9**	**$ 372.7**	**$ 379.4**	**$ 385.1**	**$ 422.1**	**$ -**	**$ -**
Energy Arbitrage	-	11.6	12.4	14.1	14.2	14.0	15.0	15.8	16.1
Frequency Regulation	-	-	-	-	-	-	-	-	-
Spinning/Non-Spinning Reserves	-	38.3	41.9	48.1	48.4	47.4	50.5	51.2	52.3
Resource Adequacy	-	71.2	71.2	71.2	71.2	71.2	71.2	71.2	71.2
Distribution Deferral	-	-	-	-	-	-	-	-	-
Demand Response–Wholesale	-	-	-	-	-	-	-	-	-
Demand Response–Utility	-	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Bill Management	-	219.3	223.3	226.3	232.6	239.5	272.3	311.7	355.7
Local Incentive Payments	-	-	-	-	-	-	-	-	-
Total Operating Costs	**$ -**	**$ (90.5)**	**$ (91.4)**	**$ (109.8)**	**$ (110.7)**	**$ (111.7)**	**$ (116.9)**	**$ -**	**$ -**
Storage O&M	-	(35.9)	(36.8)	(37.8)	(38.7)	(39.7)	(44.9)	-	-
Storage Warranty	-	-	-	(17.4)	(17.4)	(17.4)	(17.4)	-	-
Storage Augmentation Costs	-	(54.5)	(54.5)	(54.5)	(54.5)	(54.5)	(54.5)	-	-
Solar O&M	-	-	-	-	-	-	-	-	-
Storage Charging	-	-	-	-	-	-	-	-	-
EBITDA	**$ -**	**$ 263.0**	**$ 270.5**	**$ 263.0**	**$ 268.7**	**$ 273.4**	**$ 305.2**	**$ -**	**$ -**
Less: MACRS D&A	-	(1,565.1)	-	-	-	-	-	-	-
EBIT	**$ -**	**$ (1,302.1)**	**$ 270.5**	**$ 263.0**	**$ 268.7**	**$ 273.4**	**$ 305.2**	**$ -**	**$ -**
Less: Interest Expense	-	(25.0)	(23.3)	(21.4)	(19.4)	(17.3)	(3.5)	-	-
Less: Cash Taxes	-	-	-	-	-	-	(84.4)	-	-
Tax Net Income	**$ -**	**$ (1,327.2)**	**$ 247.2**	**$ 241.5**	**$ 249.2**	**$ 256.2**	**$ 217.3**	**$ -**	**$ -**
MACRS D&A	-	1,565.1	-	-	-	-	-	-	-
EPC	(474.2)	-	-	-	-	-	-	-	-
Storage Module Capital	(662.7)	-	-	-	-	-	-	-	-
Inverter / AC System Capital	(216.7)	-	-	-	-	-	-	-	-
Balance of System Capital	(211.6)	-	-	-	-	-	-	-	-
Solar Capital	-	-	-	-	-	-	-	-	-
ITC	-	-	-	-	-	-	-	-	-
Debt	313.0	-	-	-	-	-	-	-	-
Principal	-	(21.6)	(23.3)	(25.2)	(27.2)	(29.4)	(43.2)	-	-
After-Tax Levered Cash Flow	**$ (1,252.1)**	**$ 216.4**	**$ 223.8**	**$ 216.3**	**$ 222.0**	**$ 226.8**	**$ 174.1**	**$ -**	**$ -**
Levered Project IRR	11.9%								
Levered Project NPV	32,373								

Model Assumptions							
Storage Size (MW)	1.000	Storage Extended Warranty (%)	1.6%	Debt	20%	Combined Tax Rate	28%
Storage Capacity (MWh)	2.000	Storage EPC Cost (%)	54.2%	Cost of Debt	8%	Charging Cost Escalation	1%
Solar Sizing (MW)	0.000	Storage O&M Cost (%)	3.2%	Equity	80%	O&M Escalation	2.5%
Full DOD Cycles Per Year	440	Storage Efficiency (% RT)	91.1%	Cost of Equity	12%	Regional EPC Scalar	1.09
Depth of Discharge (%)	100%	Solar Fixed O&M ($/kW-yr.)	$0.00	WACC	11%	Useful Life (years)	10

Source: Lazard and Enovation Partners estimates.

Note: No incentive due to project receiving local resource adequacy payments; extended warranty costs represent coverage provided beyond the initial two-year product warranty (included in equipment capital costs); charging cost is embedded in the bill savings; 100% of 5 year MACRS taken in the first year; regional EPC scalars are adjustment factors for the national averages, determined by Bloomberg estimates and Labor Department statistics.

5 Illustrative Value Snapshot—Commercial & Industrial (PV + Storage) (CAISO)

($ in thousands, unless otherwise noted)

California	2018	2019	2020	2021	2022	2023	2028*	2033*	2038*
Total Revenue	**$ -**	**$ 477.4**	**$ 488.3**	**$ 500.7**	**$ 510.8**	**$ 520.4**	**$ 576.3**	**$ 638.7**	**$ 709.0**
Energy Arbitrage	-	7.5	8.1	8.9	9.1	9.0	9.8	10.3	11.0
Frequency Regulation	-	-	-	-	-	-	-	-	-
Spinning/Non-Spinning Reserves	-	22.2	23.9	27.1	27.5	27.1	28.8	30.1	31.3
Resource Adequacy	-	71.2	71.2	71.2	71.2	71.2	71.2	71.2	71.2
Distribution Deferral	-	-	-	-	-	-	-	-	-
Demand Response–Wholesale	-	-	-	-	-	-	-	-	-
Demand Response–Utility	-	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Bill Management	-	363.4	372.0	380.3	389.9	400.1	453.4	514.0	582.4
Local Incentive Payments	-	-	-	-	-	-	-	-	-
Total Operating Costs	**$ -**	**$ (109.5)**	**$ (110.8)**	**$ (130.1)**	**$ (131.5)**	**$ (132.9)**	**$ (140.6)**	**$ (149.4)**	**$ (159.3)**
Storage O&M	-	(35.9)	(36.8)	(37.7)	(38.7)	(39.7)	(44.9)	(50.8)	(57.4)
Storage Warranty	-	-	-	(17.9)	(17.9)	(17.9)	(17.9)	(17.9)	(17.9)
Storage Augmentation Costs	-	(56.1)	(56.1)	(56.1)	(56.1)	(56.1)	(56.1)	(56.1)	(56.1)
Solar O&M	-	(17.5)	(17.9)	(18.4)	(18.8)	(19.3)	(21.9)	(24.7)	(28.0)
Storage Charging	-	-	-	-	-	-	-	-	-
EBITDA	**$ -**	**$ 367.9**	**$ 377.5**	**$ 370.6**	**$ 379.3**	**$ 387.5**	**$ 435.6**	**$ 489.3**	**$ 549.6**
Less: MACRS D&A	-	(2,945.2)	-	-	-	-	-	-	-
EBIT	**$ -**	**$ (2,577.3)**	**$ 377.5**	**$ 370.6**	**$ 379.3**	**$ 387.5**	**$ 435.6**	**$ 489.3**	**$ 549.6**
Less: Interest Expense	-	(67.3)	(65.8)	(64.3)	(62.5)	(60.7)	(48.9)	(31.7)	(6.3)
Less: Cash Taxes	-	-	-	-	-	-	(108.2)	(128.1)	(152.0)
Tax Net Income	**$ -**	**$ (2,644.7)**	**$ 311.6**	**$ 306.4**	**$ 316.8**	**$ 326.9**	**$ 278.5**	**$ 329.5**	**$ 391.2**
MACRS D&A	-	2,945.2	-	-	-	-	-	-	-
EPC	(474.2)	-	-	-	-	-	-	-	-
Storage Module Capital	(742.9)	-	-	-	-	-	-	-	-
Inverter / AC System Capital	(127.6)	-	-	-	-	-	-	-	-
Balance of System Capital	(277.8)	-	-	-	-	-	-	-	-
Solar Capital	(2,585.0)	-	-	-	-	-	-	-	-
ITC	1,262.2	-	-	-	-	-	-	-	-
Debt	841.5	-	-	-	-	-	-	-	-
Principal	-	(18.4)	(19.9)	(21.4)	(23.2)	(25.0)	(36.8)	(54.0)	(79.4)
After-Tax Levered Cash Flow	**$ (2,103.7)**	**$ 282.2**	**$ 291.7**	**$ 284.9**	**$ 293.6**	**$ 301.8**	**$ 241.7**	**$ 275.5**	**$ 311.9**
Levered Project IRR	13.6%								
Levered Project NPV	312,222								

Model Assumptions							
Storage Size (MW)	0.500	Storage Extended Warranty (%)	1.6%	Debt	20%	Combined Tax Rate	28%
Storage Capacity (MWh)	2.000	Storage EPC Cost (%)	46.5%	Cost of Debt	8%	Charging Cost Escalation	0%
Solar Sizing (MW)	1.000	Storage O&M Cost (%)	3.1%	Equity	80%	O&M Escalation	2.5%
Full DOD Cycles Per Year	78	Storage Efficiency (% RT)	90.5%	Cost of Equity	12%	Regional EPC Scalar	1.09
Depth of Discharge (%)	100%	Solar Fixed O&M ($/kW-yr.)	$17.50	WACC	11%	Useful Life (years)	20

Source: *Lazard and Enovation Partners estimates.*

Note: *No incentive due to project receiving local resource adequacy payments; extended warranty costs represent coverage provided beyond the initial two-year product warranty (included in equipment capital costs); charging costs are zero with all energy self-generated by the PV portion of the system; 100% of 5 year MACRS taken in the first year; regional EPC scalars are adjustment factors for the national averages, determined by Bloomberg estimates and Labor Department statistics.*

6

Illustrative Value Snapshot—Residential (PV + Storage) (CAISO)

($ in thousands, unless otherwise noted)

California	2018	2019	2020	2021	2022	2023	2028*	2033*	2038*
Total Revenue	**10.0**	**$ 7.1**	**$ 7.3**	**$ 7.5**	**$ 7.7**	**$ 7.9**	**$ 8.9**	**$ 10.0**	**$ 11.4**
Energy Arbitrage	-	-	-	-	-	-	-	-	-
Frequency Regulation	-	-	-	-	-	-	-	-	-
Spinning/Non-Spinning Reserves	-	-	-	-	-	-	-	-	-
Resource Adequacy	-	-	-	-	-	-	-	-	-
Distribution Deferral	-	-	-	-	-	-	-	-	-
Demand Response–Wholesale	-	-	-	-	-	-	-	-	-
Demand Response–Utility	-	-	-	-	-	-	-	-	-
Bill Management	-	7.1	7.3	7.5	7.7	7.9	8.9	10.0	11.4
Local Incentive Payments	10.0	-	-	-	-	-	-	-	-
Total Operating Costs	**$ -**	**$ (2.6)**	**$ (2.6)**	**$ (3.1)**	**$ (3.1)**	**$ (3.2)**	**$ (3.3)**	**$ (3.5)**	**$ (3.7)**
Storage O&M	-	(0.6)	(0.6)	(0.7)	(0.7)	(0.7)	(0.8)	(0.9)	(1.0)
Storage Warranty	-	-	-	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)
Storage Augmentation Costs	-	(1.6)	(1.6)	(1.6)	(1.6)	(1.6)	(1.6)	(1.6)	(1.6)
Solar O&M	-	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(0.5)	(0.6)	(0.6)
Storage Charging	-	-	-	-	-	-	-	-	-
EBITDA	**$ 10.0**	**$ 4.5**	**$ 4.7**	**$ 4.4**	**$ 4.5**	**$ 4.7**	**$ 5.6**	**$ 6.6**	**$ 7.7**
Less: MACRS D&A	-	(68.1)	-	-	-	-	-	-	-
EBIT	**$ 10.0**	**$ (63.6)**	**$ 4.7**	**$ 4.4**	**$ 4.5**	**$ 4.7**	**$ 5.6**	**$ 6.6**	**$ 7.7**
Less: Interest Expense	-	(1.6)	(1.5)	(1.5)	(1.4)	(1.4)	(1.1)	(0.7)	(0.1)
Less: Cash Taxes	(2.8)	-	-	-	-	-	-	-	(2.1)
Tax Net Income	**$ 7.2**	**$ (65.2)**	**$ 3.2**	**$ 2.9**	**$ 3.1**	**$ 3.3**	**$ 4.4**	**$ 5.8**	**$ 5.4**
MACRS D&A	-	68.1	-	-	-	-	-	-	-
EPC	(3.3)	-	-	-	-	-	-	-	-
Storage Module Capital	(26.4)	-	-	-	-	-	-	-	-
Inverter / AC System Capital	(2.0)	-	-	-	-	-	-	-	-
Balance of System Capital	(3.3)	-	-	-	-	-	-	-	-
Solar Capital	(62.3)	-	-	-	-	-	-	-	-
ITC	29.2	-	-	-	-	-	-	-	-
Debt	19.5	-	-	-	-	-	-	-	-
Principal	-	(0.4)	(0.5)	(0.5)	(0.5)	(0.6)	(0.9)	(1.2)	(1.8)
After-Tax Levered Cash Flow	**$ (41.5)**	**$ 2.6**	**$ 2.7**	**$ 2.4**	**$ 2.5**	**$ 2.7**	**$ 3.6**	**$ 4.6**	**$ 3.6**
Levered Project IRR	5.2%								
Levered Project NPV	(15,565)								

Model Assumptions							
Storage Size (MW)	0.010	Storage Extended Warranty (%)	1.5%	Debt	20%	Combined Tax Rate	28%
Storage Capacity (MWh)	0.040	Storage EPC Cost (%)	11.2%	Cost of Debt	8%	Charging Cost Escalation	0%
Solar Sizing (MW)	0.020	Storage O&M Cost (%)	1.9%	Equity	80%	O&M Escalation	2.5%
Full DOD Cycles Per Year	170	Storage Efficiency (% RT)	88.3%	Cost of Equity	12%	Regional EPC Scalar	1.09
Depth of Discharge (%)	100%	Solar Fixed O&M ($/kW-yr.)	$19.78	WACC	11%	Useful Life (years)	20

Source: *Lazard and Enovation Partners estimates.*
Note: *Project receives 100% of SGIP benefit in the first year; extended warranty costs represent coverage provided beyond the initial two-year product warranty (included in equipment capital costs); charging costs are zero with all energy self-generated by the PV portion of the system; 100% of 5 year MACRS taken in the first year; regional EPC scalars are adjustment factors for the national averages, determined by Bloomberg estimates and Labor Department statistics.*

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Illustrative Value Snapshot—Wholesale (U.K.)

($ in thousands, unless otherwise noted)

United Kingdom	2018	2019	2020	2021	2022	2023	2028*	2033*	2038*
Total Revenue	**$ -**	**$ 46,754.5**	**$ 47,302.8**	**$ 47,378.4**	**$ 47,456.3**	**$ 8,922.4**	**$ 10,003.2**	**$ 11,220.6**	**$ 12,592.9**
Energy Arbitrage	-	-	-	-	-	-	-	-	-
Frequency Regulation	-	44,780.8	44,780.8	44,780.8	44,780.8	-	-	-	-
Spinning/Non-Spinning Reserves	-	-	-	-	-	6,166.6	6,808.5	7,517.1	8,299.5
Resource Adequacy	-	1,973.7	2,521.9	2,597.6	2,675.5	2,755.8	3,194.7	3,703.5	4,293.4
Distribution Deferral	-	-	-	-	-	-	-	-	-
Demand Response–Wholesale	-	-	-	-	-	-	-	-	-
Demand Response–Utility	-	-	-	-	-	-	-	-	-
Bill Management	-	-	-	-	-	-	-	-	-
Local Incentive Payments	-	-	-	-	-	-	-	-	-
Total Operating Costs	**$ -**	**$ (6,460.8)**	**$ (6,496.9)**	**$ (8,359.2)**	**$ (8,397.1)**	**$ (8,435.9)**	**$ (8,644.7)**	**$ (8,880.5)**	**$ (9,146.6)**
Storage O&M	-	(1,312.2)	(1,345.0)	(1,378.7)	(1,413.1)	(1,448.5)	(1,638.8)	(1,854.1)	(2,097.8)
Storage Warranty	-	-	-	(1,825.3)	(1,825.3)	(1,825.3)	(1,825.3)	(1,825.3)	(1,825.3)
Storage Augmentation Costs	-	(4,984.6)	(4,984.6)	(4,984.6)	(4,984.6)	(4,984.6)	(4,984.6)	(4,984.6)	(4,984.6)
Solar O&M	-	-	-	-	-	-	-	-	-
Storage Charging	-	(164.0)	(167.3)	(170.7)	(174.1)	(177.6)	(196.0)	(216.4)	(239.0)
EBITDA	**$ -**	**$ 40,293.7**	**$ 40,805.8**	**$ 39,019.2**	**$ 39,059.3**	**$ 486.5**	**$ 1,358.5**	**$ 2,340.2**	**$ 3,446.3**
Less: MACRS D&A	-	(19,407.2)	(33,259.8)	(23,753.1)	(16,962.6)	(12,127.8)	-	-	-
EBIT	**$ -**	**$ 20,886.5**	**$ 7,546.1**	**$ 15,266.1**	**$ 22,096.6**	**$ (11,641.3)**	**$ 1,358.5**	**$ 2,340.2**	**$ 3,446.3**
Less: Interest Expense	-	(2,173.0)	(2,125.5)	(2,074.2)	(2,018.8)	(1,959.0)	(1,580.0)	(1,023.1)	(204.9)
Less: Cash Taxes	-	(6,549.7)	(1,897.2)	(4,617.2)	(7,027.2)	-	-	-	-
Tax Net Income	**$ -**	**$ 12,163.8**	**$ 3,523.4**	**$ 8,574.8**	**$ 13,050.6**	**$ (13,600.2)**	**$ (221.5)**	**$ 1,317.0**	**$ 3,241.3**
MACRS D&A	-	19,407.2	33,259.8	23,753.1	16,962.6	12,127.8	-	-	-
EPC	(16,283.0)	-	-	-	-	-	-	-	-
Storage Module Capital	(96,693.3)	-	-	-	-	-	-	-	-
Inverter / AC System Capital	(6,479.5)	-	-	-	-	-	-	-	-
Balance of System Capital	(16,353.8)	-	-	-	-	-	-	-	-
Solar Capital	-	-	-	-	-	-	-	-	-
ITC	-	-	-	-	-	-	-	-	-
Debt	27,161.9	-	-	-	-	-	-	-	-
Principal	-	(593.5)	(641.0)	(692.3)	(747.7)	(807.5)	(1,186.5)	(1,743.4)	(2,561.6)
After-Tax Levered Cash Flow	**$ (108,647.7)**	**$ 30,977.4**	**$ 36,142.1**	**$ 31,635.5**	**$ 29,265.5**	**$ (2,280.0)**	**$ (1,408.0)**	**$ (426.3)**	**$ 679.8**
Levered Project IRR	4.4%								
Levered Project NPV	(9,932,582)								

Model Assumptions							
Storage Size (MW)	100.000	Storage Extended Warranty (%)	1.5%	Debt	20%	Combined Tax Rate	35%
Storage Capacity (MWh)	400.000	Storage EPC Cost (%)	14.4%	Cost of Debt	8%	Charging Cost Escalation	2%
Solar Sizing (MW)	0.000	Storage O&M Cost (%)	1.1%	Equity	80%	O&M Escalation	2.5%
Full DOD Cycles Per Year	55	Storage Efficiency (% RT)	87.4%	Cost of Equity	12%	Regional EPC Scalar	1
Depth of Discharge (%)	100%	Solar Fixed O&M ($/kW-yr.)	$0.00	WACC	11%	Useful Life (years)	20

Source: Lazard and Enovation Partners estimates.

Note: Extended warranty costs represent coverage provided beyond the initial two-year product warranty (included in equipment capital costs); charging costs are based on forward estimates of day-ahead baseload contracts (GB); 7 years MACRS; all figures presented in USD using the following exchange rate: GBP/USD 0.76.

3

Illustrative Value Snapshot—Utility-Scale (PV + Storage) (Australia)

($ in thousands, unless otherwise noted)

Australia	2018	2019	2020	2021	2022	2023	2028*	2033*	2038*
Total Revenue	**$ -**	**$ 8,868.8**	**$ 9,113.4**	**$ 9,364.8**	**$ 9,623.3**	**$ 9,888.9**	**$ 11,332.0**	**$ 12,987.8**	**$ 14,887.6**
Energy Arbitrage	-	6,584.6	6,760.7	6,941.6	7,127.3	7,318.1	8,351.8	9,532.8	10,882.4
Frequency Regulation	-	455.6	469.3	483.4	497.9	512.8	594.5	689.2	799.0
Spinning/Non-Spinning Reserves	-	-	-	-	-	-	-	-	-
Resource Adequacy	-	1,828.5	1,883.3	1,939.8	1,998.0	2,058.0	2,385.7	2,765.7	3,206.2
Distribution Deferral	-	-	-	-	-	-	-	-	-
Demand Response–Wholesale	-	-	-	-	-	-	-	-	-
Demand Response–Utility	-	-	-	-	-	-	-	-	-
Bill Management	-	-	-	-	-	-	-	-	-
Local Incentive Payments	-	-	-	-	-	-	-	-	-
Total Operating Costs	**$ -**	**$ (1,956.6)**	**$ (1,980.1)**	**$ (2,365.5)**	**$ (2,390.3)**	**$ (2,415.6)**	**$ (2,552.3)**	**$ (2,707.0)**	**$ (2,882.0)**
Storage O&M	-	(522.4)	(535.5)	(548.9)	(562.6)	(576.7)	(652.5)	(738.2)	(835.2)
Storage Warranty	-	-	-	(361.2)	(361.2)	(361.2)	(361.2)	(361.2)	(361.2)
Storage Augmentation Costs	-	(1,014.1)	(1,014.1)	(1,014.1)	(1,014.1)	(1,014.1)	(1,014.1)	(1,014.1)	(1,014.1)
Solar O&M	-	(420.0)	(430.5)	(441.3)	(452.3)	(463.6)	(524.5)	(593.4)	(671.4)
Storage Charging	-	-	-	-	-	-	-	-	-
EBITDA	**$ -**	**$ 6,912.2**	**$ 7,133.3**	**$ 6,999.3**	**$ 7,233.0**	**$ 7,473.2**	**$ 8,779.7**	**$ 10,280.8**	**$ 12,005.6**
Less: MACRS D&A	-	(14,467.6)	(23,148.1)	(13,888.9)	(8,333.3)	(8,333.3)	-	-	-
EBIT	**$ -**	**$ (7,555.4)**	**$ (16,014.8)**	**$ (6,889.5)**	**$ (1,100.3)**	**$ (860.1)**	**$ 8,779.7**	**$ 10,280.8**	**$ 12,005.6**
Less: Interest Expense	-	(1,157.4)	(1,132.1)	(1,104.8)	(1,075.3)	(1,043.4)	(841.6)	(545.0)	(109.2)
Less: Cash Taxes	-	-	-	-	-	-	-	(3,407.5)	(4,163.8)
Tax Net Income	**$ -**	**$ (8,712.8)**	**$ (17,146.9)**	**$ (7,994.3)**	**$ (2,175.6)**	**$ (1,903.5)**	**$ 7,938.1**	**$ 6,328.3**	**$ 7,732.7**
MACRS D&A	-	14,467.6	23,148.1	13,888.9	8,333.3	8,333.3	-	-	-
EPC	(4,677.5)	-	-	-	-	-	-	-	-
Storage Module Capital	(20,266.0)	-	-	-	-	-	-	-	-
Inverter / AC System Capital	(1,265.1)	-	-	-	-	-	-	-	-
Balance of System Capital	(2,129.2)	-	-	-	-	-	-	-	-
Solar Capital	(44,000.0)	-	-	-	-	-	-	-	-
ITC	-	-	-	-	-	-	-	-	-
Debt	14,467.6	-	-	-	-	-	-	-	-
Principal	-	(316.1)	(341.4)	(368.8)	(398.3)	(430.1)	(632.0)	(928.6)	(1,364.4)
After-Tax Levered Cash Flow	**$ (57,870.2)**	**$ 5,438.6**	**$ 5,659.7**	**$ 5,525.8**	**$ 5,759.4**	**$ 5,999.7**	**$ 7,306.2**	**$ 5,399.7**	**$ 6,368.3**
Levered Project IRR	8.7%								
Levered Project NPV	(8,544,983)								

Model Assumptions							
Storage Size (MW)	20.000	Storage Extended Warranty (%)	1.5%	Debt	20%	Combined Tax Rate	35%
Storage Capacity (MWh)	80.000	Storage EPC Cost (%)	20.9%	Cost of Debt	8%	Charging Cost Escalation	0%
Solar Sizing (MW)	40.000	Storage O&M Cost (%)	2.2%	Equity	80%	O&M Escalation	2.5%
Full DOD Cycles Per Year	350	Storage Efficiency (% RT)	87.2%	Cost of Equity	12%	Regional EPC Scalar	1
Depth of Discharge (%)	100%	Solar Fixed O&M ($/kW-yr.)	$10.50	WACC	11%	Useful Life (years)	20

Source: Lazard and Enovation Partners estimates.

Note: Extended warranty costs represent coverage provided beyond the initial two-year product warranty (included in equipment capital costs); charging costs are zero with all energy self-generated by the PV portion of the system; 5 years MACRS; all figures presented in USD using the following exchange rate: AUD/USD 1.38.

4

Illustrative Value Snapshot—Commercial & Industrial (Standalone) (Ontario)

($ in thousands, unless otherwise noted)

Ontario	2018	2019	2020	2021	2022	2023	2028*	2033*	2038*
Total Revenue	**$ -**	**$ 489.5**	**$ 502.1**	**$ 515.1**	**$ 528.4**	**$ 542.0**	**$ 615.7**	**$ -**	**$ -**
Energy Arbitrage	-	-	-	-	-	-	-	-	-
Frequency Regulation	-	-	-	-	-	-	-	-	-
Spinning/Non-Spinning Reserves	-	-	-	-	-	-	-	-	-
Resource Adequacy	-	-	-	-	-	-	-	-	-
Distribution Deferral	-	-	-	-	-	-	-	-	-
Demand Response–Wholesale	-	56.5	57.9	59.3	60.8	62.3	70.5	79.8	90.2
Demand Response–Utility	-	-	-	-	-	-	-	-	-
Bill Management	-	433.0	444.3	455.8	467.6	479.7	545.2	619.8	704.6
Local Incentive Payments	-	-	-	-	-	-	-	-	-
Total Operating Costs	**$ -**	**$ (148.0)**	**$ (150.6)**	**$ (170.8)**	**$ (173.6)**	**$ (176.4)**	**$ (191.9)**	**$ (87.0)**	**$ (100.9)**
Storage O&M	-	(35.9)	(36.8)	(37.8)	(38.7)	(39.7)	(44.9)	-	-
Storage Warranty	-	-	-	(17.4)	(17.4)	(17.4)	(17.4)	-	-
Storage Augmentation Costs	-	(54.5)	(54.5)	(54.5)	(54.5)	(54.5)	(54.5)	-	-
Solar O&M	-	-	-	-	-	-	-	-	-
Storage Charging	-	(57.5)	(59.3)	(61.0)	(62.9)	(64.7)	(75.1)	(87.0)	(100.9)
EBITDA	**$ -**	**$ 341.5**	**$ 351.5**	**$ 344.3**	**$ 354.8**	**$ 365.6**	**$ 423.8**	**$ (87.0)**	**$ (100.9)**
Less: MACRS D&A	-	(218.1)	(373.7)	(266.9)	(190.6)	(136.3)	-	-	-
EBIT	**$ -**	**$ 123.4**	**$ (22.2)**	**$ 77.4**	**$ 164.2**	**$ 229.3**	**$ 423.8**	**$ (87.0)**	**$ (100.9)**
Less: Interest Expense	-	(24.4)	(22.7)	(20.9)	(18.9)	(16.8)	(3.4)	-	-
Less: Cash Taxes	-	(34.6)	-	(4.0)	(50.8)	(74.4)	(147.2)	-	-
Tax Net Income	**$ -**	**$ 64.3**	**$ (45.0)**	**$ 52.5**	**$ 94.4**	**$ 138.1**	**$ 273.3**	**$ (87.0)**	**$ (100.9)**
MACRS D&A	-	218.1	373.7	266.9	190.6	136.3	-	-	-
EPC	(435.0)	-	-	-	-	-	-	-	-
Storage Module Capital	(662.7)	-	-	-	-	-	-	-	-
Inverter / AC System Capital	(216.7)	-	-	-	-	-	-	-	-
Balance of System Capital	(211.6)	-	-	-	-	-	-	-	-
Solar Capital	-	-	-	-	-	-	-	-	-
ITC	-	-	-	-	-	-	-	-	-
Debt	305.2	-	-	-	-	-	-	-	-
Principal	-	(21.1)	(22.8)	(24.6)	(26.5)	(28.7)	(42.1)	-	-
After-Tax Levered Cash Flow	**$ (1,220.8)**	**$ 261.3**	**$ 306.0**	**$ 294.8**	**$ 258.5**	**$ 245.7**	**$ 231.2**	**$ -**	**$ -**
Levered Project IRR	20.1%								
Levered Project NPV	399,363								

Model Assumptions							
Storage Size (MW)	1.000	Storage Extended Warranty (%)	1.6%	Debt	20%	Combined Tax Rate	35%
Storage Capacity (MWh)	2.000	Storage EPC Cost (%)	49.8%	Cost of Debt	8%	Charging Cost Escalation	3%
Solar Sizing (MW)	0.000	Storage O&M Cost (%)	3.2%	Equity	80%	O&M Escalation	2.5%
Full DOD Cycles Per Year	225	Storage Efficiency (% RT)	91.1%	Cost of Equity	12%	Regional EPC Scalar	1
Depth of Discharge (%)	100%	Solar Fixed O&M ($/kW-yr.)	$0.00	WACC	11%	Useful Life (years)	10

Source: Lazard and Enovation Partners estimates.
Note: Extended warranty costs represent coverage provided beyond the initial two-year product warranty (included in equipment capital costs); charging costs are based on Ontario Power Authority commercial rates; 7 year MACRS; all figures presented in USD using the following exchange rate: CAD/USD 1.29.

5 Illustrative Value Snapshot—Commercial & Industrial (PV + Storage) (Australia)

($ in thousands, unless otherwise noted)

Australia	2018	2019	2020	2021	2022	2023	2028*	2033*	2038*
Total Revenue	**$ -**	**$ 621.6**	**$ 650.8**	**$ 682.6**	**$ 704.7**	**$ 727.9**	**$ 859.2**	**$ 1,021.4**	**$ 1,222.3**
Energy Arbitrage	-	-	-	-	-	-	-	-	-
Frequency Regulation	-	-	-	-	-	-	-	-	-
Spinning/Non-Spinning Reserves	-	-	-	-	-	-	-	-	-
Resource Adequacy	-	-	-	-	-	-	-	-	-
Distribution Deferral	-	-	-	-	-	-	-	-	-
Demand Response–Wholesale	-	-	-	-	-	-	-	-	-
Demand Response–Utility	-	-	-	-	-	-	-	-	-
Bill Management	-	621.6	650.8	682.6	704.7	727.9	859.2	1,021.4	1,222.3
Local Incentive Payments	-	-	-	-	-	-	-	-	-
Total Operating Costs	**$ -**	**$ (109.5)**	**$ (110.8)**	**$ (130.1)**	**$ (131.5)**	**$ (132.9)**	**$ (140.6)**	**$ (149.4)**	**$ (159.3)**
Storage O&M	-	(35.9)	(36.8)	(37.7)	(38.7)	(39.7)	(44.9)	(50.8)	(57.4)
Storage Warranty	-	-	-	(17.9)	(17.9)	(17.9)	(17.9)	(17.9)	(17.9)
Storage Augmentation Costs	-	(56.1)	(56.1)	(56.1)	(56.1)	(56.1)	(56.1)	(56.1)	(56.1)
Solar O&M	-	(17.5)	(17.9)	(18.4)	(18.8)	(19.3)	(21.9)	(24.7)	(28.0)
Storage Charging	-	-	-	-	-	-	-	-	-
EBITDA	**$ -**	**$ 512.1**	**$ 540.0**	**$ 552.5**	**$ 573.3**	**$ 595.0**	**$ 718.5**	**$ 872.0**	**$ 1,062.9**
Less: MACRS D&A	-	(833.7)	(1,333.9)	(800.3)	(480.2)	(480.2)	-	-	-
EBIT	**$ -**	**$ (321.6)**	**$ (793.9)**	**$ (247.8)**	**$ 93.1**	**$ 114.8**	**$ 718.5**	**$ 872.0**	**$ 1,062.9**
Less: Interest Expense	-	(66.7)	(65.2)	(63.7)	(62.0)	(60.1)	(48.5)	(31.4)	(6.3)
Less: Cash Taxes	-	-	-	-	-	-	(234.5)	(294.2)	(369.8)
Tax Net Income	**$ -**	**$ (388.3)**	**$ (859.1)**	**$ (311.5)**	**$ 31.1**	**$ 54.6**	**$ 435.5**	**$ 546.4**	**$ 686.8**
MACRS D&A	-	833.7	1,333.9	800.3	480.2	480.2	-	-	-
EPC	(435.0)	-	-	-	-	-	-	-	-
Storage Module Capital	(742.9)	-	-	-	-	-	-	-	-
Inverter / AC System Capital	(127.6)	-	-	-	-	-	-	-	-
Balance of System Capital	(277.8)	-	-	-	-	-	-	-	-
Solar Capital	(2,585.0)	-	-	-	-	-	-	-	-
ITC	-	-	-	-	-	-	-	-	-
Debt	833.7	-	-	-	-	-	-	-	-
Principal	-	(18.2)	(19.7)	(21.2)	(22.9)	(24.8)	(36.4)	(53.5)	(78.6)
After-Tax Levered Cash Flow	**$ (3,334.7)**	**$ 427.2**	**$ 455.1**	**$ 467.6**	**$ 488.4**	**$ 510.1**	**$ 399.1**	**$ 492.9**	**$ 608.2**
Levered Project IRR	14.3%								
Levered Project NPV	646,862								

Model Assumptions							
Storage Size (MW)	0.500	Storage Extended Warranty (%)	1.6%	Debt	20%	Combined Tax Rate	35%
Storage Capacity (MWh)	2.000	Storage EPC Cost (%)	42.6%	Cost of Debt	8%	Charging Cost Escalation	0%
Solar Sizing (MW)	1.000	Storage O&M Cost (%)	3.1%	Equity	80%	O&M Escalation	2.5%
Full DOD Cycles Per Year	250	Storage Efficiency (% RT)	90.5%	Cost of Equity	12%	Regional EPC Scalar	1
Depth of Discharge (%)	100%	Solar Fixed O&M ($/kW-yr.)	$17.50	WACC	11%	Useful Life (years)	20

Source: Lazard and Enovation Partners estimates.

Note: Extended warranty costs represent coverage provided beyond the initial two-year product warranty (included in equipment capital costs); charging costs are zero with all energy self-generated by the PV portion of the system; 5 years MACRS; all figures presented in USD using the following exchange rate: AUD/USD 1.38.

6 Illustrative Value Snapshot—Residential (PV + Storage) (Germany)

($ in thousands, unless otherwise noted)

Germany	2018	2019	2020	2021	2022	2023	2028*	2033*	2038*
Total Revenue	**12.6**	**$ 7.5**	**$ 7.8**	**$ 8.0**	**$ 8.2**	**$ 8.5**	**$ 9.8**	**$ 11.4**	**$ 13.2**
Energy Arbitrage	-	-	-	-	-	-	-	-	-
Frequency Regulation	-	-	-	-	-	-	-	-	-
Spinning/Non-Spinning Reserves	-	-	-	-	-	-	-	-	-
Resource Adequacy	-	-	-	-	-	-	-	-	-
Distribution Deferral	-	-	-	-	-	-	-	-	-
Demand Response–Wholesale	-	-	-	-	-	-	-	-	-
Demand Response–Utility	-	-	-	-	-	-	-	-	-
Bill Management	-	7.5	7.8	8.0	8.2	8.5	9.8	11.4	13.2
Local Incentive Payments	12.6	-	-	-	-	-	-	-	-
Total Operating Costs	**$ -**	**$ (2.6)**	**$ (2.6)**	**$ (3.1)**	**$ (3.1)**	**$ (3.2)**	**$ (3.3)**	**$ (3.5)**	**$ (3.7)**
Storage O&M	-	(0.6)	(0.6)	(0.7)	(0.7)	(0.7)	(0.8)	(0.9)	(1.0)
Storage Warranty	-	-	-	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)
Storage Augmentation Costs	-	(1.6)	(1.6)	(1.6)	(1.6)	(1.6)	(1.6)	(1.6)	(1.6)
Solar O&M	-	(0.4)	(0.4)	(0.4)	(0.4)	(0.4)	(0.5)	(0.6)	(0.6)
Storage Charging	-	-	-	-	-	-	-	-	-
EBITDA	**$ 12.6**	**$ 5.0**	**$ 5.2**	**$ 4.9**	**$ 5.1**	**$ 5.3**	**$ 6.5**	**$ 7.9**	**$ 9.6**
Less: MACRS D&A	-	(19.4)	(31.1)	(18.6)	(11.2)	(11.2)	-	-	-
EBIT	**$ 12.6**	**$ (14.4)**	**$ (25.9)**	**$ (13.7)**	**$ (6.1)**	**$ (5.9)**	**$ 6.5**	**$ 7.9**	**$ 9.6**
Less: Interest Expense	-	(1.6)	(1.5)	(1.5)	(1.4)	(1.4)	(1.1)	(0.7)	(0.1)
Less: Cash Taxes	(4.4)	-	-	-	-	-	-	-	(3.3)
Tax Net Income	**$ 8.2**	**$ (16.0)**	**$ (27.4)**	**$ (15.2)**	**$ (7.5)**	**$ (7.3)**	**$ 5.4**	**$ 7.2**	**$ 6.1**
MACRS D&A	-	19.4	31.1	18.6	11.2	11.2	-	-	-
EPC	(3.1)	-	-	-	-	-	-	-	-
Storage Module Capital	(26.4)	-	-	-	-	-	-	-	-
Inverter / AC System Capital	(2.0)	-	-	-	-	-	-	-	-
Balance of System Capital	(3.3)	-	-	-	-	-	-	-	-
Solar Capital	(62.3)	-	-	-	-	-	-	-	-
ITC	-	-	-	-	-	-	-	-	-
Debt	19.4	-	-	-	-	-	-	-	-
Principal	-	(0.4)	(0.5)	(0.5)	(0.5)	(0.6)	(0.8)	(1.2)	(1.8)
After-Tax Levered Cash Flow	**$ (69.4)**	**$ 3.0**	**$ 3.2**	**$ 2.9**	**$ 3.1**	**$ 3.4**	**$ 4.6**	**$ 6.0**	**$ 4.3**
Levered Project IRR	2.5%								
Levered Project NPV	(36,513)								

Model Assumptions							
Storage Size (MW)	0.010	Storage Extended Warranty (%)	1.5%	Debt	20%	Combined Tax Rate	35%
Storage Capacity (MWh)	0.040	Storage EPC Cost (%)	10.3%	Cost of Debt	8%	Charging Cost Escalation	0%
Solar Sizing (MW)	0.020	Storage O&M Cost (%)	1.9%	Equity	80%	O&M Escalation	2.5%
Full DOD Cycles Per Year	250	Storage Efficiency (% RT)	88.3%	Cost of Equity	12%	Regional EPC Scalar	1
Depth of Discharge (%)	100%	Solar Fixed O&M ($/kW-yr.)	$19.78	WACC	11%	Useful Life (years)	20

Source: Lazard and Enovation Partners estimates.

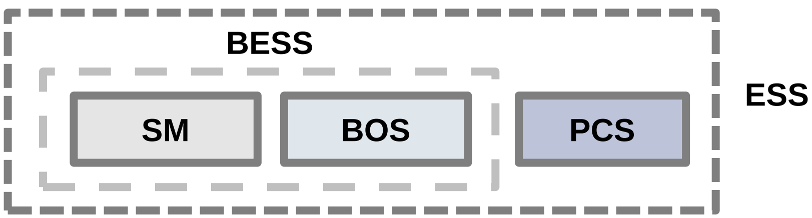
Note: 13% German Development Bank, KfW incentive for renewable/DER technologies; extended warranty costs represent coverage provided beyond the initial two-year product warranty (included in equipment capital costs); charging costs are zero with all energy self-generated by the PV portion of the system; 5 years MACRS; all figures presented in USD using the following exchange rate: EUR/USD 0.85.

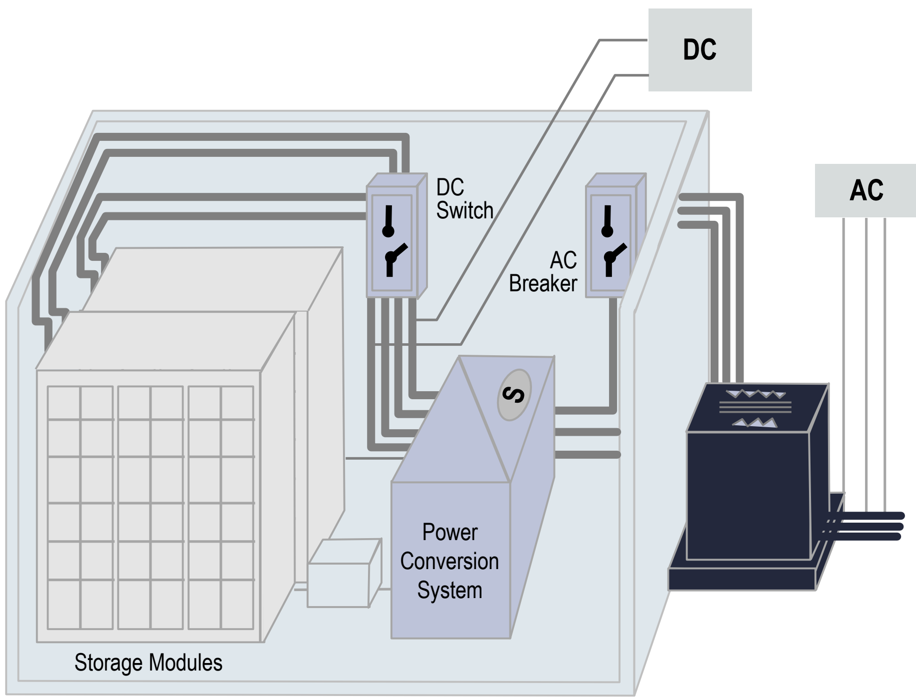
C Supplementary Energy Storage Background Materials

Components of Energy Storage System Equipment Costs

Lazard's LCOS study incorporates capital costs for the entirety of the energy storage system ("ESS"), which is composed of the storage module ("SM"), balance of system ("BOS" and, together with the SM, the Battery Energy Storage System "BESS"), power conversion system ("PCS") and related EPC costs

Physical Energy Storage System





Selected Equipment & Cost Components

System Layer		Component
SM	Storage Module	• Racking Frame/Cabinet • Battery Management System ("BMS") • Battery Modules
BOS	Balance of System	• Container • Monitors and Controls • Thermal Management • Fire Suppression
PCS	Power Conversion System	• Inverter • Protection (Switches, Breakers, etc.) • Energy Management System ("EMS")
EPC	Engineering, Procurement & Construction	• Project Management • Engineering Studies/Permitting • Site Preparation/Construction • Foundation/Mounting • Commissioning
Other (not included in analysis)		• SCADA • Shipping • Grid Integration Equipment • Metering • Land

Source: Sandia National Laboratories.

Overview of Selected Energy Storage Technologies

A wide variety of energy storage technologies are currently available or in development; however, given limited current or future commercial deployment expectations, only a subset are assessed in this study

Category	Technology	Description	Size (MW)	Selected Providers	Life (Yrs)(1)
Mechanical/Gravity/Thermal	Compressed Air	• Compressed Air Energy Storage ("CAES") uses electricity to compress air into confined spaces (e.g., underground mines, salt caverns, etc.) where the pressurized air is stored. When required, this pressurized air is released to drive the compressor of a natural gas turbine	150 MW+	Dresser Rand, Alstom Power	20 years
Mechanical/Gravity/Thermal	Flywheel	• Flywheels are mechanical devices that spin at high speeds, storing electricity as rotational energy, which is released by decelerating the flywheel's rotor, releasing quick bursts of energy (i.e., high power and short duration) or releasing energy slowly (i.e., low power and long duration), depending on short-duration or long-duration flywheel technology, respectively	30 kW – 1 MW	Amber Kinetics, Vycon	20+ years
Mechanical/Gravity/Thermal	Pumped Hydro	• Pumped hydro storage uses two vertically separated water reservoirs, using low cost electricity to pump water from the lower to the higher reservoir and running as a conventional hydro power plant during high electricity cost periods	100 MW+	MWH Global	20+ years
Mechanical/Gravity/Thermal	Thermal	• Thermal energy storage uses conventional cryogenic technology, compressing and storing air into a liquid form (charging) then releasing it at a later time (discharge). Best suited for large-scale applications; the technology is still emerging but has a number of units in early development and operation	5 MW – 100 MW+	Highview Power	20+ years
Chemical	Flow Battery‡	• Flow batteries store energy through chemically changing the electrolyte (vanadium) or plating zinc (zinc bromide). Physically, systems typically contain two electrolyte solutions in two separate tanks, circulated through two independent loops, separated by a membrane. Emerging alternatives allow for simpler and less costly designs utilizing a single tank, single loop, and no membrane. • The subcategories of flow batteries are defined by the chemical composition of the electrolyte solution; the most prevalent of such solutions are vanadium and zinc bromide. Other solutions include zinc chloride, ferrochrome and zinc chromate	25 kW – 100 MW+	Sumitomo, UET, Primus Power	20 years
Chemical	Lead Acid‡	• Lead-acid batteries date from the 19th century and are the most common batteries; they are low cost and adaptable to numerous uses (e.g., electric vehicles, off-grid power systems, uninterruptible power supplies, etc.) • "Advanced" lead-acid battery technology adds ultra-capacitors, increasing efficiency, lifetimes and improve partial state-of-charge operability(2)	5 kW – 2 MW	Enersys, GS Yuasa, East Penn Mfg.	5 – 10 years
Chemical	Lithium-Ion‡	• Lithium-ion batteries have historically been used in electronics and advanced transportation industries; they are increasingly replacing lead-acid batteries in many applications, and have relatively high energy density, low self-discharge and high charging efficiency • Lithium-ion systems designed for energy applications are designed to have a higher efficiency and longer life at slower discharges, while systems designed for power applications are designed to support faster charging and discharging rates, requiring extra capital equipment	5 kW – 100 MW+	LG Chem, Samsung, Panasonic, BYD	10 years
Chemical	Sodium‡	• "High temperature"/"liquid-electrolyte-flow" sodium batteries have high power and energy density and are designed for large commercial and utility scale projects; "low temperature" batteries are designed for residential and small commercial applications	1 MW – 100 MW+	NGK	10 years
Chemical	Zinc‡	• Zinc batteries cover a wide range of possible technology variations, including metal-air derivatives; they are non-toxic, non-combustible and potentially low cost due to the abundance of the primary metal; however, this technology remains unproven in widespread commercial deployment	5 kW – 100 MW+	Fluidic Energy, EOS Energy Storage	10 years

Technologies analyzed in LCOS v4.0.
‡ Denotes battery technology.
(1) Indicates general ranges of useful economic life for a given family of technology. Useful life will vary in practice depending on sub-technology, intensity of use/cycling, engineering factors, etc.
(2) Advanced lead acid is an emerging technology with wider potential applications and greater cost than traditional lead-acid batteries.

Overview of Selected Energy Storage Technologies (cont'd)

A wide variety of energy storage technologies are currently available or in development; however, given limited current or future commercial deployment expectations, only a subset are assessed in this study

		Selected Advantages	Selected Disadvantages
Mechanical/Gravity/Thermal	Compressed Air	• Low cost, flexible sizing, relatively large scale • Mature technology and well-developed design • Proven track record of safe operation • Leverages existing gas turbine technologies	• Requires suitable geology • Relatively difficult to modularize for smaller installations • Exposure to natural gas price changes • Relies on natural gas
Mechanical/Gravity/Thermal	Flywheel	• High power density and scalability for short-duration technology; low power, higher energy for long-duration technology • High depth of discharge capability • Compact design with integrated AC motor	• Relatively low energy capacity • High heat generation • Sensitive to vibrations
Mechanical/Gravity/Thermal	Pumped Hydro	• Mature technology (commercially available; leverages existing hydropower technology) • High-power capacity solution • Large scale, easily scalable in power rating	• Relatively low energy density • Limited available sites (i.e., water availability required) • Cycling generally limited to once per day
Mechanical/Gravity/Thermal	Thermal	• Low cost, flexible sizing, relatively large scale • Power and energy ratings independently scalable • Leverages mature industrial cryogenic technology base; can utilize waste industrial heat to improve efficiency	• Technology is pre-commercial • Difficult to modularize for smaller installations • On-site safely concerns from cryogenic storage
Chemical	Flow Battery‡	• Power and energy profiles independently scalable for vanadium system • Zinc bromide designed in fixed modular blocks for system design • No degradation in "energy storage capacity" • No potential for fire • High cycle/lifespan	• Power and energy rating scaled in a fixed manner for zinc bromide technology • Electrolyte based on acid • Relatively high balance of system costs • Reduced efficiency due to rapid charge/discharge
Chemical	Lead Acid‡	• Mature technology with established recycling infrastructure • Advanced lead-acid technologies leverage existing technologies • Low cost	• Poor ability to operate in a partially charged state • Relatively poor depth of discharge and short lifespan • Acid-based electrolyte
Chemical	Lithium-Ion‡	• Multiple chemistries available • Rapidly expanding manufacturing base leading to cost reductions • Efficient power and energy density • Cost reduction continues	• Cycle life limited, especially in harsh conditions • Safety issues from overheating • Requires advanced manufacturing capabilities to achieve high performance
Chemical	Sodium‡	• High temperature technology: Relatively mature technology (commercially available); high energy capacity and long duration • Low temperature technology: Smaller scale design; emerging technology and low-cost potential; safer	• Although mature, inherently higher costs—low temperature batteries currently have a higher cost with lower efficiency • Potential flammability issues for high-temperature batteries • Poor cycling capability
Chemical	Zinc‡	• Deep discharge capability • Designed for long life • Designed for safe operation	• Currently unproven commercially • Lower efficiency • Poor cycling/rate of charge/discharge

Technologies analyzed in LCOS v4.0.
Source: DOE Energy Storage Database.
‡ Denotes battery technology.