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Cost Projections for Utility-Scale Battery Storage: 2025 Update

Wesley Cole, Vignesh Ramasamy, and Merve Turan

National Renewable Energy Laboratory

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Executive Summary

In this work we describe the development of cost and performance projections for utility-scale lithium-ion battery systems, with a focus on 4-hour duration systems. The projections are developed from an analysis of recent publications that include utility-scale storage costs. The suite of publications demonstrates wide variation in projected cost reductions for battery storage over time. Figure ES-1 shows the suite of projected cost reductions (on a normalized basis) collected from the literature (shown in gray) as well as the low, mid, and high cost projections developed in this work (shown in black). Figure ES-2 shows the overall capital cost for a 4-hour battery system based on those projections, with storage costs of \$147/kWh, \$243/kWh, and \$339/kWh in 2035 and \$108/kWh, \$178/kWh, and \$307/kWh in 2050 (values in 2024\$). Battery variable operations and maintenance costs, lifetimes, and efficiencies are also discussed, with recommended values selected based on the publications surveyed. In this work we also provide bottom-up cost estimates for the 2024, 2035, and 2050 systems to show how the various components impact the cost of the system.

Costs in this 2025 update report are most closely aligned with the low projection from the 2023 report primarily due to lower estimates for current battery system costs.

This work was completed in January and February 2025. It does not include impacts from changes in tariffs that have occurred since that time.

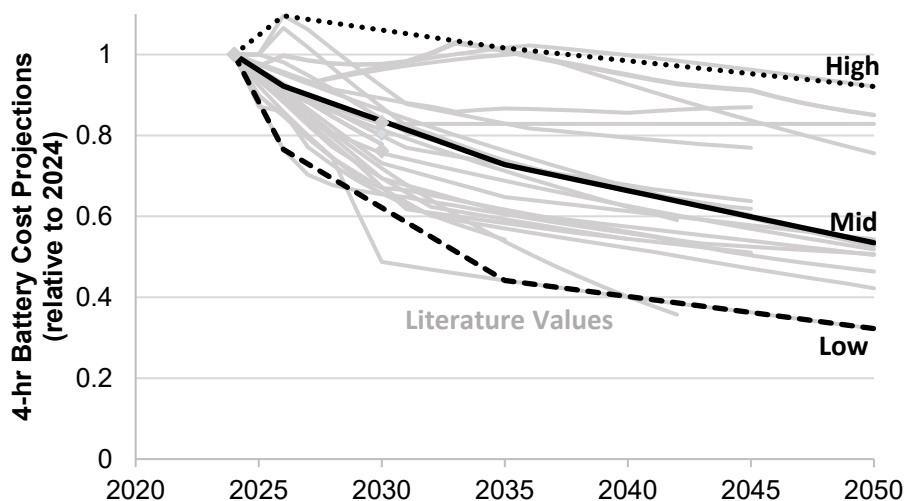


Figure ES-1. Battery cost projections for 4-hour lithium-ion systems, with values normalized relative to 2024. *The high, mid, and low cost projections developed in this work are shown as bold lines.*

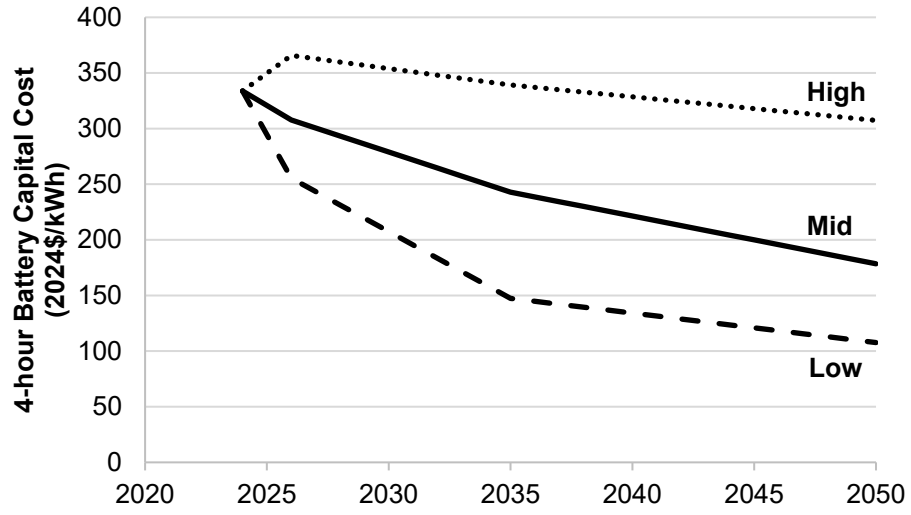


Figure ES-2. Battery cost projections for 4-hour lithium-ion systems.

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1 Background

Battery storage costs have changed rapidly over the past decade. In 2016, the National Renewable Energy Laboratory (NREL) published a set of cost projections for utility-scale lithium-ion batteries (Cole et al. 2016). Those 2016 projections relied heavily on electric vehicle battery projections because utility-scale battery projections were largely unavailable for durations longer than 30 minutes. In 2019, battery cost projections were updated based on publications that focused on utility-scale battery systems (Cole and Frazier 2019), with updates published in 2020 (Cole and Frazier 2020), 2021 (Cole, Frazier, and Augustine 2021), and 2023 (Cole and Karmakar 2023). This report updates those cost projections with data published in 2023 through early 2025.

The projections in this work focus on utility-scale lithium-ion battery systems for use in capacity expansion models. NREL utilizes the Regional Energy Deployment System (ReEDS) (Ho et al. 2021) for capacity expansion modeling, and the battery cost projections developed here are designed to be used in those models. Additionally, the projections are intended to inform the cost projections published in the Annual Technology Baseline (NREL 2024). These costs also underpin a variety of battery techno-economic analyses beyond those mentioned here.

This work was completed in January and February 2025. It does not include impacts from changes in tariffs that have occurred since that time.

2 Methods

The methods for this work relied on both literature projections and a bottom-up cost model. These methods are described in their respective subsections below.

2.1 Literature projections

The cost and performance projections developed in this work use a literature-based approach in which projections are generally based on the low, median, and highest values from the literature. Table 1 lists the publications that are used in this work. Because of rapid price changes and expectations for battery storage, only the publications released in 2023 or later are used to create the projections.

There are a number of challenges inherent in developing cost and performance projections based on published values. First among those is that the definition of the published values is not always clear. For example, dollar year, facility online year, duration, depth-of-discharge, lifetime, and O&M are not always defined in the same way (or even defined at all) for a given set of values. As such, some of the values presented here required interpretation from the sources specified. Second, many of the published values compare their published projection against projections produced by others, and it is unclear how much the projections rely upon one another. Thus, if one projection is used to inform another, that projection might artificially bias our results (toward that particular projection) more than others. Third, because of the relatively limited dataset for actual battery systems and the rapidly changing costs, it is not clear how different battery projections should be weighted. For example, should projections published in the latter half of 2024 be given higher weight than those published earlier? Or are some organizations better at making projections and therefore should be given higher weight?

In the interest of providing a neutral survey of the current literature, all cost projections included in this report are weighted equally. As we performed our review of published projections, we found that many of them cited either the previous updates of this report, or they cited the Annual Technology Baseline, which also relies on this cost projection report for its inputs. Thus, including all of the latest published projections would create known redundancies (per the second challenge listed above) and were therefore excluded from this work. In some cases, our previous work was provided as a starting point for projections, and then adjustments were made to better capture analysts' view of battery storage pricing. If that was the case, we considered the projection unique and included it in our survey.

Table 1. List of publications used in this study to determine battery cost and performance projections.

Organization	Source
BNEF	Energy Storage System Cost Survey 2024 (BNEF 2024)
CenterPoint Energy	2022/2023 Integrated Resource Plan (CenterPoint Energy 2023)
Duke Energy Indiana	Duke Energy Indiana 2024 Integrated Resource Plan (Duke Energy 2024a)
Duke Energy Kentucky	Duke Energy Kentucky 2024 Integrated Resource Plan (Duke Energy 2024b)
E Source	Battery Price Forecast 2024 (E Source 2023)
EPRI	Forthcoming REGEN model documentation
Entergy Arkansas	Entergy Arkansas 2024 Integrated Resource Plan (Entergy Arkansas 2024)
Entergy New Orleans	Entergy New Orleans 2024 Integrated Resource Plan (Entergy New Orleans 2024)
Energy Information Administration (EIA)	Annual Energy Outlook 2025 (EIA 2025) and Capital Cost and Performance Characteristic Estimates for Utility Scale Electric Power Generating Technologies (EIA 2024)
Grant Public Utility District (PUD)	Integrated Resource Plan 2024 (Grant PUD 2024)
Hoosier Energy	Hoosier Energy 2023 Integrated Resource Plan (Hoosier Energy 2024)
International Energy Agency	World Energy Outlook 2024 (IEA 2024)
Lazard	Lazard's Levelized Cost of Storage Analysis 9.0 (Lazard 2024)
NorthWestern Energy	NorthWestern Energy's South Dakota 2024 Integrated Resource Plan (NorthWestern Energy 2024)
Pacific Northwest National Laboratory (PNNL)	Energy Storage Cost and Performance Database 2024 (PNNL 2024)
Tampa Electric	Tampa Electric Ten-Year Site Plan 2023 (Tampa Electric 2023)
Wood Mackenzie	Q4 2024 Energy Storage Monitor Executive Summary and North America Levelized Cost of Electricity (Wood Mackenzie and American Clean Power 2024; Wood Mackenzie 2024)

All cost values were converted to 2024\$ using the consumer pricing index. In cases where the dollar year was not specified, the dollar year was assumed to be the same as the publication year. When future costs were presented in nominal dollars, they were converted to real dollars using the inflation rate specified by the document. If no inflation rate was found in the document, we assumed a 2.5% inflation rate.

We only used projections for 4-hour lithium-ion storage systems for the mainland United States. We define the 4-hour duration as the output duration of the battery, such that a 4-hour device would be able to discharge at its rated power capacity for 4-hours.¹ In practice that would mean that the device would charge for more than 4 hours and would nominally hold more than its rated energy capacity in order to compensate for losses.

We report our cost projections as a total system overnight capital cost expressed in units of \$/kWh. However, not all components of the battery system cost scale directly with the rated energy capacity (i.e., kWh) of the system (Ramasamy et al. 2022). For example, the inverter costs scale according to the rated power capacity (i.e., kW) of the system, and some cost components such as the developer costs can scale with both power and energy. By expressing battery system costs in \$/kWh, we are deviating from other power generation technologies such as combustion turbines or solar photovoltaic plants where capital costs are usually expressed as \$/kW. We use the units of \$/kWh because that is the most common way that battery system costs have been expressed in published material to date. The \$/kWh costs we report can be converted to \$/kW costs simply by multiplying by the assumed 4-hour duration (e.g., a \$300/kWh, 4-hour battery would have a power capacity cost of \$1200/kW).

To develop cost projections, storage costs were normalized to their 2024 value such that each projection started with a value of 1 in 2024. We chose to use normalized costs rather than absolute costs because systems were not always clearly defined in the publications. For example, it is not clear if a system is more expensive because it is more efficient and has a longer lifetime, or if the authors simply anticipate higher system costs. With the normalized method, many of the differences matter to a lesser degree.

We defined our low, mid, and high projections as the minimum, median, and maximum point, respectively in 2026, 2035, and 2050. The projections for the years between 2026 and 2035, and between 2035 and 2050 were set based on linear interpolation between years with values assigned. To convert these normalized low, mid, and high projections into cost values, the normalized values were multiplied by the 4-hour battery storage cost for the year 2024 from bottom-up cost assessment discussed below.

2.2 Bottom-up Cost Model

We use a bottom-up cost model to estimate component-level cost of battery systems in 2024, 2035, and 2050. For the bottom-up cost model, the owner's overnight capital cost for an installed battery system is categorized into ten subcomponents:

¹ This definition does not preclude the device from operating below its rated capacity. For example, a 4-hour storage device could discharge at half of its rated capacity for 8 hours and still meet this definition.

1. Li-ion battery cabinets/containers – Cost to the installer for battery cabinets including battery modules (using lithium iron phosphate [LFP] cells), racks, fire suppression and thermal management, and battery management systems, as delivered.
2. Battery bi-directional inverter – Cost to the installer for equipment that converts direct current to alternating current, as delivered.
3. Structural balance of system (SBOS) – Cost to the installer for structural components such as concrete pads, site preparation and site staging work, as delivered.² The site preparation and site staging work would include preconstruction survey, access road and parking, security fencing, temporary office/utilities setup, geotechnical investigation, soil stripping, stockpiling, clearing, grubbing, grading, compaction, and erosion control.
4. Electrical balance of system (EBOS) – Cost to the installer for electrical components such as transformer, switch gear, conductors, AC and DC disconnects, grounding, SCADA, MV to HV substation equipment, transmission line, and network upgrade related equipment, as delivered.
5. Installation labor – Cost for on-site installation work including both structural and electrical labor.
6. Permitting & interconnection – Cost of environmental studies, permitting applications, and interconnection studies. Cost of interconnection upgrades are not included in these costs.
7. Sales tax – Tax costs associated with materials and hardware using the national average rate of 5.8%.
8. Contingency – Costs allocated for unforeseen expenses.
9. Developer Overhead – Project overhead costs such as warehousing, logistics, design and engineering, outreach, management salaries incurred by the developer.
10. Profit – Markup costs for developer using a 5% markup value on items #1-4 in this list.

Additional details for these categories are included in Table 3 in the appendix. The first four categories are classified as hardware costs, while the remaining six fall under soft costs.

For the 2024 cost of 4-hour storage, we adapted and applied the 2024 Photovoltaic (PV) System Cost Model (PVSCM) framework published by the Solar Energy Technologies Office (SETO) for standalone PV and PV plus battery energy storage systems (SETO 2024). Specifically, we separated the battery pack-related costs, added any applicable balance of system costs, and soft costs related to standalone battery systems missing from the PV + battery cost framework.

² The SBOS includes structural costs for the electrical equipment. For example, the concrete pad for the switch gear is included in the SBOS rather than the EBOS.

The PVSCM model reports the U.S. average cost of PV and BESS systems installed in Q1 2024 by component, representing a benchmarked system that reflects current installations in the United States.

Unlike most system cost studies, the PVSCM cost framework reports values using intrinsic units for each component. For example, structural balance of system (SBOS) cost is measured in dollars per square meter of battery container area. This unit of measurement is independent of the power output of the battery packs, allowing for a clearer assessment of efficiency improvements.

Additionally, all reported costs are represented in two ways: Minimum Sustainable Price (MSP) and Modeled Market Price (MMP).

- MSP represents the minimum price (adjusted for inflation) that a company must charge for its product or service to remain financially solvent in a competitive market, assuming all input costs also reflect their respective MSP values. MSP is particularly useful for long-term planning, including R&D direction and power grid forecasting.
- MMP represents the actual price in the current market, which may deviate from MSP due to temporary market distortions. MMP is more relevant for short-term planning, such as evaluating the impact of tax and trade policies.

For this work, we use MMP for the 2024 costs and MSP for the 2035 and 2050 costs, with the resulting costs for each of the 10 categories shown in Figure 1.

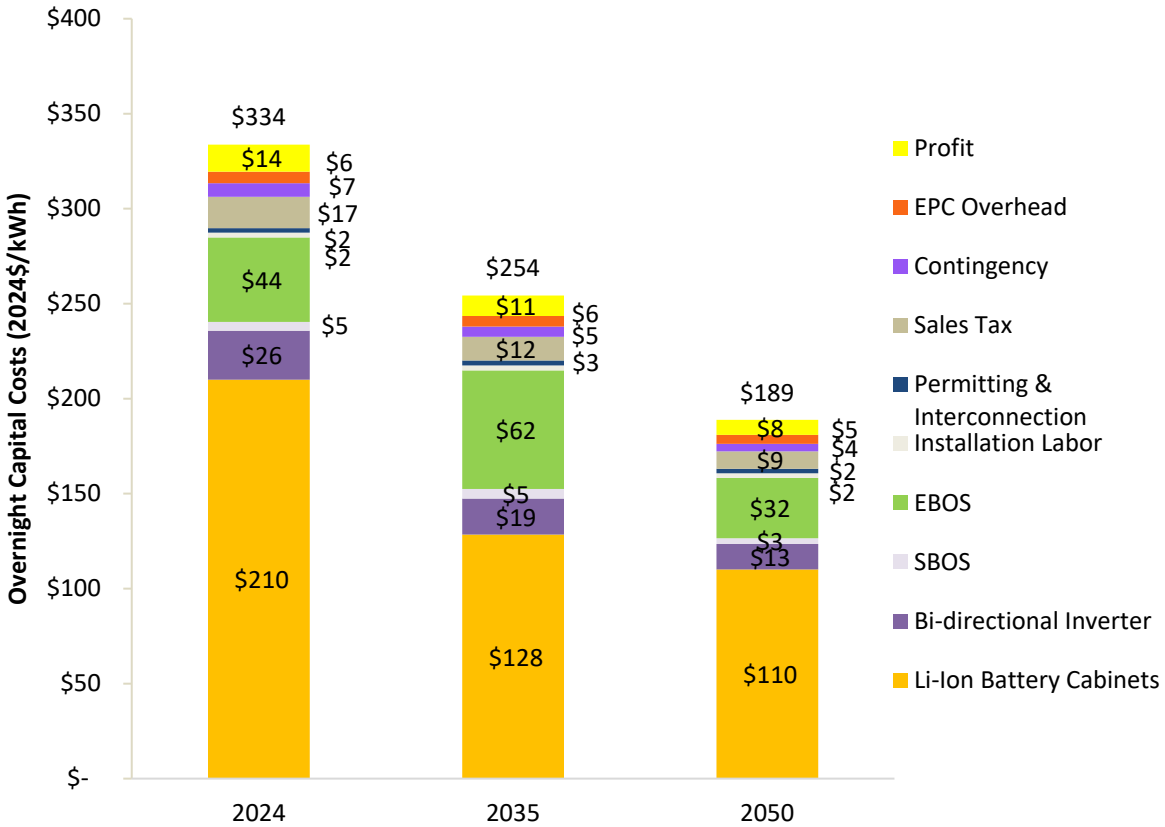


Figure 1. Overnight capital cost estimate of utility-scale batteries by each of the bottom-up cost categories for 2024, 2035, and 2050.

To estimate the costs for other storage durations (i.e., durations other than 4 hours), we assign separate energy costs and power costs such that

$$\text{Total Cost (\$/kW)} = \text{Energy Cost (\$/kWh)} * \text{Duration (hr)} + \text{Power Cost (\$/kW)}$$

In other words, every significant cost element in the system is either proportional to its energy rating (e.g., li-ion battery cabinets), proportional to its power rating (e.g. bi-directional inverters), or proportional to a linear combination of the two (e.g., tax, profit).

To separate the total cost into energy and power components, we used the bottom-up cost model to calculate the cost of a storage system with durations ranging from one hour to ten hours, and then fit that cost data to the line to estimate the Energy Cost and Power Cost components (see Figure 2). We then made an adjustment to the power cost such that the 4-hour duration system cost is exactly the same as the bottom-up cost model. In the case of Figure 2, the energy cost is \$241/kWh, and the power cost is \$379/kW adjusted down by \$7/kW for a final power cost of \$372/kW.

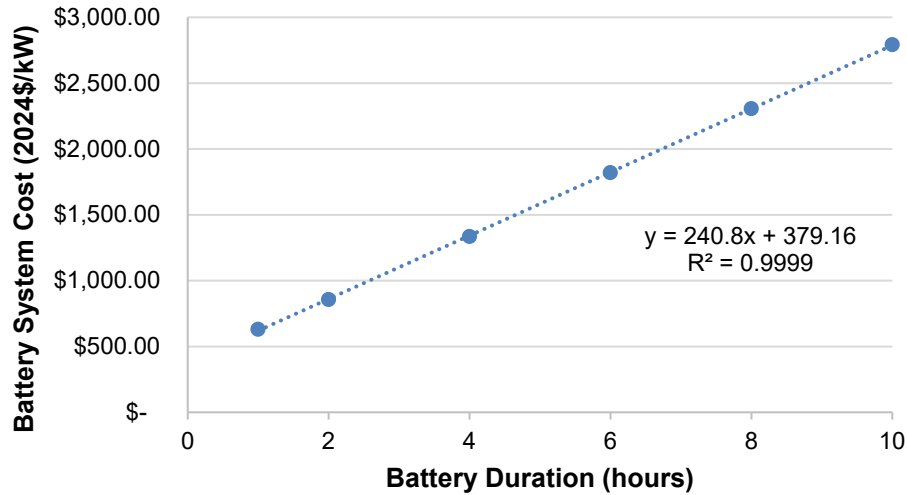


Figure 2. Battery system cost in 2024 as a function of duration.

2.3 Projections Beyond 2050

Because some studies are interested in cost data that is projected beyond 2050, we extend the cost projections in this work through 2060 using a simple extrapolation of cost reductions. For post-2050 cost reductions, we assume that costs will decline at half the rate they declined before 2050. In other words, the slope of the normalized cost projection from 2050-2060 would be half the value of the slope from 2035-2050. The values for the low, mid, and high cost projections would still be unique because each projection has a unique slope for 2035-2050.

3 Results and Discussion

The normalized cost trajectories with the low, mid, and high projections are shown in Figure 3. The high projection has an immediate increase in costs due to supply chain constraints, tariff impacts, and other factors, with costs not reaching 2024 cost levels until the late 2030s. After the 2026 peak in costs, the high cost projection declines by less than 1% per year throughout the projection horizon. The mid and low projections have initial slopes that are steeper than later slopes, indicating that most publications see larger cost reductions in the near-term that then slow over time. By 2035, costs are reduced by 56%, 28%, and -2% in the low, mid, and high cases, respectively, and by 2050 are reduced by 68%, 47%, and 8%, respectively.

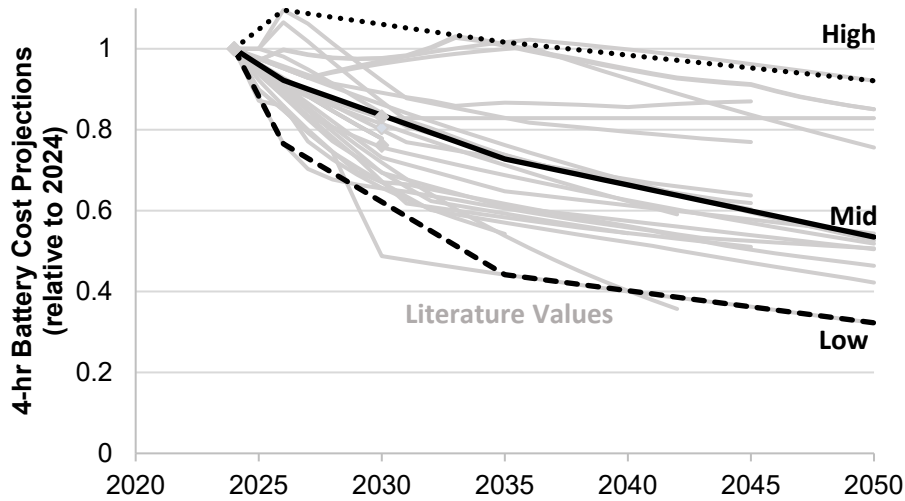


Figure 3. Battery cost projections for 4-hour lithium-ion systems, with values relative to 2024. The high, mid, and low cost projections developed in this work are shown as bold lines. Published projections are shown as gray lines. Figure values are included in the Appendix.

The resulting total system cost for a 4-hour battery storage device is shown in Figure 4. The 2024 starting point of \$334/kWh is derived from the bottom-up cost model described in Section 2.2. Although there is uncertainty in the 2024 cost (which is discussed later), we use a single cost for 2024 for convenience as we apply these costs in our long-term planning models (applying the same costs in 2024 means that the 2024 solution will not change as we shift from a “high” to a “mid” to a “low” cost projection for storage). By definition, the projections follow the same trajectories as the normalized cost values. Storage costs are \$147/kWh, \$234/kWh, and \$339/kWh in 2035 and \$108/kWh, \$178/kWh, and \$307/kWh in 2050. Costs for each year and each trajectory are included in the Appendix, including costs for years after 2050.

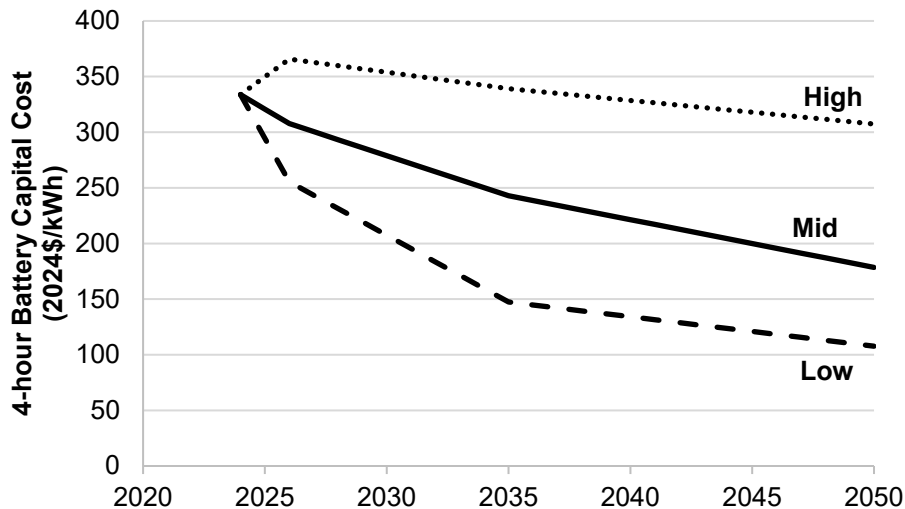


Figure 4. Battery cost projections for 4-hour lithium-ion systems. These values represent overnight capital costs for the complete battery system. Figure values are included in the Appendix.

One of the key assumptions in our projections is the choice of the starting point. A higher or lower starting point would shift the set of projections up or down relative to the change in magnitude of the starting point. To better assess the quality of our starting point, we compared the value from our bottom-up cost estimate with other recently published values (shown in Figure 5). This comparison shows that our starting point is within the range of estimated current pricing, though it is higher than many current estimates.

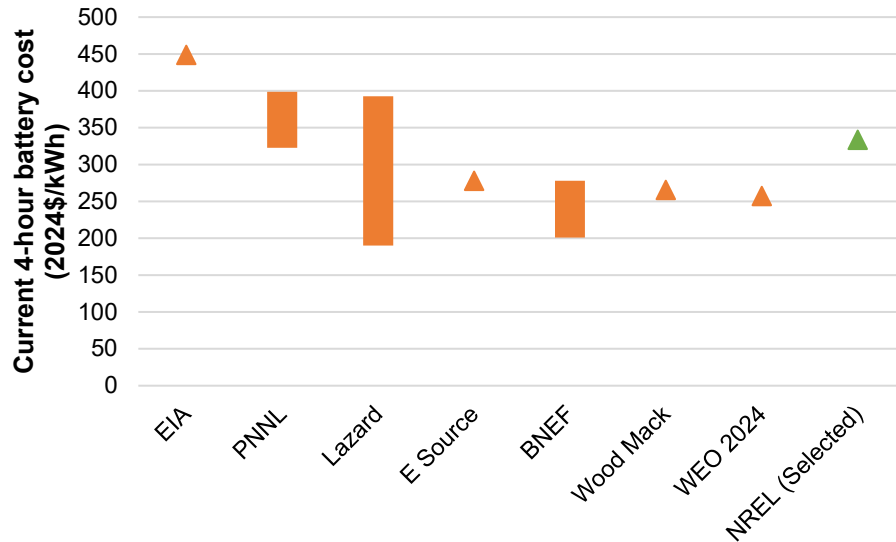


Figure 5. Current battery storage costs from recent studies. The NREL value (from the bottom-up cost model) was selected as the 2024 starting cost for this work.

One of the other challenges with using the normalized cost reductions to develop our projections is that projections that start at a higher value than our starting point might see greater cost reduction potential, and thus have a high percent reduction but still not have a low \$/kWh cost. Conversely, projections that start lower than our starting point might have smaller cost reduction potential on a percentage basis but achieve very low \$/kWh costs. However, we still prefer to use the normalized cost reduction numbers because of the large discrepancy in starting costs across published projections, and because it helps to obviate the challenge of different cost and system definitions in the different publications.

Figure 6 shows the cost projections for the energy and power components of the battery system. These components are combined to give a total system cost, where the total system cost (in \$/kWh) is the power component cost in \$/kW divided by the duration in hours plus the energy component cost in \$/kWh.

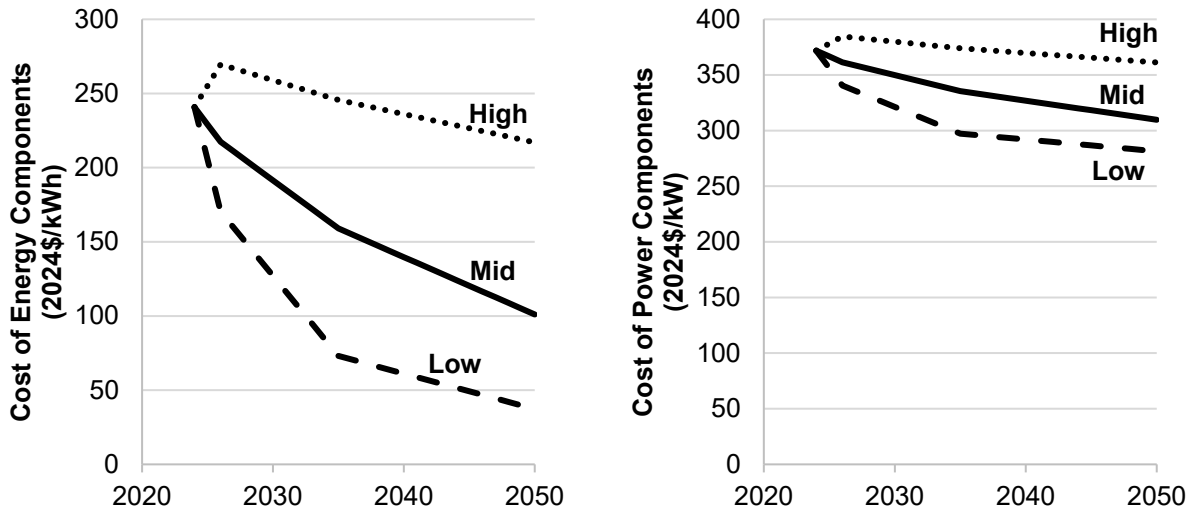


Figure 6. Cost projections for power (left) and energy (right) components of lithium-ion systems.
Note the different units and scales in the two plots.

These power and energy costs can be used to specify the capital costs for other durations. Figure 7 shows the cost projections for 2-, 4-, and 6-hour duration batteries (using the mid projection only). As expected, on a \$/kWh basis, longer duration batteries have a lower capital cost, and on a \$/kW basis, shorter duration batteries have a lower capital cost. Figure 7 also demonstrates why it is critical to cite the duration whenever providing a capital cost in \$/kWh or \$/kW.

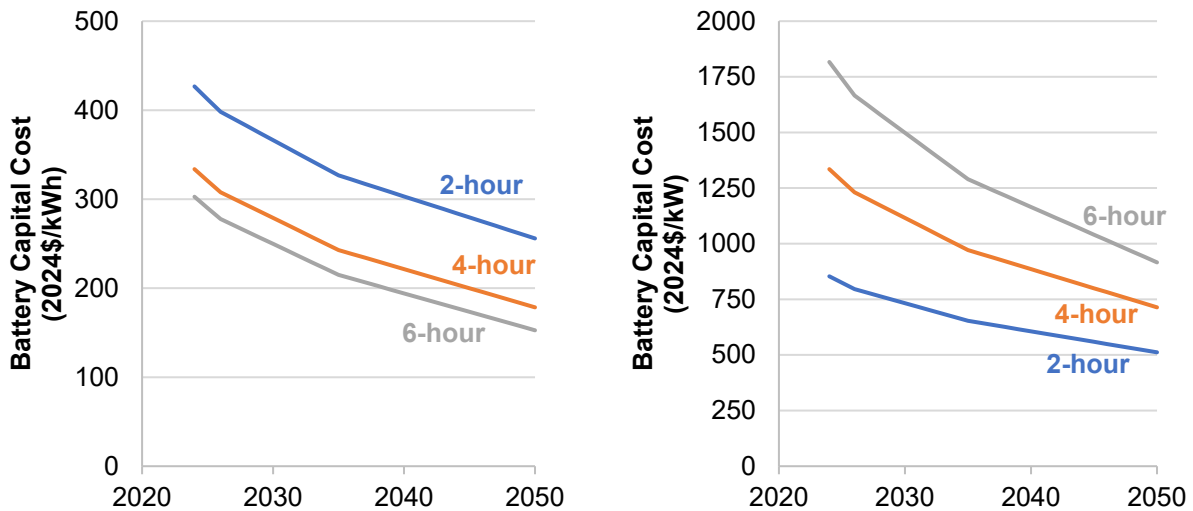


Figure 7. Cost projections for 2-, 4-, and 6-hour duration batteries using the mid cost projection.
Left shows the values in \$/kWh, while right shows the costs in \$/kW.

To fully specify the cost and performance of a battery storage system for capacity expansion modeling tools, additional parameters besides the capital costs are needed. Figure 8 shows the range of variable operations and maintenance (VOM), fixed operations and maintenance (FOM),

lifetime, and round-trip efficiency³ assumptions from the publications surveyed. The right-most point in the figure shows the value that we have selected to represent our 4-hour battery system. The VOM is often taken to be zero or near zero, and we have adopted zero for the VOM. This VOM is defined to coincide with an assumed one full cycle per day and a given calendar lifetime.

We have allocated all operating costs (at the one-cycle-per-day level) to the FOM. By putting the operations and maintenance costs in the FOM rather than the VOM we in essence assume that battery performance has been guaranteed over the lifetime, such that operating the battery does not incur any costs to the battery operator. The FOM has a much broader range of values. One of the primary differences in the level of FOM was whether augmentation or other performance maintenance were included in the cost. Lower FOM numbers typically include only simple maintenance while higher FOM numbers include some capacity additions or replacements to address degradation. We have adopted a FOM value from the high end and assume that the FOM cost will counteract degradation such that the system will be able to perform at rated capacity throughout its lifetime. The FOM value selected is 4% of the \$/kW capacity cost for a 4-hour battery. This value is selected based on the more-detailed analysis of FOM costs (with augmentation) presented by Newell et al. (2022). We assume that this FOM is consistent with providing approximately one cycle per day. If the battery is operating at a much higher rate of cycling, then this FOM value might not be sufficient to counteract degradation.

³ Round-trip efficiency is defined as the system efficiency through a charge/discharge cycle. For example, it would include losses associated with cooling systems or battery control equipment.

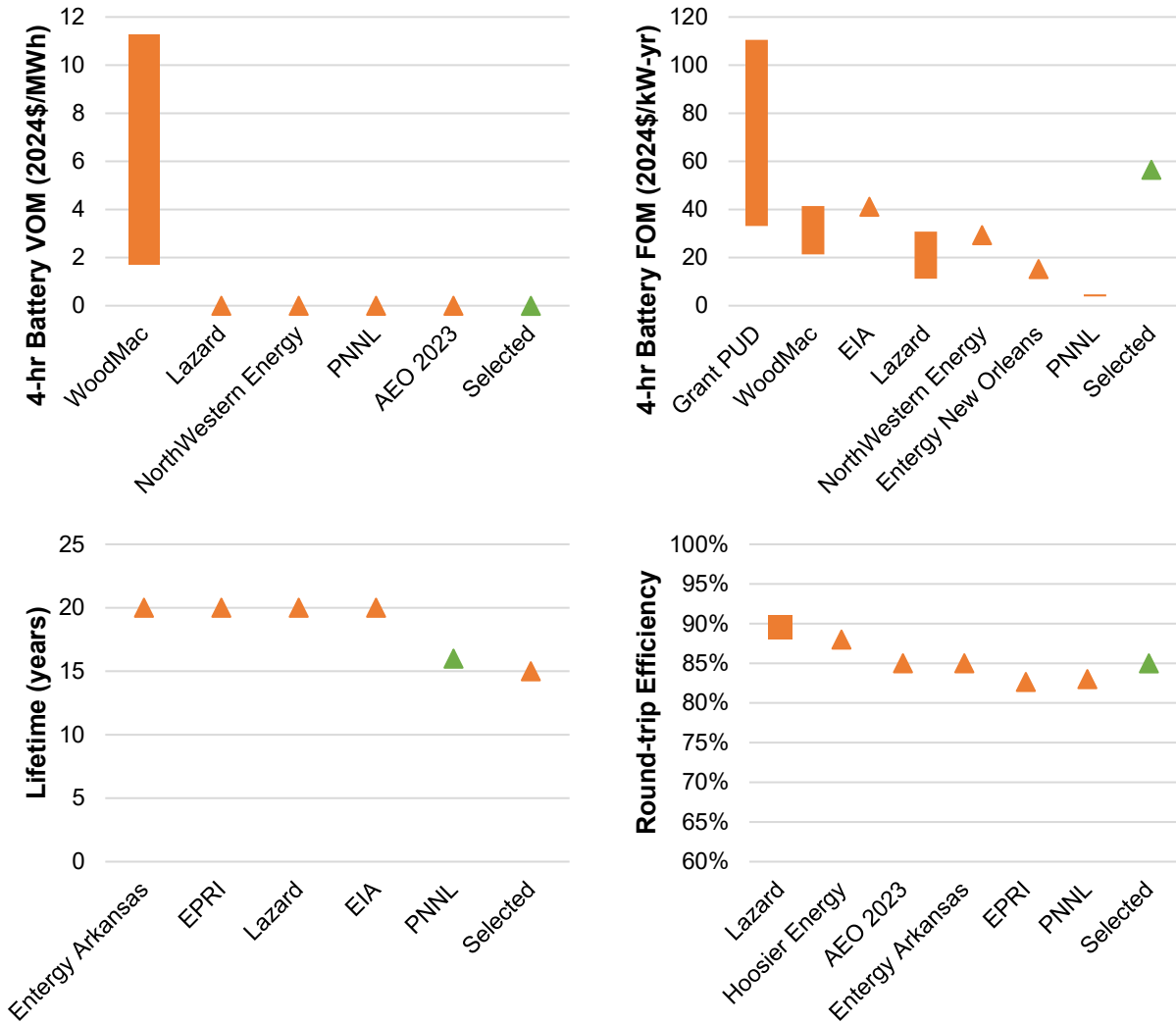


Figure 8. Variable O&M (top right), fixed O&M (top left), lifetime (bottom right), and round-trip efficiency (bottom left) from various published sources. The values selected for this study are the right-most values shown.

The lifetime we selected is 15 years, which is on the lower end of published values. This is a conservative choice, which we make because of the uncertainty in battery lifetimes (existing 4-hour batteries are all new, so no system has yet reached 15 or more years). The round-trip efficiency is chosen to be 85%, which is well aligned with published values.

4 Summary

Battery storage costs have evolved rapidly over the past several years, necessitating an update to storage cost projections used in long-term planning models and other activities. This work documents the development of these projections, which are based on recent publications of storage costs.

Many factors might influence how costs evolve going forward including market demand, supply chain expansions or constraints, interplay with other sectors such as electric vehicles, and material costs and availability. Consequently, the projections show a wide range of storage costs, both in terms of current costs as well as future costs. In the near term (by 2026), some projections show costs increasing up to 10% while others show substantial declines of up to 23%.

The cost projections developed in this work utilize normalized cost reductions across the literature, and result in a range of 2% capital cost increase to 56% capital cost reduction by 2035, and 8-68% cost reductions by 2050 (see Table 2 in the appendix). The cost projections are also accompanied by assumed operations and maintenance costs, lifetimes, and round-trip efficiencies, and these performance metrics are benchmarked against other published values.

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Appendix

Table 2 includes the values that are plotted in Figure 3 and Figure 4. Figure 9 and Figure 10 show the comparison of the projections developed in this work relative to the projections that were produced in our last update (Cole and Karmakar 2023). The 4-hour cost projections in this report are much lower in 2024 primarily due to the updated initial cost from the bottom-up cost model used in this work. The lower costs persist through 2050 because of that lower starting point.

Table 2. Values from Figure 3 and Figure 4, which show the normalized and absolute storage costs over time. Storage costs are overnight capital costs for a complete 4-hour battery system.

Year	Normalized Cost Reduction			4-hour Storage Costs (2024\$/kWh)		
	Low	Mid	High	Low	Mid	High
2024	1.00	1.00	1.00	334	334	334
2025	0.88	0.96	1.05	295	321	350
2026	0.77	0.92	1.10	255	308	366
2027	0.73	0.90	1.09	243	301	363
2028	0.69	0.88	1.08	231	293	360
2029	0.66	0.86	1.07	219	286	357
2030	0.62	0.84	1.06	207	279	354
2031	0.59	0.81	1.05	195	272	351
2032	0.55	0.79	1.04	183	265	348
2033	0.51	0.77	1.03	171	257	345
2034	0.48	0.75	1.03	159	250	342
2035	0.44	0.73	1.02	147	243	339
2036	0.43	0.71	1.01	145	239	337
2037	0.43	0.70	1.00	142	234	335
2038	0.42	0.69	1.00	139	230	333
2039	0.41	0.68	0.99	137	226	331
2040	0.40	0.66	0.98	134	221	329
2041	0.39	0.65	0.98	132	217	326
2042	0.39	0.64	0.97	129	213	324
2043	0.38	0.62	0.97	126	209	322
2044	0.37	0.61	0.96	124	204	320
2045	0.36	0.60	0.95	121	200	318
2046	0.35	0.59	0.95	118	196	316
2047	0.35	0.57	0.94	116	191	314
2048	0.34	0.56	0.93	113	187	312
2049	0.33	0.55	0.93	110	183	309
2050	0.32	0.53	0.92	108	178	307
2051	0.32	0.53	0.92	106	176	306
2052	0.31	0.52	0.91	105	174	305

	Normalized Cost Reduction			4-hour Storage Costs (2024\$/kWh)		
2053	0.31	0.52	0.91	104	172	304
2054	0.31	0.51	0.91	102	170	303
2055	0.30	0.50	0.91	101	168	302
2056	0.30	0.50	0.90	100	166	301
2057	0.29	0.49	0.90	98	163	300
2058	0.29	0.48	0.90	97	161	299
2059	0.29	0.48	0.89	96	159	298
2060	0.28	0.47	0.89	94	157	297

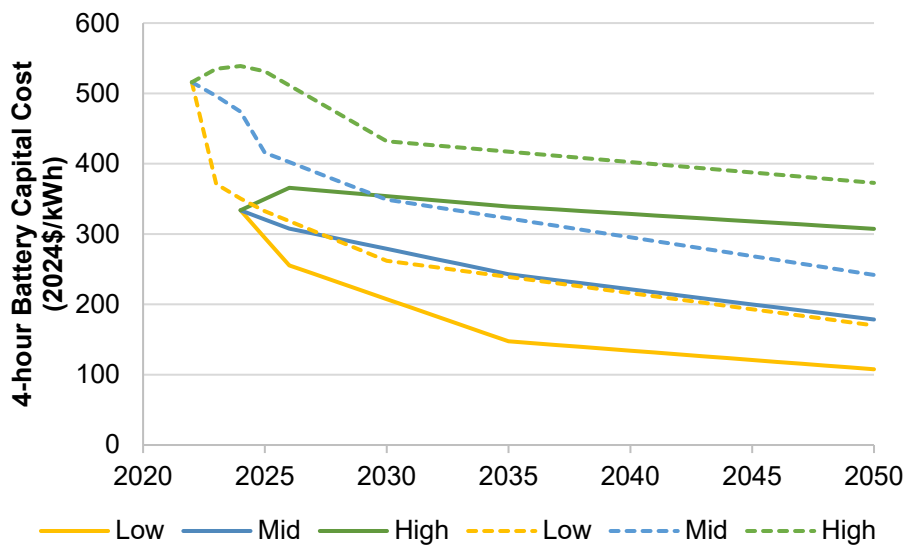


Figure 9. Comparison of cost projections developed in this report (solid lines) against the values from the 2023 cost projection report (Cole and Karmakar 2023) (dashed lines).

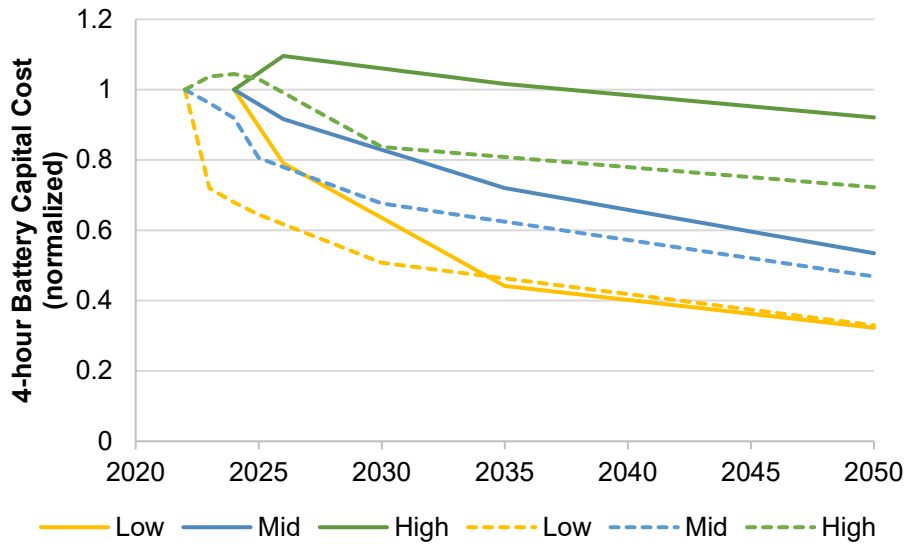


Figure 10. Comparison of cost projections developed in this report (solid lines) the values from the 2023 cost projection report (Cole and Karmakar 2023) (dashed lines).

Table 3. Breakdown of battery cost categories

Li-Ion Battery Cabinets	Comments
Li-Ion Cells	LFP cells from China. Distortion: 301 tariff and 3.4% general duty
Battery Packs	70% battery management, 30% thermal management
Enclosure	Container, racks, fire suppression
Labor	Fixed: Salaried supervisory personnel
Electricity	Representative U.S. rate for commercial loads in Q1 2024
Depreciation	Estimated facility capex of \$7M per annual GWh of ESS capacity
Maintenance	Maintenance of facility capex estimated at 4% per year
Profit	Profit markup of module manufacturer
Shipping	Shipping cost of battery components to the installation site
Passthrough	Distortion: Half of 45X used to decrease price to improve competitiveness
Inverter	
Bi-directional Inverter	Bi-directional Inverter. 30% PCBAs, 10% Electrical Parts, 10% Climate Control, 10% Enclosure, 40% Domestic Production
SBOS	
Site Preparation & Staging	Includes preconstruction survey, access road and parking, security fencing, temporary office/utilities setup, geotechnical investigation, soil stripping, stockpiling, clearing, grubbing, grading, compaction, erosion control

Concrete Pads	Assumes 0.5m thick concrete pad for ESS, transformer, switchgear and circuit breaker
EBOS	
Transformer	2.8 MVA Transformer, 0.8pf Inverters to point of interconnection
Switch Gear	DC/AC disconnects from China. Distortion: Section 301 tariff
Conductors	DC & AC cables ~10AWG or 4-6mm
Breaker/DC Disconnect	Oversize 20%-25% to avoid tripping, sourced from China. Distortion: Section 301 tariff
Grounding	Earthing Cables and Lightning Rods
SCADA	Control and Monitoring Setup for the whole system
Substation	MV to HV equipment, sourced from China. Distortion: Section 301 tariff
Transmission	2.4-mile line with poles, towers, cables
Shipping	Shipping of components to installer site
Installation Labor	
Structural and Electrical Labor	Labor cost related to construction, structural, and electrical work at the installation site
Permitting & Interconnection	Fixed: Permit application fee. Utility engagement amortized across all proposals. Excludes network upgrade equipment costs
Sales Tax	U.S. average sales tax proportional to system hardware cost
Contingency	Contingency acknowledges there will be cost overruns of unknown origin
EPC Overhead	
Warehousing	Distortion: Storage during Customs process for compliance with UFLPA
Logistics	Cost related to third party logistics related fee
Engineering	Fixed: Engineering salaries independent of system size
Outreach	Time to scout and agree on land lease, Community engagement amortized across all proposals
Management	Fixed: Management salaries independent of developer's annual installations
Profit	Developer profit markup on total material cost