

LAZARD'S LEVELIZED COST OF ENERGY ANALYSIS—VERSION 13.0

# LAZARD

## Introduction

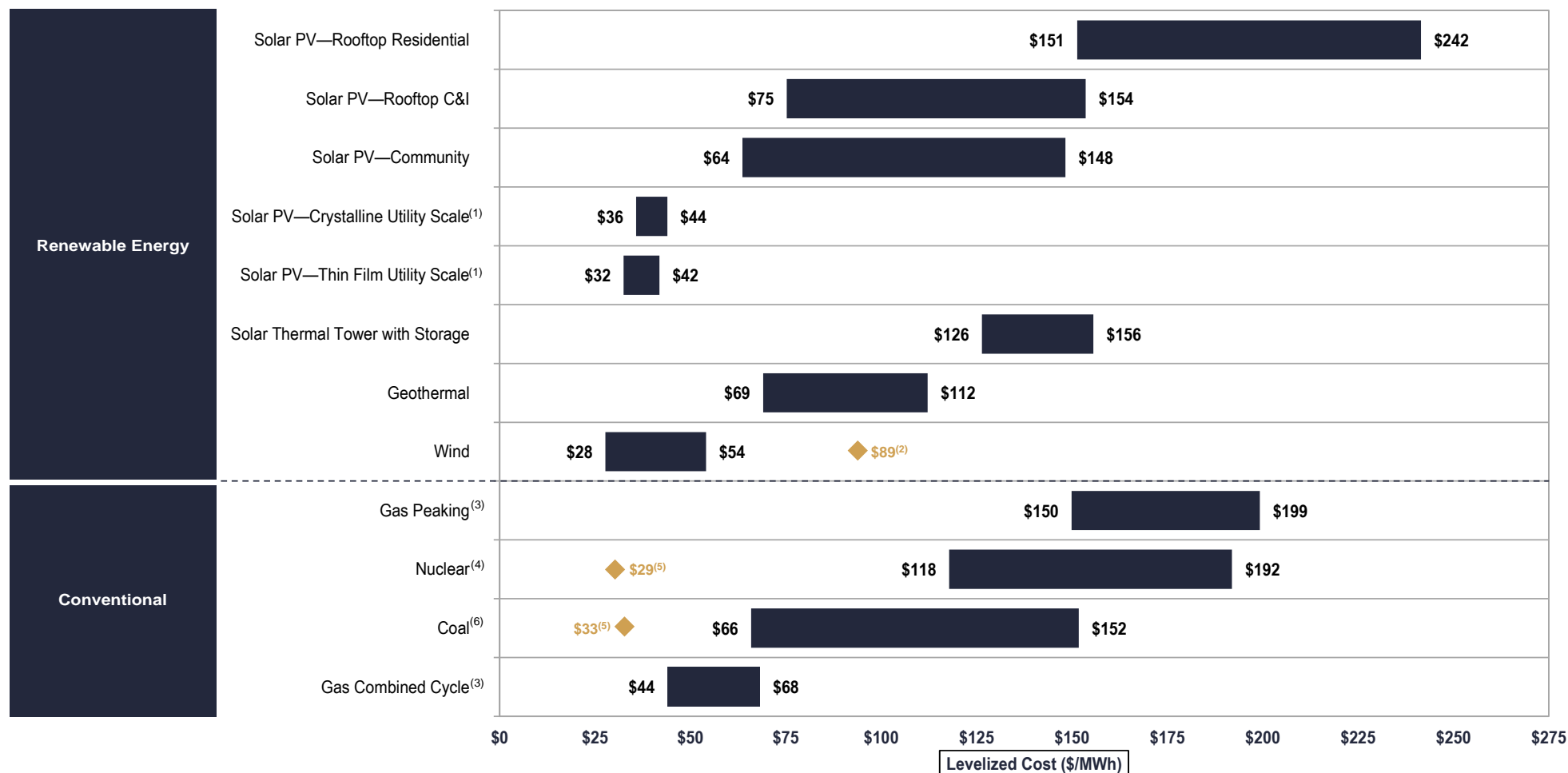
Lazard's Levelized Cost of Energy ("LCOE") analysis addresses the following topics:

- **Comparative LCOE analysis for various generation technologies on a \$/MWh basis, including sensitivities for U.S. federal tax subsidies, fuel prices and costs of capital**
- **Illustration of how the LCOE of onshore wind and utility-scale solar compare to the marginal cost of selected conventional generation technologies**
- **Historical LCOE comparison of various utility-scale generation technologies**
- **Illustration of the historical LCOE declines for wind and utility-scale solar technologies**
- **Illustration of how the LCOEs of utility-scale solar and wind compare to those of gas peaking and combined cycle**
- **Comparison of capital costs on a \$/kW basis for various generation technologies**
- **Deconstruction of the LCOE for various generation technologies by capital cost, fixed operations and maintenance expense, variable operations and maintenance expense and fuel cost**
- **Overview of the methodology utilized to prepare Lazard's LCOE analysis**
- **Considerations regarding the operating characteristics and applications of various generation technologies**
- **An illustrative comparison of the value of carbon abatement of various renewable energy technologies**
- **Summary of assumptions utilized in Lazard's LCOE analysis**
- **Summary considerations in respect of Lazard's approach to evaluating the LCOE of various conventional and renewable energy technologies**

Other factors would also have a potentially significant effect on the results contained herein, but have not been examined in the scope of this current analysis. These additional factors, among others, could include: capacity value vs. energy value; network upgrades, transmission, congestion or other integration-related costs; significant permitting or other development costs, unless otherwise noted; and costs of complying with various environmental regulations (e.g., carbon emissions offsets or emissions control systems). This analysis also does not address potential social and environmental externalities, including, for example, the social costs and rate consequences for those who cannot afford distributed generation solutions, as well as the long-term residual and societal consequences of various conventional generation technologies that are difficult to measure (e.g., nuclear waste disposal, airborne pollutants, greenhouse gases, etc.)

# Levelized Cost of Energy Comparison—Unsubsidized Analysis

Selected renewable energy generation technologies are cost-competitive with conventional generation technologies under certain circumstances



Source: Lazard estimates.

Note: Here and throughout this presentation, unless otherwise indicated, the analysis assumes 60% debt at 8% interest rate and 40% equity at 12% cost. Please see page titled "Levelized Cost of Energy Comparison—Sensitivity to Cost of Capital" for cost of capital sensitivities. These results are not intended to represent any particular geography. Please see page titled "Solar PV versus Gas Peaking and Wind versus CCGT—Global Markets" for regional sensitivities to selected technologies.

(1) Unless otherwise indicated herein, the low end represents a single-axis tracking system and the high end represents a fixed-tilt system.

(2) Represents the estimated implied midpoint of the LCOE of offshore wind, assuming a capital cost range of approximately \$2.33 – \$3.53 per watt.

(3) The fuel cost assumption for Lazard's global, unsubsidized analysis for gas-fired generation resources is \$3.45/MMBTU.

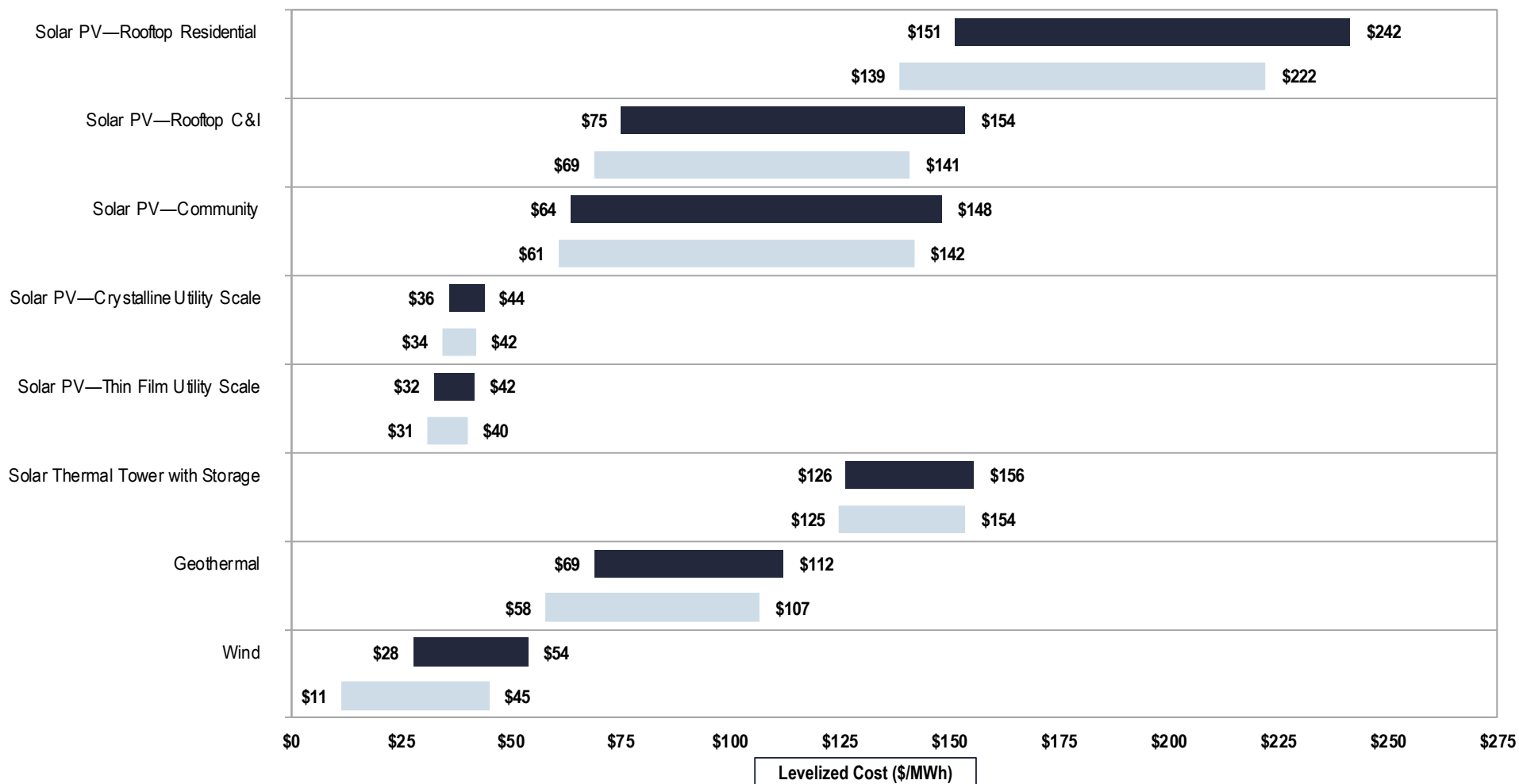
(4) Unless otherwise indicated, the analysis herein does not reflect decommissioning costs, ongoing maintenance-related capital expenditures or the potential economic impacts of federal loan guarantees or other subsidies.

(5) Represents the midpoint of the marginal cost of operating coal and nuclear facilities, inclusive of decommissioning costs for nuclear facilities. Analysis assumes that the salvage value for a decommissioned coal plant is equivalent to its decommissioning and site restoration costs. Inputs are derived from a benchmark of operating coal and nuclear assets across the U.S. Capacity factors, fuel and variable and fixed operating expenses are based on upper and lower quartile estimates derived from Lazard's research. Please see page titled "Levelized Cost of Energy Comparison—Renewable Energy versus Marginal Cost of Selected Existing Conventional Generation" for additional details.

(6) High end incorporates 90% carbon capture and compression. Does not include cost of transportation and storage.

## Levelized Cost of Energy Comparison—Sensitivity to U.S. Federal Tax Subsidies<sup>(1)</sup>

The Investment Tax Credit (“ITC”) and Production Tax Credit (“PTC”), extended in December 2015, remain an important component of the levelized cost of renewable energy generation technologies



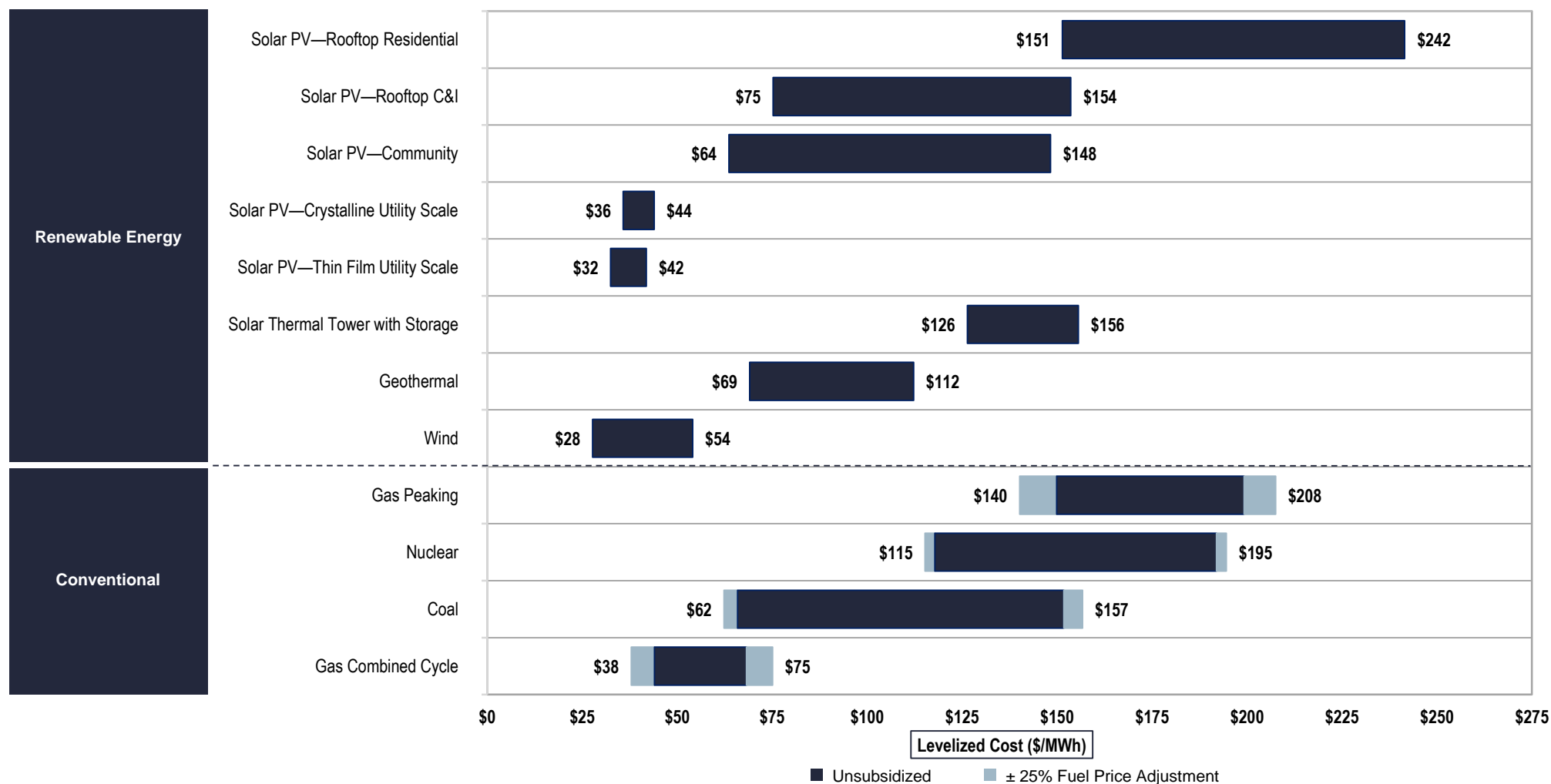
Source: Lazard estimates.

Note: The sensitivity analysis presented on this page also includes sensitivities related to the U.S. Tax Cuts and Jobs Act (“TCJA”) of 2017. The TCJA contains several provisions that impact the LCOE of various generation technologies (e.g., a reduced federal corporate income tax rate, an ability to elect immediate bonus depreciation, limitations on the deductibility of interest expense and restrictions on the utilization of past net operating losses). On balance, the TCJA reduced the LCOE of conventional generation technologies and marginally increased the LCOE for renewable energy technologies.

(1) The sensitivity analysis presented on this page assumes that projects qualify for the full ITC/PTC and have a capital structure that includes sponsor equity, tax equity and debt.

## Levelized Cost of Energy Comparison—Sensitivity to Fuel Prices

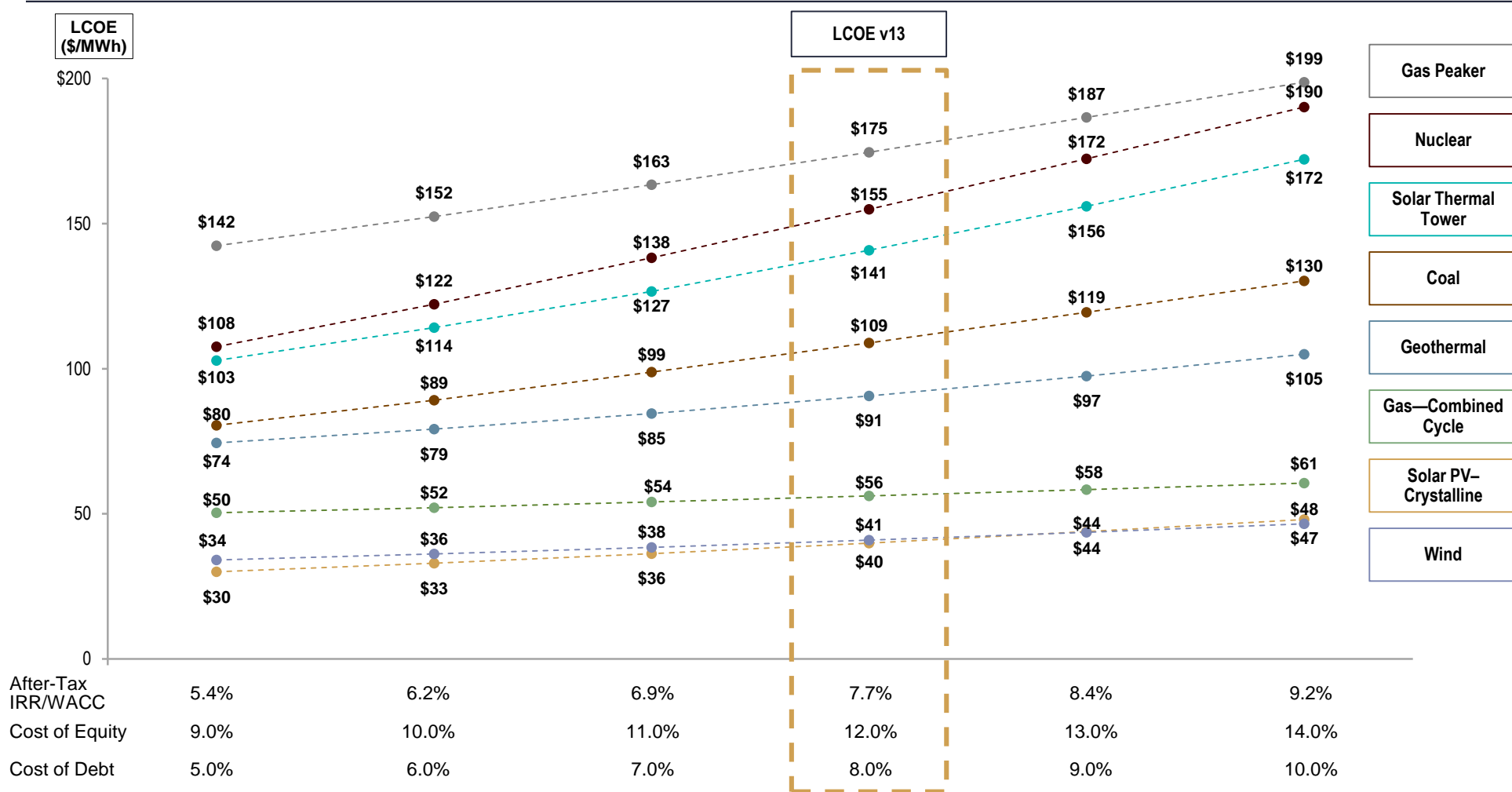
Variations in fuel prices can materially affect the LCOE of conventional generation technologies, but direct comparisons to “competing” renewable energy generation technologies must take into account issues such as dispatch characteristics (e.g., baseload and/or dispatchable intermediate capacity vs. those of peaking or intermittent technologies)



# Levelized Cost of Energy Comparison—Sensitivity to Cost of Capital

A key consideration in determining the LCOE values for utility-scale generation technologies is the cost, and availability, of capital<sup>(1)</sup>; this dynamic is particularly significant for renewable energy generation technologies

Midpoint of Unsubsidized LCOE<sup>(2)</sup>



Source: Lazard estimates.

Note: Analysis assumes 60% debt and 40% equity. Unless otherwise noted, the assumptions used in this sensitivity correspond to those used in the global, unsubsidized analysis as presented on the page titled "Levelized Cost of Energy Comparison—Unsubsidized Analysis".

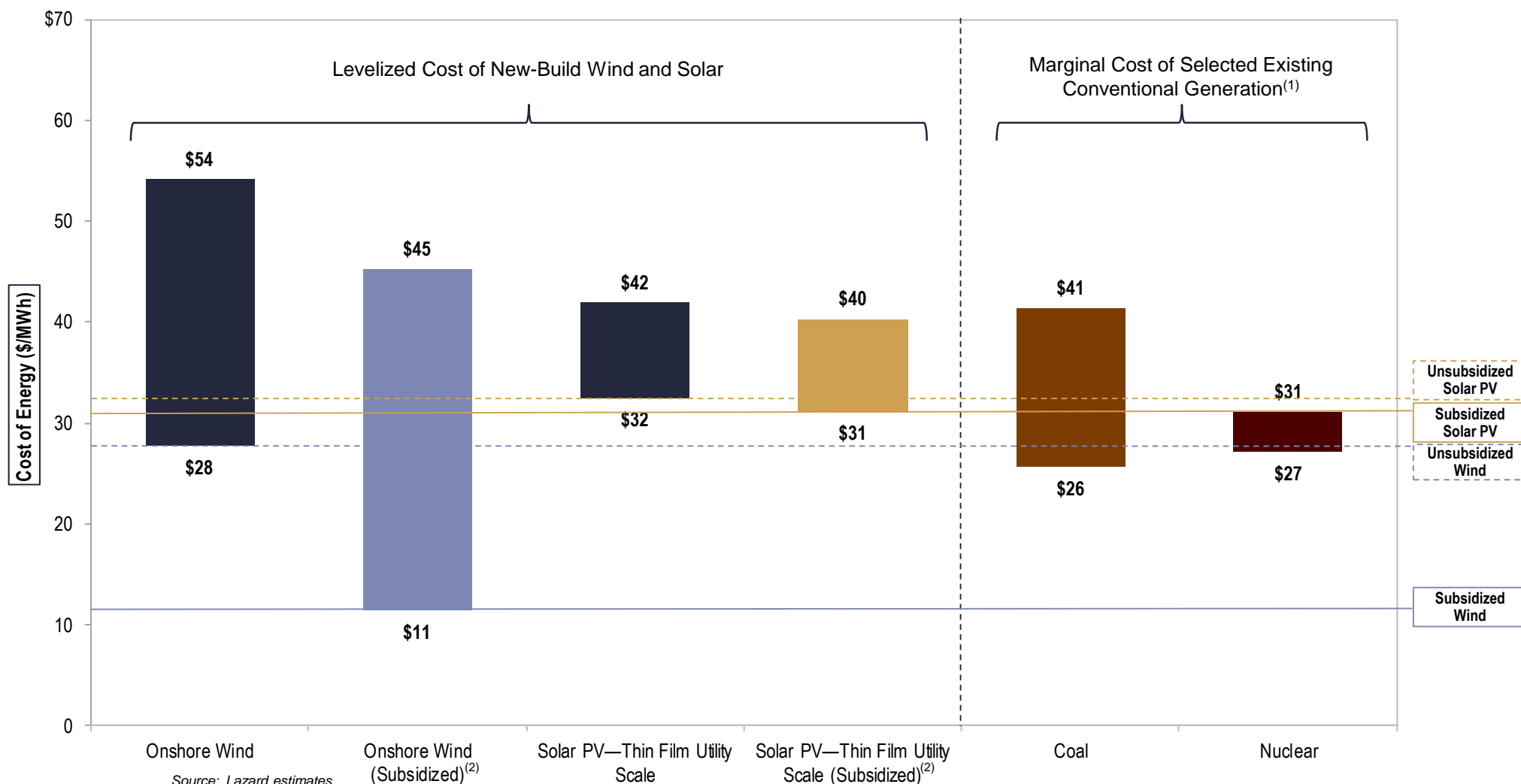
(1) Cost of capital as used herein indicates the cost of capital applicable to the asset/plant and not the cost of capital of a particular investor/owner.

(2) Reflects the average of the high and low LCOE for each respective cost of capital assumption.

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# Levelized Cost of Energy Comparison—Renewable Energy versus Marginal Cost of Selected Existing Conventional Generation

Certain renewable energy generation technologies are approaching an LCOE that is competitive with the marginal cost of existing conventional generation



Source: Lazard estimates.

Note: Unless otherwise noted, the assumptions used in this sensitivity correspond to those used in the global, unsubsidized analysis as presented on the page titled "Levelized Cost of Energy Comparison—Unsubsidized Analysis".

(1) Represents the marginal cost of operating coal and nuclear facilities, inclusive of decommissioning costs for nuclear facilities. Analysis assumes that the salvage value for a decommissioned coal plant is equivalent to its decommissioning and site restoration costs. Inputs are derived from a benchmark of operating coal and nuclear assets across the U.S. Capacity factors, fuel and variable and fixed operating expenses are based on upper and lower quartile estimates derived from Lazard's research.

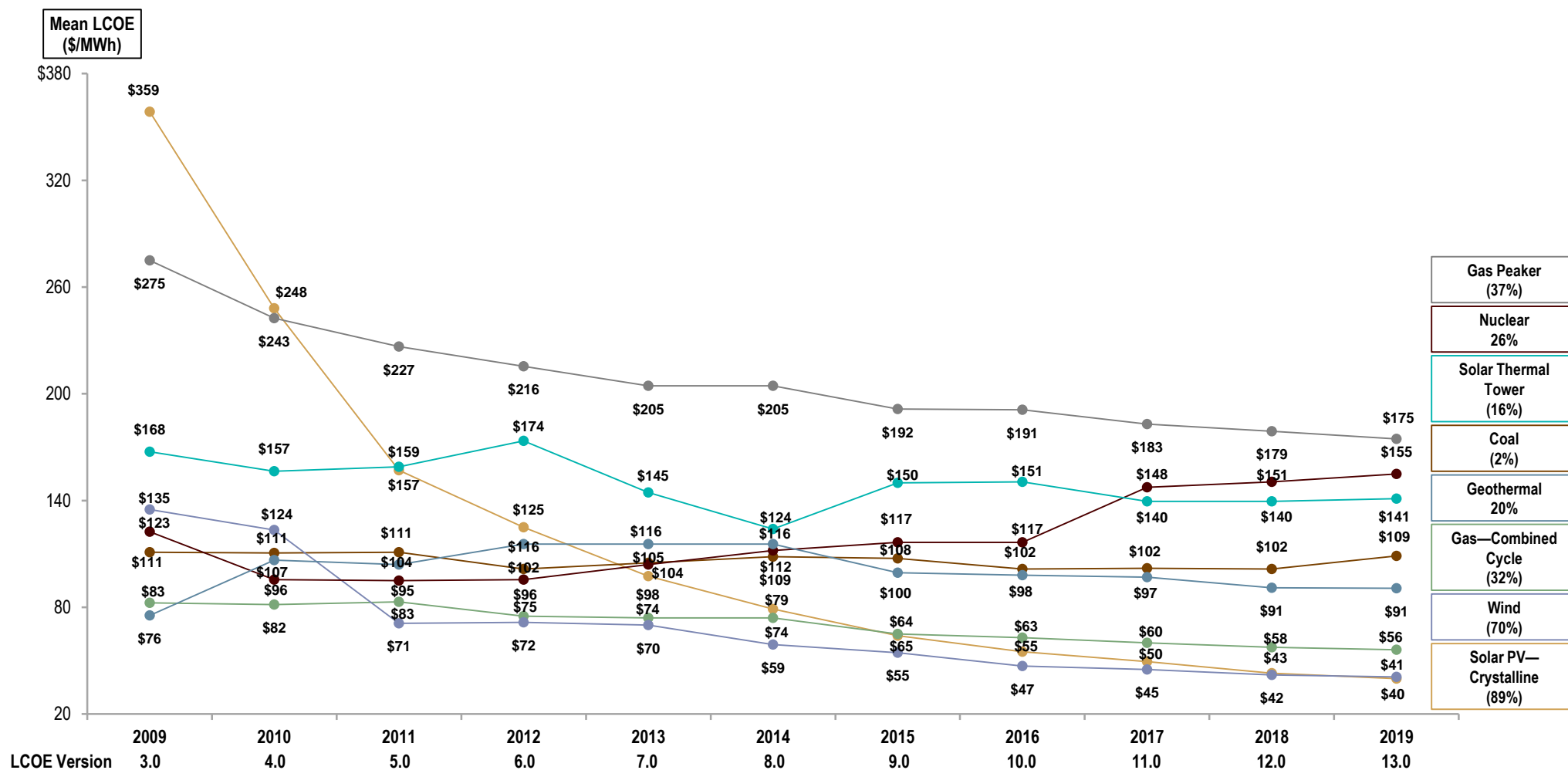
(2) The subsidized analysis includes sensitivities related to the TCJA and U.S. federal tax subsidies. Please see page titled "Levelized Cost of Energy Comparison—Sensitivity to U.S. Federal Tax Subsidies" for additional details.

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# Levelized Cost of Energy Comparison—Historical Utility-Scale Generation Comparison

Lazard's unsubsidized LCOE analysis indicates significant historical cost declines for utility-scale renewable energy generation technologies driven by, among other factors, decreasing capital costs, improving technologies and increased competition

Selected Historical Mean Unsubsidized LCOE Values<sup>(1)</sup>

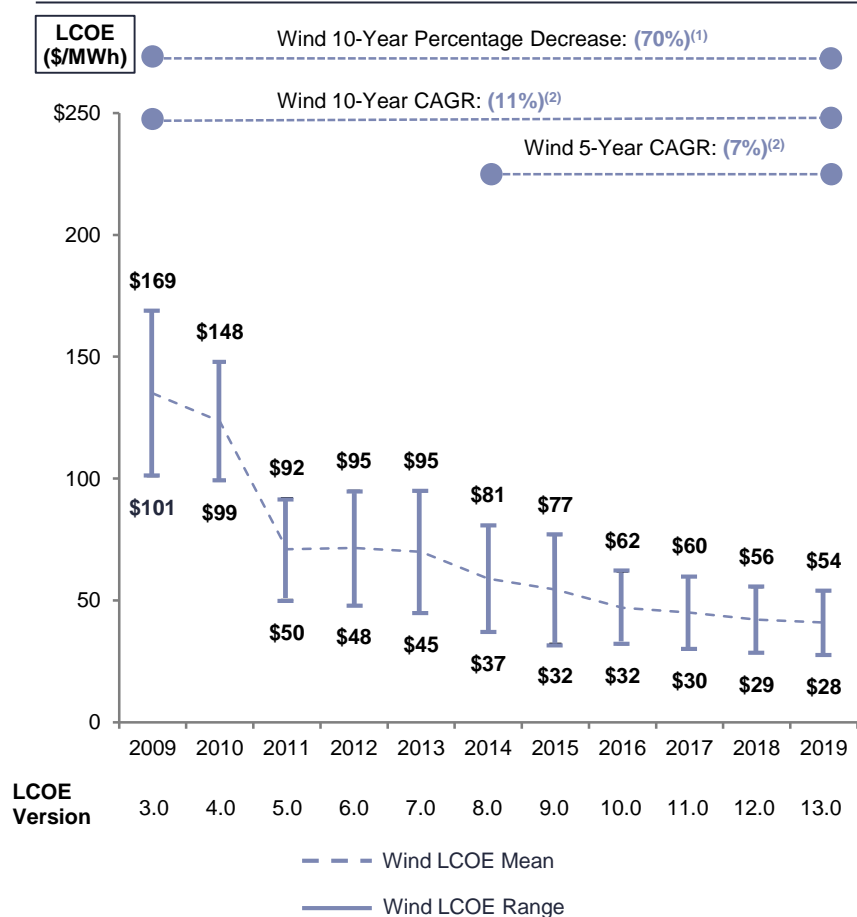




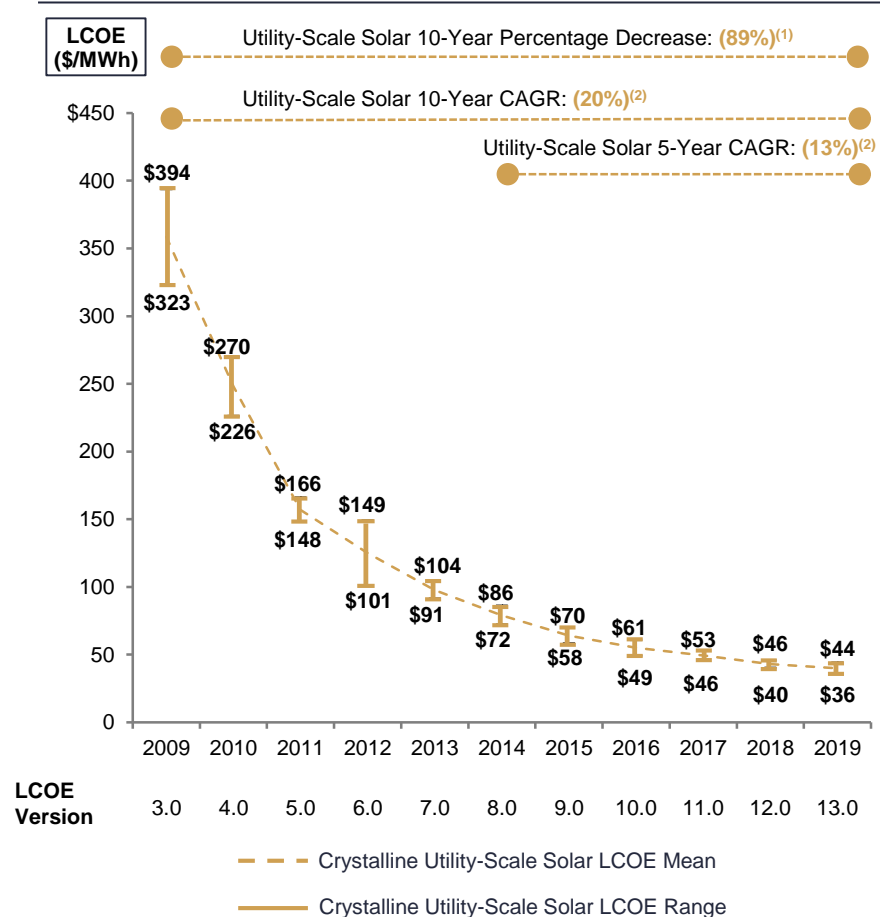
# Levelized Cost of Energy Comparison—Historical Renewable Energy LCOE Declines

In light of material declines in the pricing of system components and improvements in efficiency, among other factors, wind and utility-scale solar PV have exhibited dramatic LCOE declines; however, as these industries mature, the rates of decline have diminished

### Unsubsidized Wind LCOE

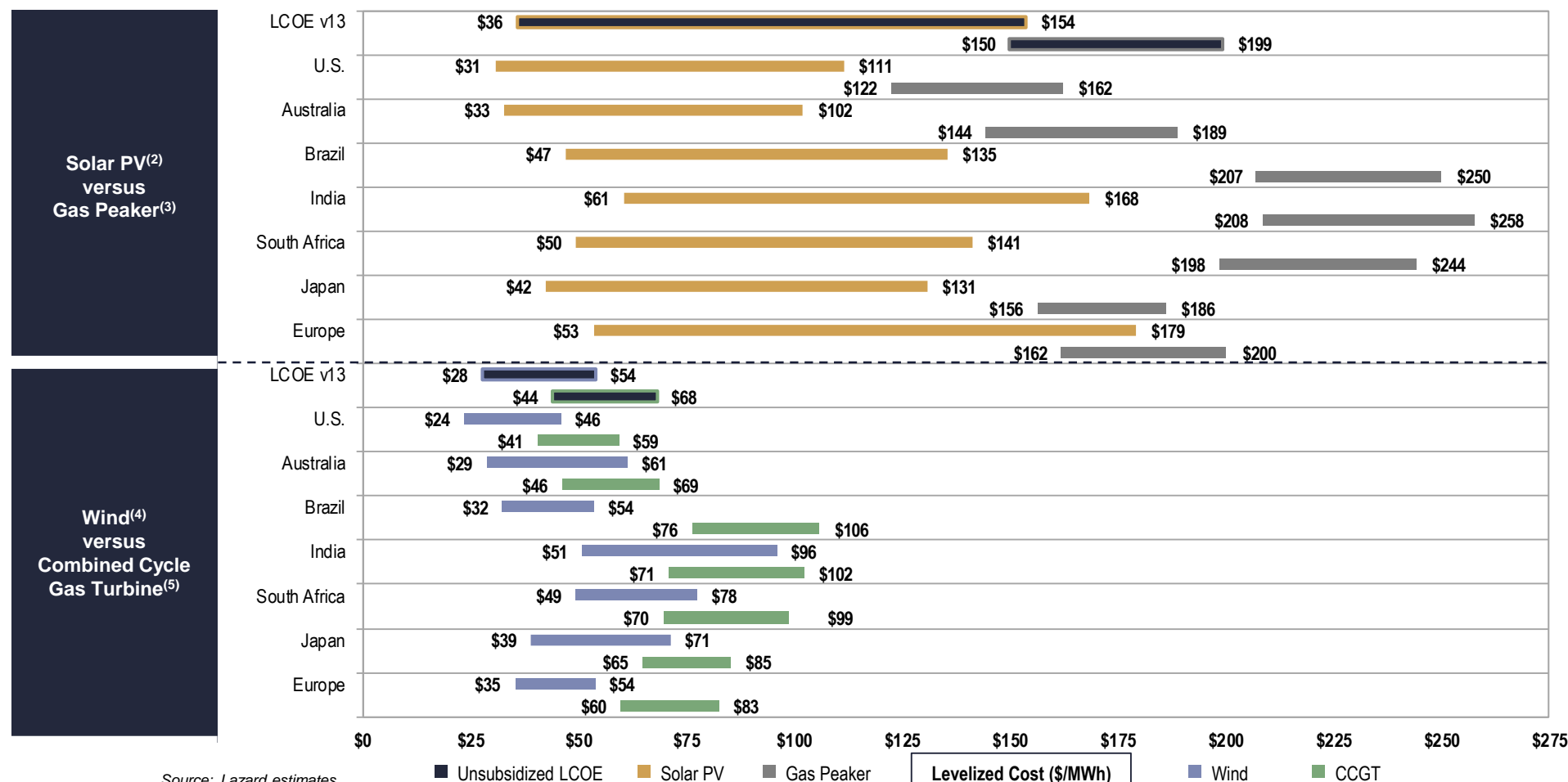


### Unsubsidized Solar PV LCOE



# Solar PV versus Gas Peaking and Wind versus CCGT—Global Markets<sup>(1)</sup>

Solar PV and wind have become increasingly competitive with conventional technologies with similar generation profiles; without storage, however, these resources lack the dispatch characteristics, and associated benefits, of such conventional technologies



Source: Lazard estimates.

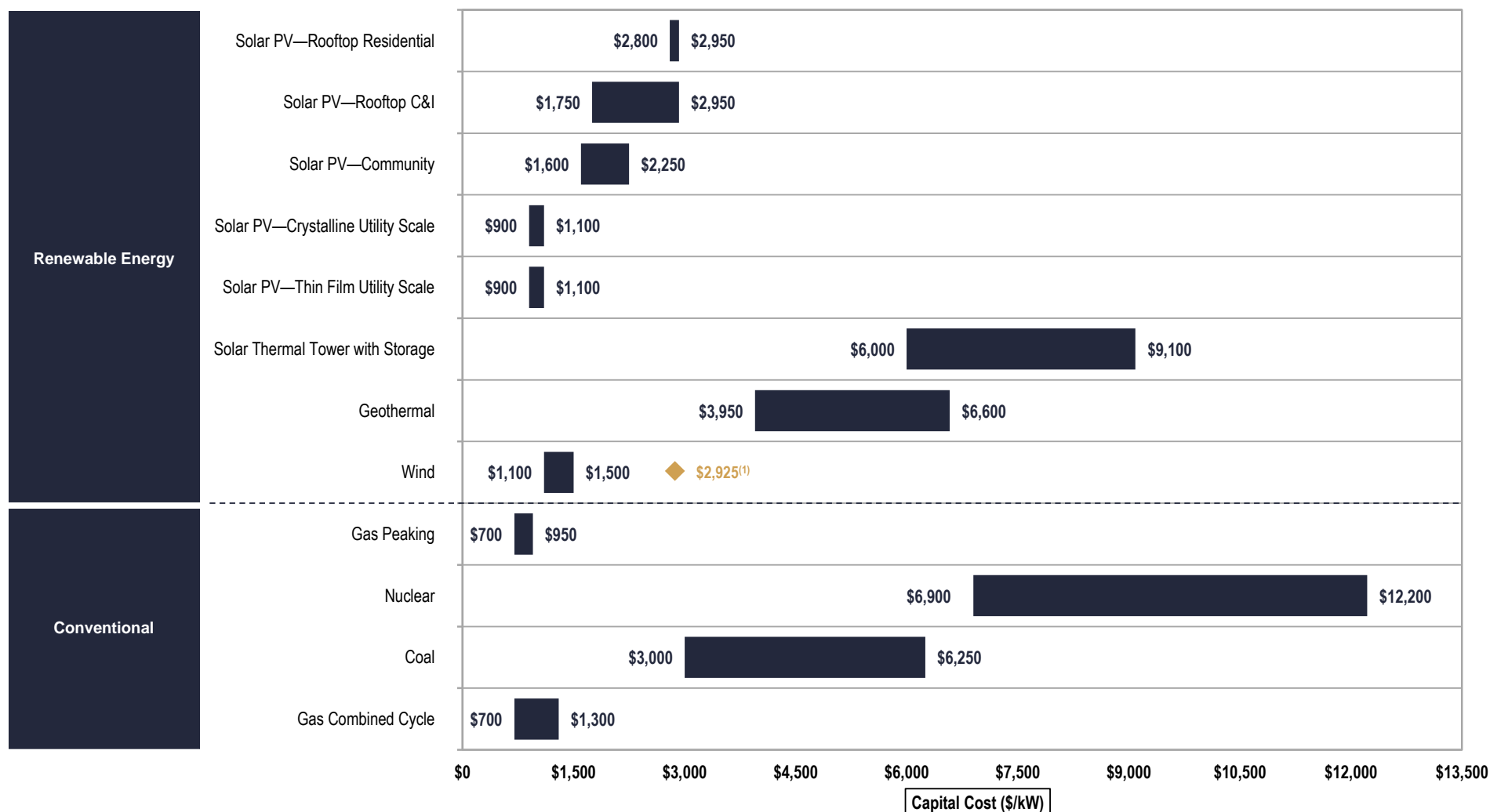
Note: The analysis presented on this page assumes country-specific or regionally-applicable tax rates.

- (1) Equity IRRs are assumed to be 10.0% – 12.0% for Australia, 15.0% for Brazil and South Africa, 13.0% – 15.0% for India, 8.0% – 10.0% for Japan, 7.5% – 12.0% for Europe and 7.5% – 9.0% for the U.S. Cost of debt is assumed to be 5.0% – 5.5% for Australia, 10.0% – 12.0% for Brazil, 12.0% – 13.0% for India, 3.0% for Japan, 4.5% – 5.5% for Europe, 12.0% for South Africa and 4.0% – 4.5% for the U.S.
- (2) Low end assumes crystalline utility-scale solar with a single-axis tracker. High end assumes rooftop C&I solar. Solar projects assume illustrative capacity factors of 21% – 28% for the U.S., 26% – 30% for Australia, 26% – 28% for Brazil, 22% – 23% for India, 27% – 29% for South Africa, 16% – 18% for Japan and 13% – 16% for Europe.
- (3) Assumes natural gas prices of \$3.45 for the U.S., \$4.00 for Australia, \$8.00 for Brazil, \$7.00 for India, South Africa and Japan and \$6.00 for Europe (all in U.S.\$ per MMBtu). Assumes a capacity factor of 10% for all geographies.
- (4) Wind projects assume illustrative capacity factors of 38% – 55% for the U.S., 29% – 46% for Australia, 45% – 55% for Brazil, 25% – 35% for India, 31% – 36% for South Africa, 22% – 30% for Japan and 33% – 38% for Europe.
- (5) Assumes natural gas prices of \$3.45 for the U.S., \$4.00 for Australia, \$8.00 for Brazil, \$7.00 for India, South Africa and Japan and \$6.00 for Europe (all in U.S.\$ per MMBtu). Assumes capacity factors of 55% – 70% on the high and low ends, respectively, for all geographies.

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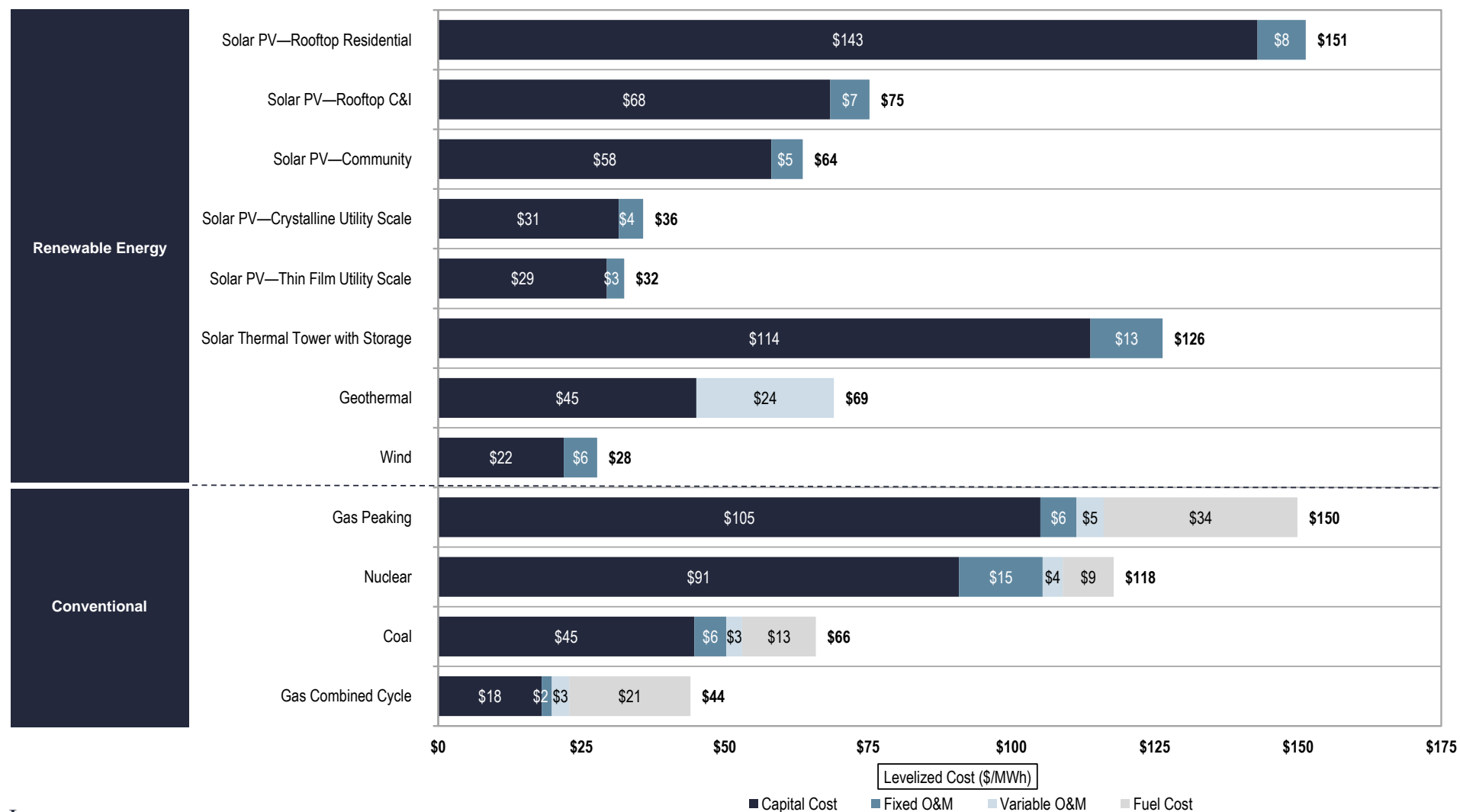
## Capital Cost Comparison

In some instances, the capital costs of renewable energy generation technologies have converged with those of certain conventional generation technologies, which coupled with improvements in operational efficiency for renewable energy technologies, have led to a convergence in LCOE between the respective technologies



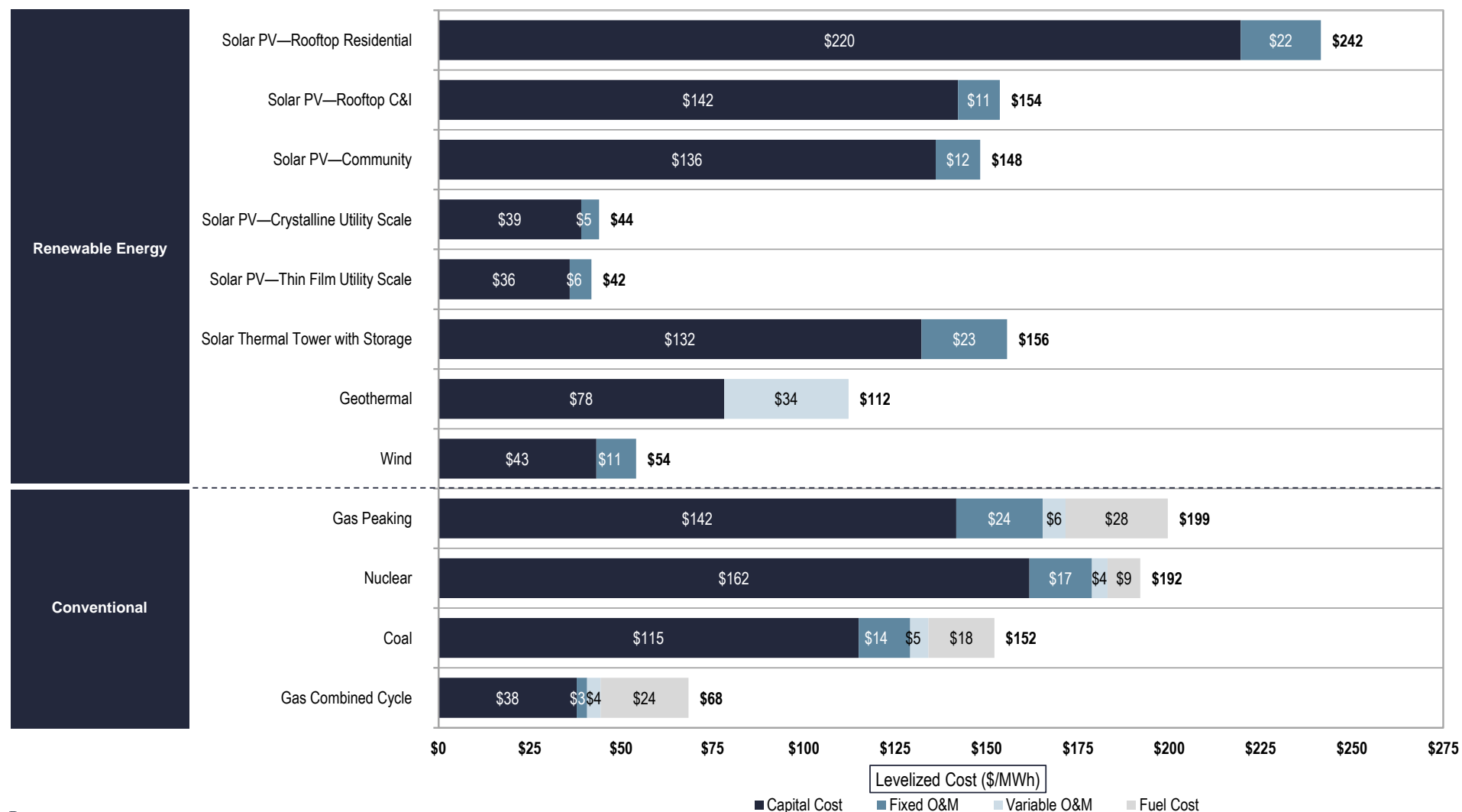
## Levelized Cost of Energy Components—Low End

Certain renewable energy generation technologies are already cost-competitive with conventional generation technologies; a key factor regarding the continued cost decline of renewable energy generation technologies is the ability of technological development and industry scale to continue lowering operating expenses and capital costs for renewable energy generation technologies



## Levelized Cost of Energy Components—High End

Certain renewable energy generation technologies are already cost-competitive with conventional generation technologies; a key factor regarding the continued cost decline of renewable energy generation technologies is the ability of technological development and industry scale to continue lowering operating expenses and capital costs for renewable energy generation technologies



# Levelized Cost of Energy Comparison—Methodology

(\$ in millions, unless otherwise noted)

Lazard's LCOE analysis consists of creating a power plant model representing an illustrative project for each relevant technology and solving for the \$/MWh value that results in a levered IRR equal to the assumed cost of equity (see subsequent "Key Assumptions" pages for detailed assumptions by technology)

		Unsubsidized Wind — High Case Sample Illustrative Calculations						Key Assumptions <sup>(4)</sup>	
Year <sup>(1)</sup>		0	1	2	3	4	5	20	
Capacity (MW)	(A)		150	150	150	150	150		150
Capacity Factor	(B)		38%	38%	38%	38%	38%		38%
Total Generation ('000 MWh)	(A) x (B) = (C)*		499	499	499	499	499		499
<b>Levelized Energy Cost (\$/MWh)</b>	<b>(D)</b>		<b>\$54.1</b>	<b>\$54.1</b>	<b>\$54.1</b>	<b>\$54.1</b>	<b>\$54.1</b>		<b>\$54.1</b>
<b>Total Revenues</b>	<b>(C) x (D) = (E)*</b>		<b>\$27.0</b>	<b>\$27.0</b>	<b>\$27.0</b>	<b>\$27.0</b>	<b>\$27.0</b>		<b>\$27.0</b>
Total Fuel Cost	(F)		--	--	--	--	--		--
Total O&M	(G)*		5.4	5.6	5.7	5.8	5.9		8.5
<b>Total Operating Costs</b>	<b>(F) + (G) = (H)</b>		<b>\$5.4</b>	<b>\$5.6</b>	<b>\$5.7</b>	<b>\$5.8</b>	<b>\$5.9</b>		<b>\$8.5</b>
<b>EBITDA</b>	<b>(E) - (H) = (I)</b>		<b>\$21.6</b>	<b>\$21.5</b>	<b>\$21.3</b>	<b>\$21.2</b>	<b>\$21.1</b>		<b>\$18.5</b>
Debt Outstanding - Beginning of Period	(J)		\$135.0	\$132.3	\$129.4	\$126.3	\$122.9		\$12.5
Debt - Interest Expense	(K)		(10.8)	(10.6)	(10.4)	(10.1)	(9.8)		(1.0)
Debt - Principal Payment	(L)		(2.7)	(2.9)	(3.1)	(3.4)	(3.6)		(12.5)
Levelized Debt Service	(K) + (L) = (M)		(\$13.5)	(\$13.5)	(\$13.5)	(\$13.5)	(\$13.5)		(\$13.5)
<b>EBITDA</b>	<b>(I)</b>		<b>\$21.6</b>	<b>\$21.5</b>	<b>\$21.3</b>	<b>\$21.2</b>	<b>\$21.1</b>		<b>\$18.5</b>
Depreciation (MACRS)	(N)		(45.0)	(72.0)	(43.2)	(25.9)	(25.9)		--
Interest Expense	(K)		(10.8)	(10.6)	(10.4)	(10.1)	(9.8)		(1.0)
<b>Taxable Income</b>	<b>(I) + (N) + (K) = (O)</b>		<b>(\$34.2)</b>	<b>(\$61.1)</b>	<b>(\$32.2)</b>	<b>(\$14.8)</b>	<b>(\$14.7)</b>		<b>\$17.5</b>
<b>Tax Benefit (Liability)<sup>(2)</sup></b>	<b>(O) x (tax rate) = (P)</b>		<b>\$13.7</b>	<b>\$24.5</b>	<b>\$12.9</b>	<b>\$5.9</b>	<b>\$5.9</b>		<b>(\$7.0)</b>
<b>After-Tax Net Equity Cash Flow</b>	<b>(I) + (M) + (P) = (Q)</b>	<b>(\$90.0)<sup>(3)</sup></b>	<b>\$21.8</b>	<b>\$32.4</b>	<b>\$20.7</b>	<b>\$13.7</b>	<b>\$13.5</b>		<b>(\$2.0)</b>
<b>IRR For Equity Investors</b>			<b>12.0%</b>						

Source: Lazard estimates.

Note: Wind—High LCOE case presented for illustrative purposes only.

\* Denotes unit conversion.

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

(2) Assumes full monetization of tax benefits or losses immediately.

(3) Reflects initial cash outflow from equity investors.

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

(5) Economic life sets debt amortization schedule. For comparison purposes, all technologies calculate LCOE on a 20-year IRR basis.

■ Technology-dependent

■ Levelized

## Energy Resources—Matrix of Applications

Despite convergence in the LCOE between certain renewable energy and conventional generation technologies, direct comparisons must take into account issues such as location (e.g., centralized vs. distributed) and dispatch characteristics (e.g., baseload and/or dispatchable intermediate capacity vs. those of peaking or intermittent technologies)

- This analysis does not take into account potential social and environmental externalities or reliability-related considerations

		Carbon Neutral/ REC Potential	Location		Geography	Dispatch		
			Distributed	Centralized		Intermittent	Peaking	Load-Following Baseload
Renewable Energy	Solar PV <sup>(1)</sup>	✓	✓	✓	Universal <sup>(2)</sup>	✓	✓	
	Solar Thermal	✓		✓	Rural	✓	✓	✓
	Geothermal	✓		✓	Varies			✓
	Onshore Wind	✓		✓	Rural	✓		
Conventional	Gas Peaking	✗	✓	✓	Universal		✓	✓
	Nuclear	✓		✓	Rural			✓
	Coal	✗		✓	Co-located or rural			✓
	Gas Combined Cycle	✗		✓	Universal		✓	✓

## Value of Carbon Abatement Comparison

As policymakers consider ways to limit carbon emissions, Lazard's LCOE analysis provides insight into the economic value associated with carbon abatement offered by renewable energy technologies. This analysis suggests that policies designed to shift power generation towards wind and utility-scale solar could be a particularly cost-effective means of reducing carbon emissions, providing an abatement value of \$36 – \$41/Ton vs. Coal and \$23 – \$32/Ton vs. Gas Combined Cycle

- These observations do not take into account other environmental and social externalities, reliability or grid-related considerations

		Conventional Generation			Renewable Energy Generation			
	Units	Coal	Gas Combined Cycle	Nuclear	Wind	Solar PV Rooftop	Solar PV Utility Scale	Solar Thermal with Storage
Capital Investment/KW of Capacity <sup>(1)</sup>	\$/kW	\$2,975	\$700	\$6,900	\$1,100	\$2,800	\$900	\$9,100
<b>Total Capital Investment</b>	<b>\$mm</b>	<b>1,993</b>	<b>560</b>	<b>4,209</b>	<b>1,111</b>	<b>8,232</b>	<b>1,476</b>	<b>7,462</b>
Facility Output	MW	670	800	610	1,010	2,940	1,640	820
Capacity Factor	%	83%	70%	91%	55%	19%	34%	68%
<b>MWh/Year Produced <sup>(2)</sup></b>	<b>GWh/yr</b>	<b>4,888</b>	<b>4,888</b>	<b>4,888</b>	<b>4,888</b>	<b>4,888</b>	<b>4,888</b>	<b>4,888</b>
Levelized Cost of Energy	\$/MWh	\$66	\$44	\$118	\$28	\$151	\$32	\$126
<b>Total Cost of Energy Produced</b>	<b>\$mm/yr</b>	<b>\$322</b> <b>2</b>	<b>\$215</b>	<b>\$576</b>	<b>\$136</b> <b>1</b>	<b>\$740</b>	<b>\$159</b>	<b>\$618</b>
<b>CO<sub>2</sub> Equivalent Emissions</b>	<b>Tons/MWh</b>	0.92	0.51	—	—	—	—	—
Carbon Emitted	mm Tons/yr	4.51	2.50	—	—	—	—	—
<b>Difference in Carbon Emissions</b>	<b>mm Tons/yr</b>							
vs. Coal		—	2.01	4.51	4.51	4.51	4.51	4.51
vs. Gas		—	—	2.50	2.50	2.50	2.50	2.50
<b>Difference in Total Energy Cost</b>	<b>\$mm/yr</b>							
vs. Coal		—	(\$107)	\$254	(\$187)	\$418	(\$163)	\$296
vs. Gas		—	—	\$361	(\$80)	\$525	(\$56)	\$403
<b>Implied Abatement Value/(Cost)</b>	<b>\$/Ton</b>							
vs. Coal		—	\$53	(\$56)	\$41	(\$93)	\$36	(\$66)
vs. Gas		—	—	(\$144)	\$32	(\$210)	\$23	(\$161)

: Favorable vs. Coal/Gas
: Unfavorable vs. Coal/Gas

### Implied Carbon Abatement Value Calculation (Wind vs. Coal)—Methodology

**4** Difference in Total Energy Cost (Wind vs. Coal) = **1** – **2** = \$136 mm/yr (Wind) – \$322 mm/yr (Coal) = (\$187) mm/yr

**5** Implied Carbon Abatement Value (Wind vs. Coal) = **4** ÷ **3** = \$187 mm/yr ÷ 4.51 mm Tons/yr = \$41/Ton



## Levelized Cost of Energy—Key Assumptions

		Solar PV				
	Units	Rooftop—Residential	Rooftop—C&I	Community	Utility Scale— Crystalline <sup>(2)</sup>	Utility Scale— Thin Film <sup>(2)</sup>
<b>Net Facility Output</b>	MW	0.005	1	5	100	100
<b>EPC Cost</b>	\$/kW	\$2,800 – \$2,950	\$1,750 – \$2,950	\$1,600 – \$2,250	\$1,100 – \$900	\$1,100 – \$900
<b>Capital Cost During Construction</b>	\$/kW	—	—	—	—	—
<b>Other Owner's Costs</b>	\$/kW	included	included	included	included	included
<b>Total Capital Cost <sup>(1)</sup></b>	\$/kW	\$2,800 – \$2,950	\$1,750 – \$2,950	\$1,600 – \$2,250	\$1,100 – \$900	\$1,100 – \$900
<b>Fixed O&amp;M</b>	\$/kW-yr	\$14.00 – \$25.00	\$15.00 – \$20.00	\$12.00 – \$16.00	\$12.00 – \$9.00	\$12.00 – \$9.00
<b>Variable O&amp;M</b>	\$/MWh	—	—	—	—	—
<b>Heat Rate</b>	Btu/kWh	—	—	—	—	—
<b>Capacity Factor</b>	%	19% – 13%	25% – 20%	25% – 15%	32% – 21%	34% – 23%
<b>Fuel Price</b>	\$/MMBtu	—	—	—	—	—
<b>Construction Time</b>	Months	3	3	4 – 6	9	9
<b>Facility Life</b>	Years	25	25	30	30	30
<b>Levelized Cost of Energy</b>	\$/MWh	\$151 – \$242	\$75 – \$154	\$64 – \$148	\$36 – \$44	\$32 – \$42

Source: Lazard estimates.

(1) Includes capitalized financing costs during construction for generation types with over 24 months construction time.

(2) Left column represents the assumptions used to calculate the low end LCOE for single-axis tracking. Right column represents the assumptions used to calculate the high end LCOE for fixed-tilt design.

## Levelized Cost of Energy—Key Assumptions (cont'd)

	Units	Solar Thermal Tower with Storage <sup>(2)</sup>	Geothermal	Wind—Onshore	Wind—Offshore
<b>Net Facility Output</b>	MW	110 – 150	20 – 50	150	210 – 385
<b>EPC Cost</b>	\$/kW	\$7,950 – \$5,250	\$3,450 – \$5,750	\$1,100 – \$1,500	\$2,350 – \$3,550
<b>Capital Cost During Construction</b>	\$/kW	\$1,150 – \$750	\$500 – \$850	—	—
<b>Other Owner's Costs</b>	\$/kW	included	included	included	included
<b>Total Capital Cost<sup>(1)</sup></b>	\$/kW	\$9,100 – \$6,000	\$3,950 – \$6,600	\$1,100 – \$1,500	\$2,350 – \$3,550
<b>Fixed O&amp;M</b>	\$/kW-yr	\$75.00 – \$80.00	\$0.00 – \$0.00	\$28.00 – \$36.50	\$80.00 – \$110.00
<b>Variable O&amp;M</b>	\$/MWh	—	\$24.00 – \$34.00	—	—
<b>Heat Rate</b>	Btu/kWh	—	—	—	—
<b>Capacity Factor</b>	%	68% – 39%	90% – 85%	55% – 38%	55% – 45%
<b>Fuel Price</b>	\$/MMBtu	—	—	—	—
<b>Construction Time</b>	Months	36	36	12	12
<b>Facility Life</b>	Years	35	25	20	20
<b>Levelized Cost of Energy</b>	\$/MWh	\$126 – \$156	\$69 – \$112	\$28 – \$54	\$64 – \$115

Source: Lazard estimates.

(1) Includes capitalized financing costs during construction for generation types with over 24 months construction time.

(2) Left column represents the assumptions used to calculate the low end LCOE, representing a project with 18 hours of storage capacity. Right column represents the assumptions used to calculate the high end LCOE, representing a project with eight hours of storage.

## Levelized Cost of Energy—Key Assumptions (cont'd)

	Units	Gas Peaking			Nuclear			Coal			Gas Combined Cycle		
<b>Net Facility Output</b>	MW	240	–	50	2,200			600			550		
<b>EPC Cost</b>	\$/kW	\$650	–	\$900	\$5,400	–	\$9,600	\$2,400	–	\$4,900	\$650	–	\$1,200
<b>Capital Cost During Construction</b>	\$/kW		—			—			—			—	
<b>Other Owner's Costs</b>	\$/kW		included		\$1,500	–	\$2,650	\$600	–	\$1,300	\$50	–	\$100
<b>Total Capital Cost <sup>(1)</sup></b>	\$/kW	\$700	–	\$950	\$6,900	–	\$12,200	\$3,000	–	\$6,250	\$700	–	\$1,300
<b>Fixed O&amp;M</b>	\$/kW-yr	\$5.50	–	\$20.75	\$108.50	–	\$133.00	\$40.75	–	\$81.75	\$11.00	–	\$13.50
<b>Variable O&amp;M</b>	\$/MWh	\$4.75	–	\$6.25	\$3.50	–	\$4.25	\$2.75	–	\$5.00	\$3.00	–	\$3.75
<b>Heat Rate</b>	Btu/kWh	9,804	–	8,000	10,450	–	10,450	8,750	–	12,000	6,133	–	6,900
<b>Capacity Factor</b>	%		10%		91%	–	90%	83%	–	66%	70%	–	55%
<b>Fuel Price</b>	\$/MMBtu	\$3.45	–	\$3.45	\$0.85	–	\$0.85	\$1.45	–	\$1.45	\$3.45	–	\$3.45
<b>Construction Time</b>	Months	12	–	18	69	–	69	60	–	66	24	–	24
<b>Facility Life</b>	Years		20			40			40			20	
<b>Levelized Cost of Energy</b>	\$/MWh	\$150	–	\$199	\$118	–	\$192	\$66	–	\$152	\$44	–	\$68

## Summary Considerations

Lazard has conducted this analysis comparing the LCOE for various conventional and renewable energy generation technologies in order to understand which renewable energy generation technologies may be cost-competitive with conventional generation technologies, either now or in the future, and under various operating assumptions. We find that renewable energy technologies are complementary to conventional generation technologies, and believe that their use will be increasingly prevalent for a variety of reasons, including to mitigate the environmental and social consequences of various conventional generation technologies, RPS requirements, carbon regulations, continually improving economics as underlying technologies improve and production volumes increase, and supportive regulatory frameworks in certain regions.

In this analysis, Lazard's approach was to determine the LCOE, on a \$/MWh basis, that would provide an after-tax IRR to equity holders equal to an assumed cost of equity capital. Certain assumptions (e.g., required debt and equity returns, capital structure, etc.) were identical for all technologies in order to isolate the effects of key differentiated inputs such as investment costs, capacity factors, operating costs, fuel costs (where relevant) and other important metrics. These inputs were originally developed with a leading consulting and engineering firm to the Power & Energy Industry, augmented with Lazard's commercial knowledge where relevant. This analysis (as well as previous versions) has benefited from additional input from a wide variety of Industry participants and is informed by Lazard's many client interactions on this topic.

Lazard has not manipulated the cost of capital or capital structure for various technologies, as the goal of this analysis is to compare the current levelized cost of various generation technologies, rather than the benefits of financial engineering. The results contained herein would be altered by different assumptions regarding capital structure (e.g., increased use of leverage) or the cost of capital (e.g., a willingness to accept lower returns than those assumed herein).

Key sensitivities examined included fuel costs and tax subsidies. Other factors would also have a potentially significant effect on the results contained herein, but have not been examined in the scope of this current analysis. These additional factors, among others, could include: capacity value vs. energy value; network upgrades, transmission, congestion or other integration-related costs; significant permitting or other development costs, unless otherwise noted; and costs of complying with various environmental regulations (e.g., carbon emissions offsets or emissions control systems). This analysis also does not address potential social and environmental externalities, including, for example, the social costs and rate consequences for those who cannot afford distributed generation solutions, as well as the long-term residual and societal consequences of various conventional generation technologies that are difficult to measure (e.g., nuclear waste disposal, airborne pollutants, greenhouse gases, etc.).