

LEVELIZED COST OF ENERGY ANALYSIS—VERSION 6.0

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LAZARD

Energy & Telecommunications Meeting  
September 13, 2013 - Day 2

Exhibit 10

LAZARD

## Introduction

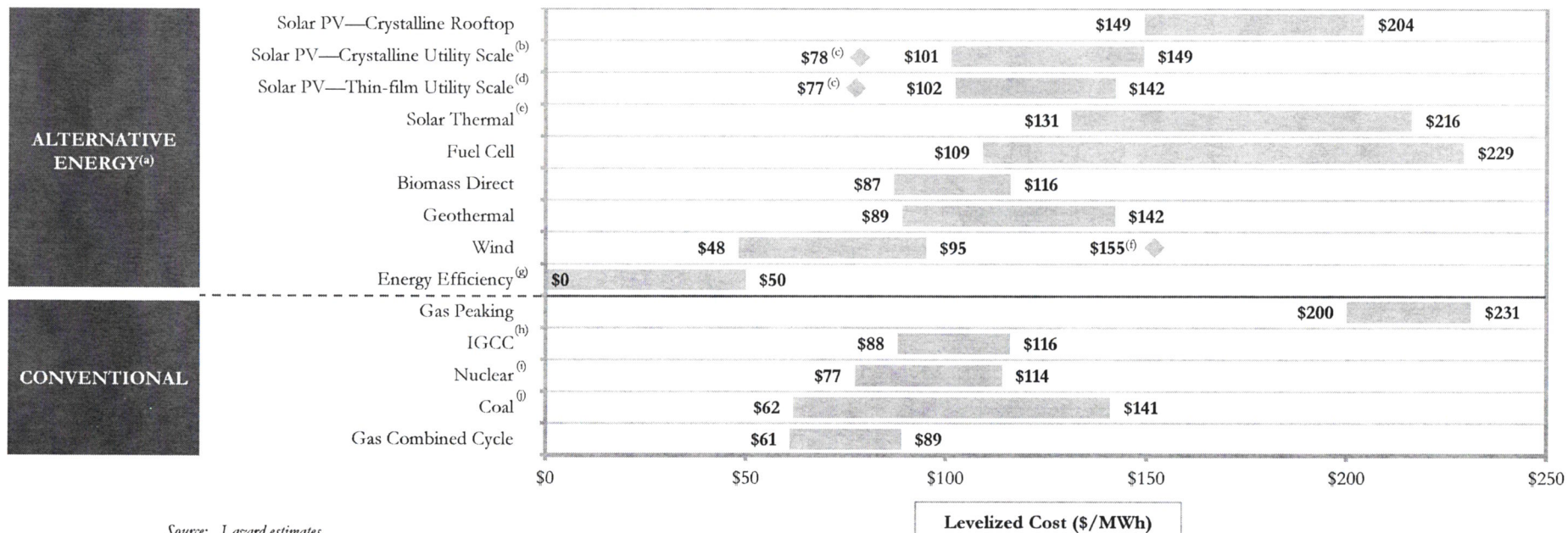
Lazard's Levelized Cost of Energy Analysis ("LCOE") addresses the following topics:

- **Comparative "levelized cost of energy" for various technologies on a \$/MWh basis, including sensitivities, as relevant, for:**
  - Fuel costs
  - U.S. federal tax subsidies
  - Cost of capital
- **Illustration of how the cost of solar-produced energy compares against peak power costs in large metropolitan areas of the United States**
- **Illustration of how the costs of solar and wind vary across the U.S., based on average available resources**
- **Comparison of assumed capital costs on a \$/kW basis for various generation technologies**
- **Decomposition of the levelized cost of energy for various generation technologies by capital cost, fixed operations & maintenance expense, variable operations & maintenance expense, and fuel cost, as relevant**
- **Considerations regarding the usage characteristics and applicability of various generation resources, taking into account factors such as location requirements/constraints, dispatch capability, land and water requirements and other contingencies**
- **Summary assumptions for the various generation technologies examined**
- **Summary of Lazard's approach to comparing the levelized cost of energy for various conventional and Alternative Energy generation technologies, including identification of key potential sensitivities not addressed in the scope of this presentation**
  - Capacity value vs. energy value
  - Network upgrade costs
  - Congestion costs
  - Integration costs
  - Transmission costs
- **Additionally, Lazard's LCOE does not evaluate the LCOE associated with adding emissions controls (e.g., selective catalytic reduction systems, scrubbers, etc.) to existing fossil power plants**
- ***While prior versions of this study have presented LCOE inclusive of the U.S. Federal Investment Tax Credit and Production Tax Credit, Version 6.0 presents LCOE on an unsubsidized basis, except as noted on the page titled "Levelized Cost of Energy—Sensitivity to U.S. Federal Tax Subsidies."***

Note: Lazard has the ability to undertake (or otherwise has undertaken) LCOE analysis for jurisdictions based on region-specific (e.g., outside the U.S.) variables and inputs.

## Unsubsidized Levelized Cost of Energy Comparison

Certain Alternative Energy generation technologies are cost-competitive with conventional generation technologies under some scenarios, before factoring in environmental and other externalities (e.g., RECs, transmission and back-up generation/system reliability costs) as well as construction and fuel cost dynamics affecting conventional generation technologies



Source: Lazard estimates.

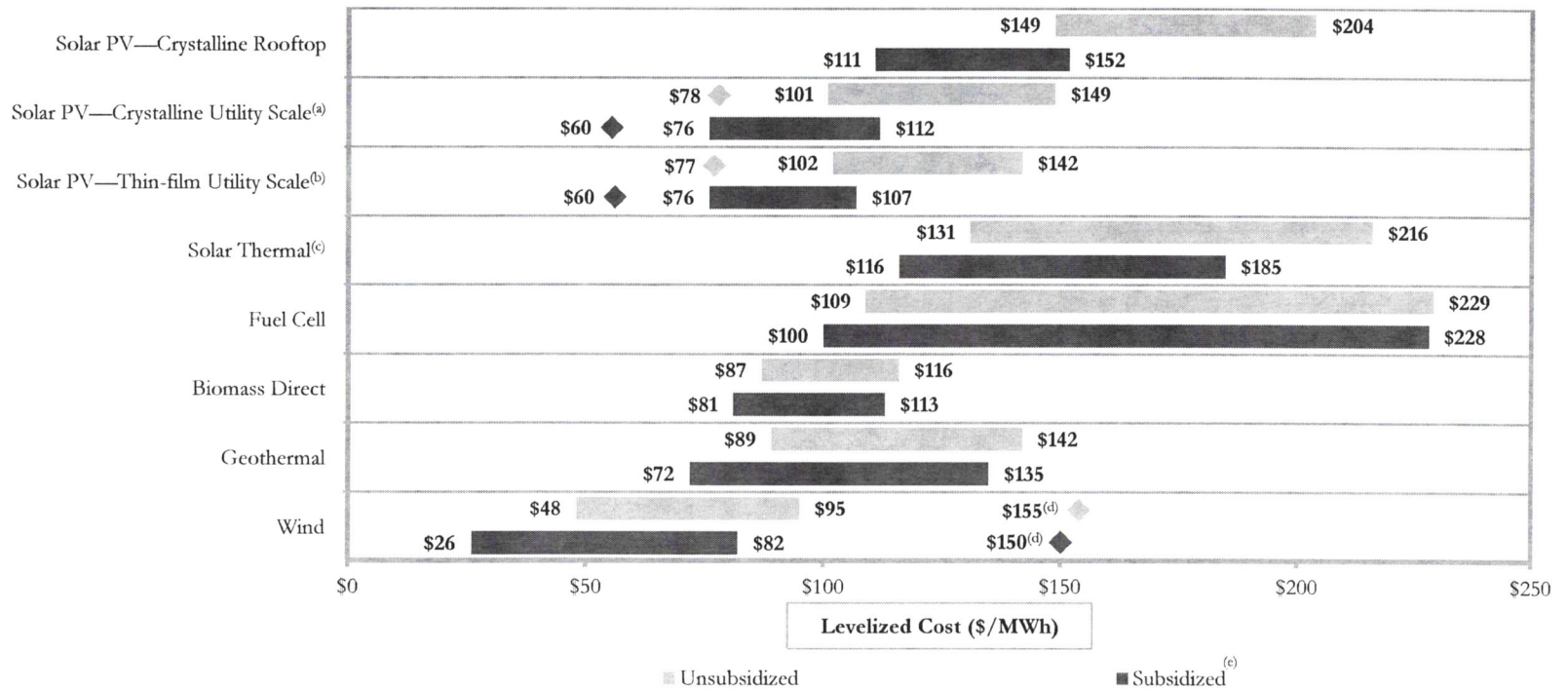
Note: Assumes 60% debt at 8.0% interest rate and 40% equity at 12% cost for conventional and Alternative Energy generation technologies. Assumes Powder River Basin coal price of \$1.70 per MMBtu and natural gas price of \$4.50 per MMBtu. As many have argued, current solar pricing trends may be masking material differences between the inherent economics of certain types of thin-film technologies and crystalline silicon.

- (a) Analysis excludes integration costs for intermittent technologies. A variety of studies suggest integration costs ranging from \$2 to \$10 per MWh.
- (b) Low end represents single-axis tracking. High end represents fixed-tilt installation. Assumes 10 MW system in high insolation jurisdiction (e.g., Southwest U.S.).
- (c) Diamonds represent estimated implied levelized cost of energy in 2015, assuming \$1.75 per watt for a crystalline single-axis tracking system and a total system cost of \$1.50 per watt for a thin-film fixed-tilt system.
- (d) Assumes 10 MW fixed-tilt installation in high insolation jurisdiction (e.g., Southwest U.S.).
- (e) Represents solar tower with and without 3 hour storage capability.
- (f) Represents estimated midpoint of levelized cost of energy for off-shore wind, assuming a range of total system cost of \$3.10 – \$5.00 per watt.
- (g) Estimates per National Action Plan for Energy Efficiency; actual cost for various initiatives varies widely.
- (h) High end incorporates 90% carbon capture and compression.
- (i) Does not reflect decommissioning costs or potential economic impact of federal loan guarantees or other subsidies.
- (j) Based on advanced supercritical pulverized coal. High end incorporates 90% carbon capture and compression.



## Levelized Cost of Energy—Sensitivity to U.S. Federal Tax Subsidies

U.S. federal tax subsidies remain an important component of the economics of Alternative Energy generation technologies (and government incentives are, generally, currently important in all regions); future cost reductions in technologies such as solar PV have the potential to enable these technologies to approach “grid parity” without tax subsidies and wind currently reaches “grid parity” under certain conditions (albeit such observation does not take into account issues such as dispatch characteristics, the cost of incremental transmission and back-up generation/system reliability costs or other factors)



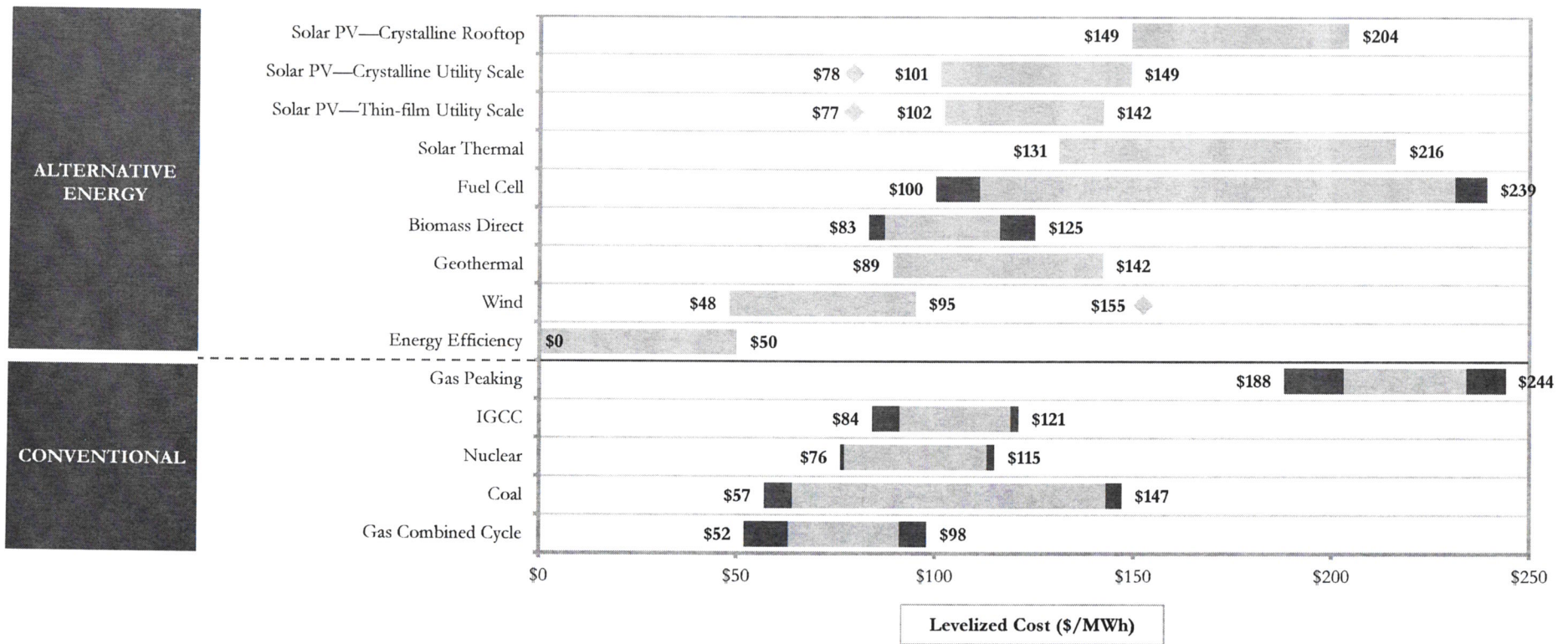
Source: Lazard estimates.

- (a) Low end represents single-axis tracking. High end represents fixed-tilt installation. Diamonds represent estimated implied levelized cost of energy in 2015, assuming a total system cost of \$1.75 per watt for a single-axis system.
- (b) Assumes fixed-tilt installation. Diamonds represent estimated implied levelized cost of energy in 2015, assuming a total system cost of \$1.50 per watt.
- (c) Represents solar tower with and without 3 hour storage capability.
- (d) Represents midpoint of levelized cost of energy for off-shore wind, assuming a range of total system cost of \$3.10 – \$5.00 per watt.
- (e) Reflects Production Tax Credit or Investment Tax Credit, as applicable. Assumes 30% debt at 8.0% interest rate, 50% tax equity at 9.5% cost and 20% common equity at 12.0% cost.



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

Variations in fuel prices can materially affect the levelized cost of energy for conventional generation technologies, but direct comparisons against “competing” Alternative Energy generation technologies must take into account issues such as dispatch characteristics (e.g., baseload and/or dispatchable intermediate load vs. peaking or intermittent technologies)

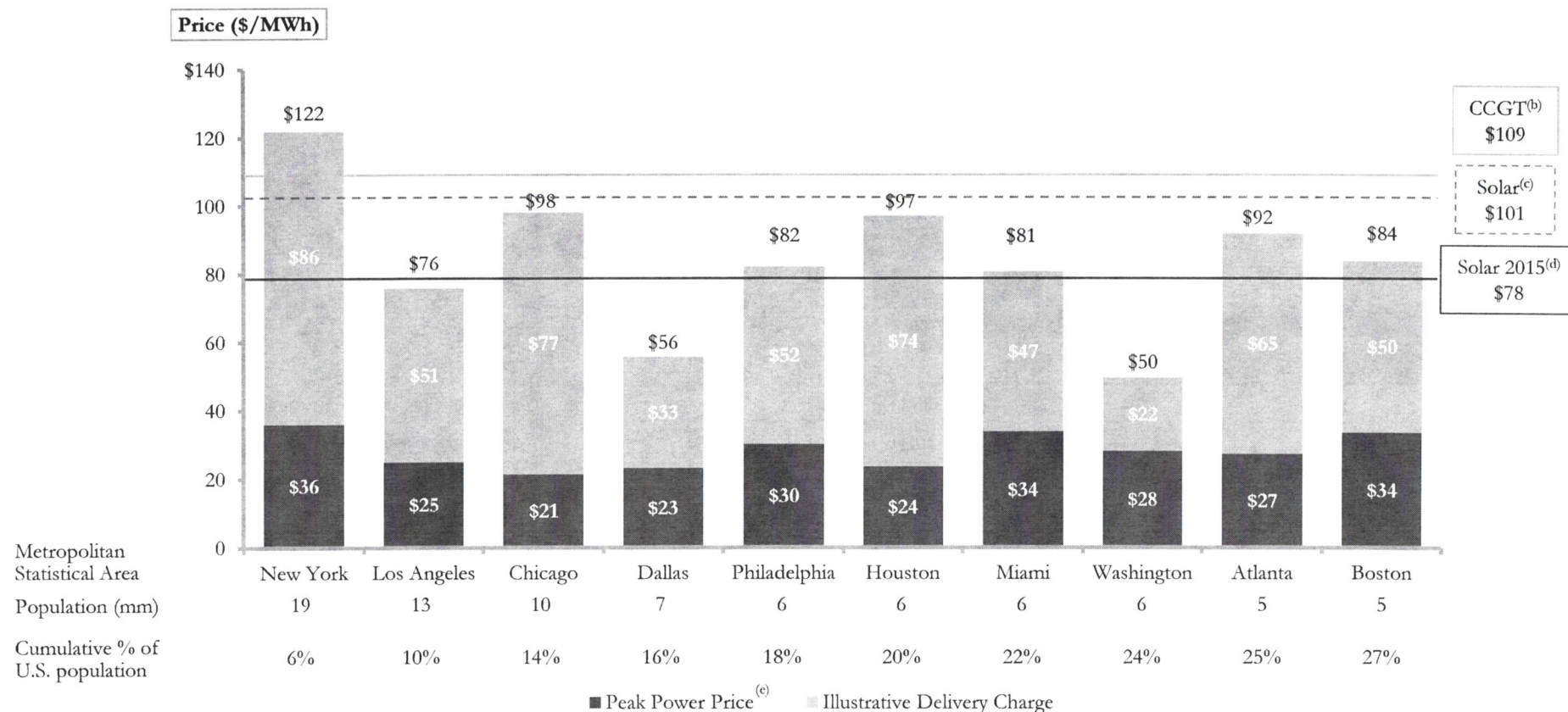


Source: Lazard estimates.

Note: Darkened areas in horizontal bars represent low end and high end levelized cost of energy corresponding with ±25% fuel price fluctuations.

## Peak Pricing for the 10 Largest U.S. Metropolitan Areas<sup>(a)</sup>

Setting aside the legislatively-mandated demand for solar and other Alternative Energy resources, solar is becoming a more economically viable peaking energy product in many areas of the U.S. and, as pricing declines, could become economically competitive across a broader array of geographies; this observation, however, does not take into account the full cost of incremental transmission and back-up generation/system reliability costs

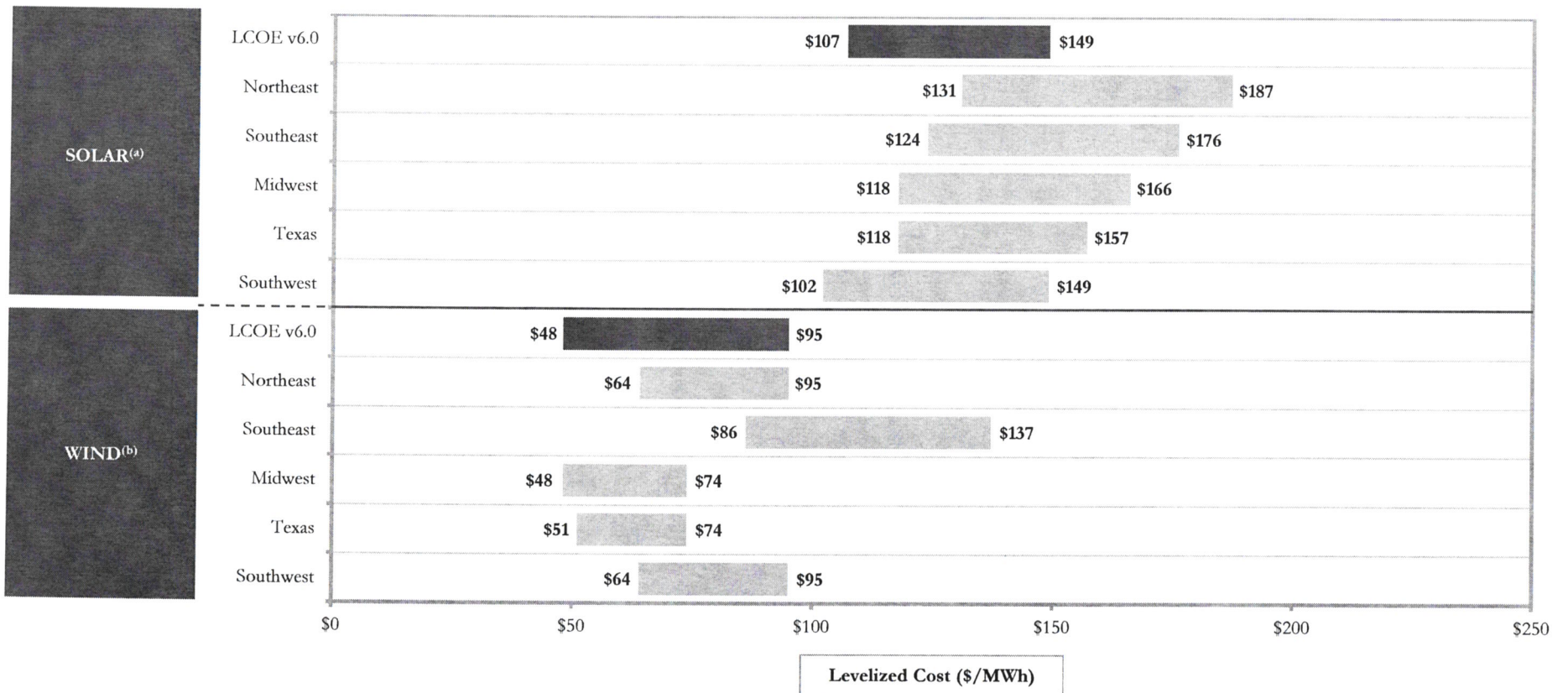


- (a) Defined as 10 largest Metropolitan Statistical Areas per the U.S. Census Bureau for a total population of 83 million.
- (b) Assumes 25% capacity factor.
- (c) Represents low end of crystalline utility scale.
- (d) Represents estimated implied levelized cost of energy in 2015, assuming a total system cost of \$1.75 per watt for a single-axis crystalline utility scale system.
- (e) Represents the average of the hourly wholesale prices between 12 noon and 6 pm at a normalized natural gas price.



## Wind and Solar Resource—U.S. Regional Sensitivity (Unsubsidized)

The availability of wind and solar resource has a meaningful impact on the LCOE for various regions of the United States. This regional analysis varies capacity factors as a proxy for resource availability, while holding other variables constant. There are a variety of other factors (e.g., labor rates, permitting costs, insurance and other costs) that could also impact regional costs



Source: Lazard estimates.

Note: Assumes solar capacity factors of 16% – 18% for the Northeast, 17% – 19% for the Southeast, 18% – 20% for the Midwest, 19% – 20% for Texas and 21% – 23% for the Southwest. Assumes wind capacity factors of 30% – 35% for the Northeast, 20% – 25% for the Southeast, 40% – 50% for the Midwest, 40% – 45% for Texas and 30% – 35% for the Southwest.

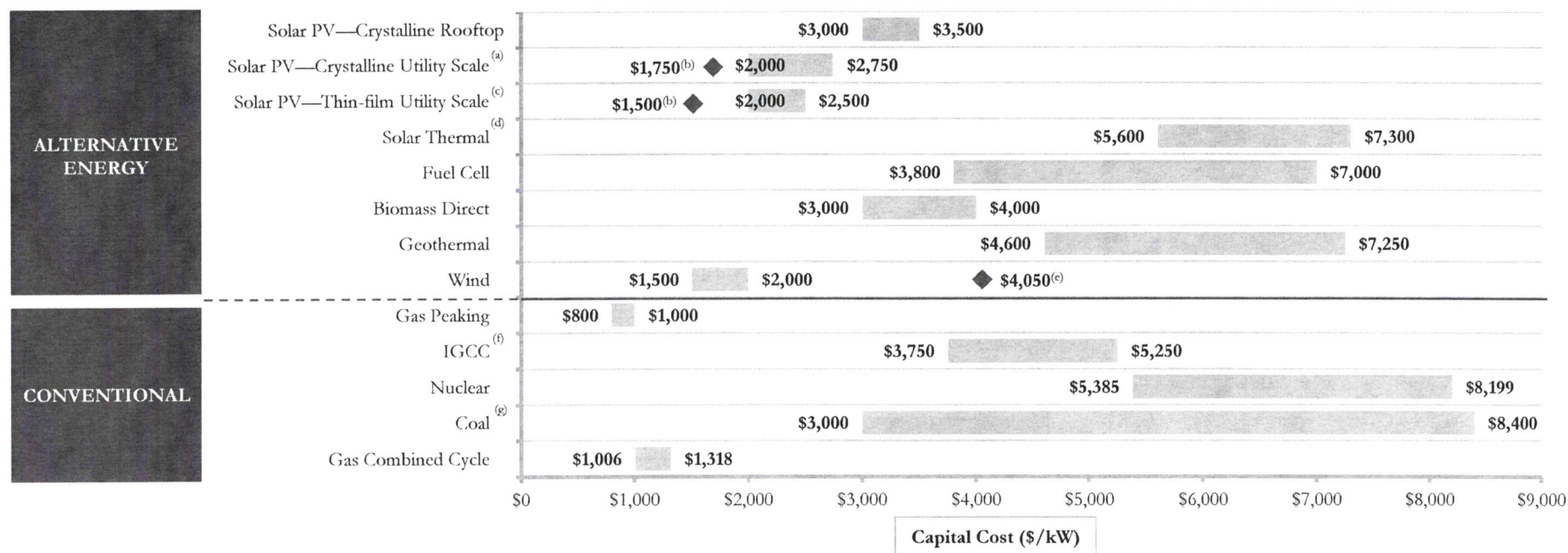
(a) Assumes a fixed-tilt crystalline utility scale system with capital costs of \$2.00 – \$2.50 per watt.

(b) Assumes an on-shore wind generation plant with capital costs of \$1.50 – \$2.00 per watt.



## Capital Cost Comparison

While capital costs for a number of Alternative Energy generation technologies (e.g., solar PV, solar thermal) are currently in excess of conventional generation technologies (e.g., gas, coal), declining costs for many Alternative Energy generation technologies, coupled with rising long-term construction and uncertain long-term fuel costs for conventional generation technologies, are working to close formerly wide gaps in electricity costs. This assessment, however, does not take into account issues such as dispatch characteristics, capacity factors, fuel and other costs needed to compare generation technologies

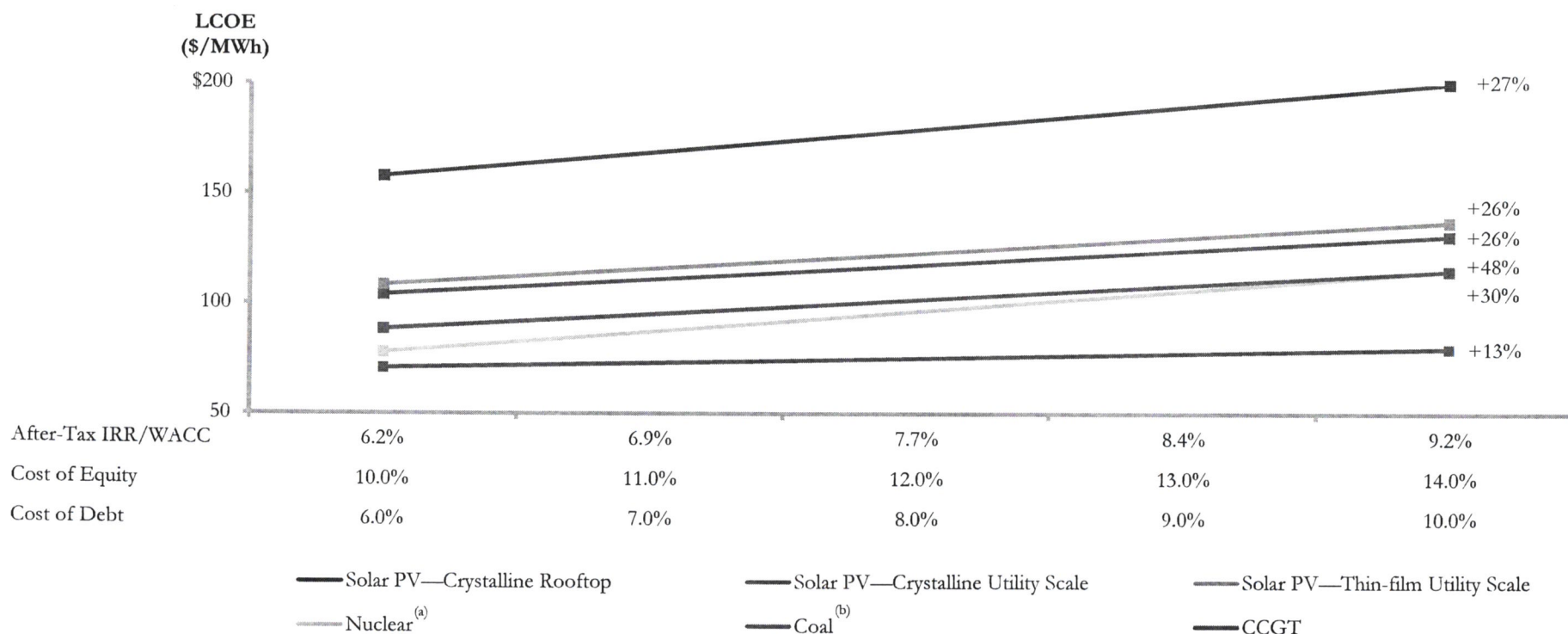


Source: Lazard estimates.

- (a) High end represents single-axis tracking. Low end represents fixed-tilt installation.
- (b) Diamonds represent estimated capital costs in 2015, assuming \$1.75 per watt for a crystalline single-axis tracking system and a total system cost of \$1.50 per watt for a thin-film fixed-tilt system.
- (c) Low and high ends represent fixed-tilt installations.
- (d) Low end represents solar tower without storage, high end represents solar tower with 3 hour storage capability.
- (e) Represents estimated midpoint of capital costs for off-shore wind, assuming a range of total system cost of \$3.10 – \$5.00 per watt.
- (f) High end incorporates 90% carbon capture and compression.
- (g) Based on advanced supercritical pulverized coal. High end incorporates 90% carbon capture and compression.

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

A key issue facing Alternative Energy generation technologies resulting from the potential for intermittently disrupted capital markets is the reduced availability, and increased cost, of capital; availability and cost of capital have a particularly significant impact on Alternative Energy generation technologies, whose costs reflect essentially the return on, and of, the capital investment required to build them



Source: Lazard estimates.

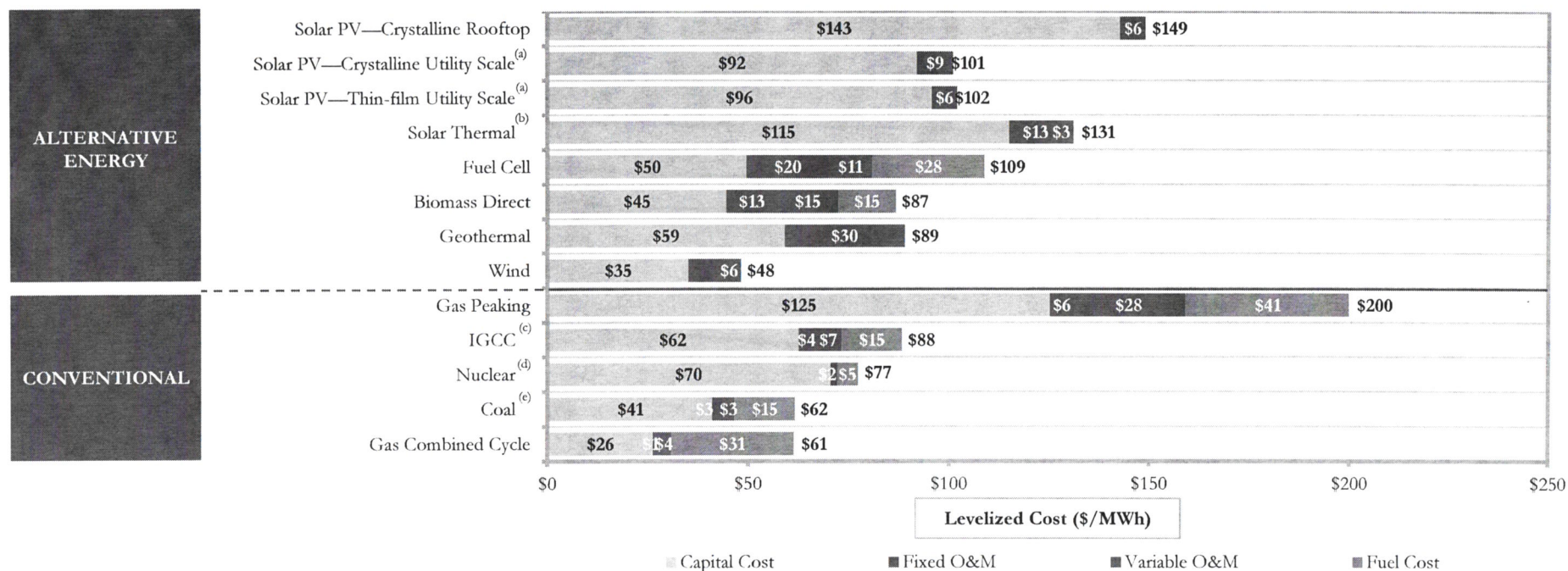
Note: Assumes Powder River Basin coal price of \$1.70 per MMBtu and natural gas price of \$4.50 per MMBtu.

(a) Does not reflect decommissioning costs or potential economic impact of federal loan guarantees or other subsidies.

(b) Based on advanced supercritical pulverized coal.

## Levelized Cost of Energy Components—Low End

Certain Alternative Energy generation technologies are already cost-competitive with conventional generation technologies; a key factor regarding the long-term competitiveness of currently more expensive Alternative Energy technologies is the ability of technological development and increased production volumes to materially lower the capital costs of certain Alternative Energy technologies, and their levelized cost of energy, over time (e.g., as is anticipated with solar PV technologies)



Source: Lazard estimates.

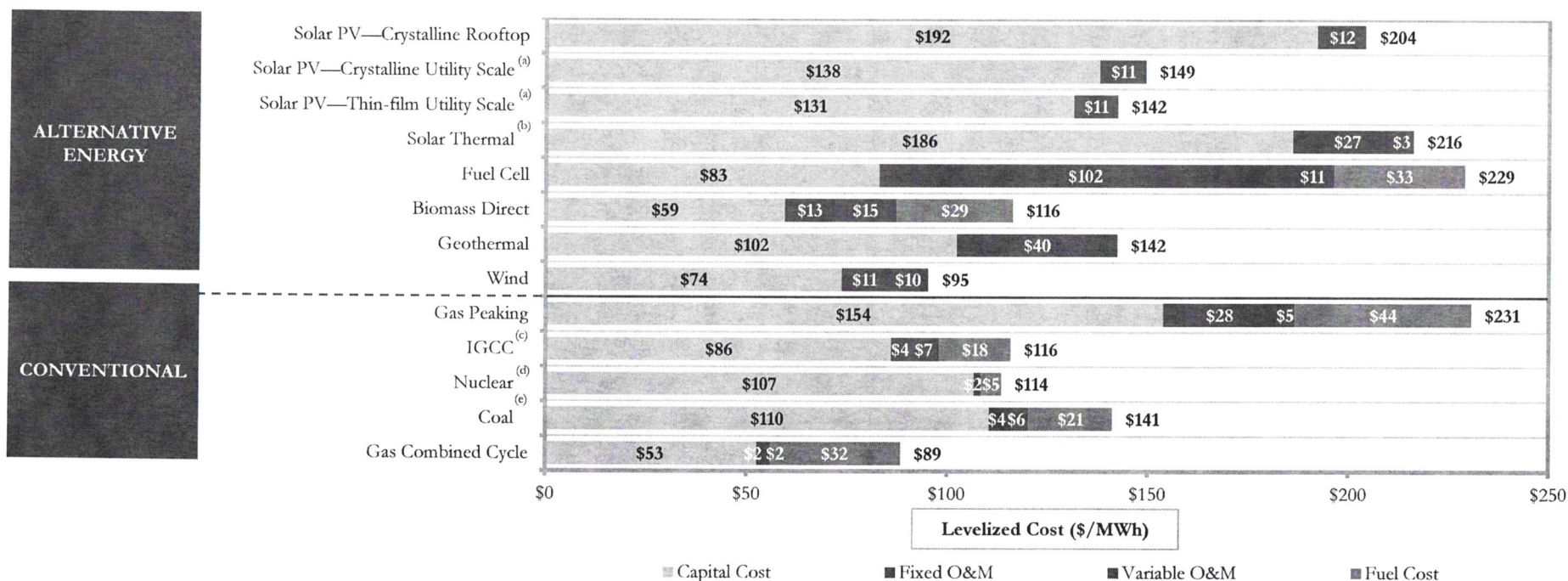
Note: Assumes 60% debt at 8.0% interest rate and 40% equity at 12% cost for conventional and Alternative Energy generation technologies. Assumes Powder River Basin coal price of \$1.70 per MMBtu and natural gas price of \$4.50 per MMBtu.

- (a) Low end represents single-axis tracking for crystalline and a fixed-tilt installation for thin-film.
- (b) Low end represents solar tower without storage capability.
- (c) Does not incorporate carbon capture and compression.
- (d) Does not reflect decommissioning costs or potential economic impact of federal loan guarantees or other subsidies.
- (e) Based on advanced supercritical pulverized coal. Does not incorporate carbon capture and compression.



## Levelized Cost of Energy Components—High End

Certain Alternative Energy generation technologies are already cost-competitive with conventional generation technologies; a key factor regarding the long-term competitiveness of currently more expensive Alternative Energy technologies is the ability of technological development and increased production volumes to materially lower the capital costs of certain Alternative Energy technologies, and their levelized cost of energy, over time (e.g., as is anticipated with solar PV technologies)



Source: Lazard estimates.

Note: Assumes 60% debt at 8.0% interest rate and 40% equity at 12% cost for conventional and Alternative Energy generation technologies. Assumes Powder River Basin coal price of \$1.70 per MMBtu and natural gas price of \$4.50 per MMBtu.

- (a) High end represents fixed-tilt installations for both crystalline and thin-film.
- (b) High end represents solar tower with 3 hour storage capability.
- (c) Incorporates 90% carbon capture and compression.
- (d) Does not reflect decommissioning costs or potential economic impact of federal loan guarantees or other subsidies.
- (e) Based on advanced supercritical pulverized coal. Incorporates 90% carbon capture and compression.

## Energy Resources: Matrix of Applications

While the levelized cost of energy for Alternative Energy generation technologies is becoming increasingly competitive with conventional generation technologies, direct comparisons must take into account issues such as location (e.g., central station vs. customer-located) and dispatch characteristics (e.g., baseload and/or dispatchable intermediate load vs. peaking or intermittent technologies)

		LEVELIZED COST OF ENERGY	CARBON NEUTRAL/ REC POTENTIAL	STATE OF TECHNOLOGY	LOCATION			DISPATCH				
					CUSTOMER LOCATED	CENTRAL STATION	GEOGRAPHY	INTERMITTENT	PEAKING	LOAD-FOLLOWING	BASE-LOAD	
ALTERNATIVE ENERGY	FUEL CELL	\$109 – 229	?(a)	Emerging/ Commercial	✓		Universal					✓
	SOLAR PV	\$101 – 204	✓	Commercial	✓	✓	Universal <sup>(b)</sup>	✓	✓			
	SOLAR THERMAL	\$131 – 216	✓	Commercial		✓	Southwest	✓	✓	✓		
	BIOMASS DIRECT	\$87 – 116	✓	Mature		✓	Universal			✓		✓
	GEO THERMAL	\$89 – 142	✓	Mature		✓	Varies					✓
	ON-SHORE WIND	\$48 – 95	✓	Mature		✓	Varies	✓				
CONVENTIONAL	GAS PEAKING	\$200 – 231	✗	Mature	✓	✓	Universal		✓			
	IGCC	\$88 – 116	✗ <sup>(c)</sup>	Emerging <sup>(d)</sup>		✓	Co-located or rural					✓
	NUCLEAR	\$77 – 114	✓	Mature/ Emerging		✓	Co-located or rural					✓
	COAL	\$62 – 141	✗ <sup>(c)</sup>	Mature <sup>(d)</sup>		✓	Co-located or rural					✓
	GAS COMBINED CYCLE	\$61 – 89	✗	Mature	✓	✓	Universal			✓		✓

Source: Lazard estimates.

- (a) Qualification for RPS requirements varies by location.
- (b) LCOE study capacity factor assumes Southwest location.
- (c) Could be considered carbon neutral technology, assuming carbon capture and compression.
- (d) Carbon capture and compression technologies are in emerging stage.

## Levelized Cost of Energy—Key Assumptions

	Units	Solar PV—Crystalline		Solar PV—Thin-film		Solar Thermal Tower
		Utility Scale <sup>(b)</sup>	Rooftop	Utility Scale <sup>(c)</sup>		
<b>Net Facility Output</b>	MW	10	10	10		120 - 100
<b>EPC Cost</b>	\$/kW	\$2,750 - \$2,000	\$3,000 - \$3,500	\$2,000 - \$2,500		\$5,600 - \$7,300
<b>Capital Cost During Construction</b>	\$/kW	included	included	included		included
<b>Other Owner's Costs</b>	\$/kW	included	included	included		included
<b>Total Capital Cost<sup>(a)</sup></b>	\$/kW	\$2,750 - \$2,000	\$3,000 - \$3,500	\$2,000 - \$2,500		\$5,600 - \$7,300
<b>Fixed O&amp;M</b>	\$/kW-yr	\$13.00 - \$25.00	\$13.00 - \$20.00	\$13.00 - \$20.00		\$50.00 - \$80.00
<b>Variable O&amp;M</b>	\$/MWh	—	—	—		\$3.00
<b>Heat Rate</b>	Btu/kWh	—	—	—		—
<b>Capacity Factor</b>	%	27% - 20%	23% - 20%	23% - 21%		50% - 30%
<b>Fuel Price</b>	\$/MMBtu	—	—	—		—
<b>Construction Time</b>	Months	12	12	12		24
<b>Facility Life</b>	Years	20	20	20		40
<b>CO<sub>2</sub> Emissions</b>	lb/MMBtu	—	—	—		—
<b>Investment Tax Credit<sup>(d)</sup></b>	%	30%	30%	30%		30%
<b>Production Tax Credit<sup>(d)</sup></b>	\$/MWh	—	—	—		—
<b>Levelized Cost of Energy<sup>(d)</sup></b>	\$/MWh	\$101 - \$149	\$149 - \$204	\$102 - \$142		\$131 - \$216

Source: Lazard estimates.

Note: Assumes 60% debt at 8.0% interest rate and 40% equity at 12% cost for conventional and Alternative Energy generation technologies. Assumes Powder River Basin coal price of \$1.70 per MMBtu and natural gas price of \$4.50 per MMBtu.

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

(b) Low end represents single-axis tracking. High end represents fixed-tilt installation. Assumes 10 MW system in high insolation jurisdiction (e.g., Southwest U.S.).

(c) Assumes 10 MW fixed-tilt installation in high insolation jurisdiction (e.g., Southwest U.S.).

(d) While prior versions of this study have presented LCOE inclusive of the U.S. Federal Investment Tax Credit and Production Tax Credit, Version 6.0 presents LCOE on an unsubsidized basis, except as noted on the page titled "Levelized Cost of Energy—Sensitivity to U.S. Federal Tax Subsidies."



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

	Units	Fuel Cell <sup>(b)</sup>	Biomass Direct	Wind	Off-Shore Wind	Geothermal
Net Facility Output	MW	2.4	35	100	210	30
EPC Cost	\$/kW	\$3,000 - \$7,000	\$2,622 - \$3,497	\$1,200 - \$1,600	\$2,500 - \$4,120	\$4,021 - \$6,337
Capital Cost During Construction	\$/kW	included	\$378 - \$503	included	included	\$579 - \$913
Other Owner's Costs	\$/kW	\$800 - included	included	\$300 - \$400	\$600 - \$880	included
Total Capital Cost <sup>(a)</sup>	\$/kW	\$3,800 - \$7,000	\$3,000 - \$4,000	\$1,500 - \$2,000	\$3,100 - \$5,000	\$4,600 - \$7,250
Fixed O&M	\$/kW-yr	\$169 - \$850	\$95.00	\$30.00	\$60.00 - \$100.00	—
Variable O&M	\$/MWh	\$11.00	\$15.00	\$6.00 - \$10.00	\$13.00 - \$18.00	\$30.00 - \$40.00
Heat Rate	Btu/kWh	6,239 - 7,260	14,500	—	—	—
Capacity Factor	%	95%	85%	48% - 30%	43% - 37%	90% - 80%
Fuel Price	\$/MMBtu	\$4.50	\$1.00 - \$2.00	—	—	—
Construction Time	Months	3	36	12	12	36
Facility Life	Years	20	20	20	20	20
CO <sub>2</sub> Emissions	lb/MMBtu	0 - 117	—	—	—	—
Investment Tax Credit <sup>(c)</sup>	%	—	—	—	—	—
Production Tax Credit <sup>(c)</sup>	\$/MWh	—	\$11	\$22	\$22	\$22
Levelized Cost of Energy <sup>(c)</sup>	\$/MWh	\$109 - \$229	\$87 - \$116	\$48 - \$95	\$110 - \$199	\$89 - \$142

Source: Lazard estimates.

Note: Assumes 60% debt at 8.0% interest rate and 40% equity at 12% cost for conventional and Alternative Energy generation technologies. Assumes Powder River Basin coal price of \$1.70 per MMBtu and natural gas price of \$4.50 per MMBtu.

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

(b) Low end incorporates illustrative economic and efficiency benefits of combined heat and power (“CHP”) applications.

(c) While prior versions of this study have presented LCOE inclusive of the U.S. Federal Investment Tax Credit and Production Tax Credit, Version 6.0 presents LCOE on an unsubsidized basis, except as noted on the page titled “Levelized Cost of Energy—Sensitivity to U.S. Federal Tax Subsidies.”

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

	Units	IGCC <sup>(b)</sup>	Gas Combined Cycle	Gas Peaking <sup>(c)</sup>	Coal <sup>(d)</sup>	Nuclear <sup>(e)</sup>
Net Facility Output	MW	580	550	152 - 34	600	1,100
EPC Cost	\$/kW	\$3,054 - \$4,193	\$743 - \$1,004	\$580 - \$700	\$2,027 - \$6,067	\$3,750 - \$5,250
Capital Cost During Construction	\$/kW	\$696 - \$1,057	\$107 - \$145	included	\$487 - \$1,602	\$1,035 - \$1,449
Other Owner's Costs	\$/kW	included	\$156 - \$170	\$220 - \$300	\$486 - \$731	\$600 - \$1,500
<b>Total Capital Cost<sup>(a)</sup></b>	\$/kW	\$3,750 - \$5,250	\$1,006 - \$1,318	\$800 - \$1,000	\$3,000 - \$8,400	\$5,385 - \$8,199
Fixed O&M	\$/kW-yr	\$26.40 - \$28.20	\$6.20 - \$5.50	\$5.00 - \$25.00	\$20.40 - \$31.60	\$12.80
Variable O&M	\$/MWh	\$6.80 - \$7.30	\$3.50 - \$2.00	\$28.00 - \$4.70	\$3.00 - \$5.90	—
Heat Rate	Btu/kWh	8,800 - 10,520	6,800 - 7,220	9,100 - 9,800	8,750 - 12,000	10,450
Capacity Factor	%	75%	70% - 40%	10%	93%	90%
Fuel Price	\$/MMBtu	\$1.70	\$4.50	\$4.50	\$1.70	\$0.50
Construction Time	Months	57 - 63	36	25	60 - 66	69
Facility Life	Years	40	20	20	40	40
CO <sub>2</sub> Emissions	lb/MMBtu	169	117	117	211	—
Investment Tax Credit <sup>(f)</sup>	%	—	—	—	—	—
Production Tax Credit <sup>(f)</sup>	\$/MWh	—	—	—	—	—
<b>Levelized Cost of Energy<sup>(f)</sup></b>	\$/MWh	\$88 - \$116	\$61 - \$89	\$200 - \$231	\$62 - \$141	\$77 - \$114

Source: Lazard estimates.

Note: Assumes 60% debt at 8.0% interest rate and 40% equity at 12% cost for conventional and Alternative Energy generation technologies. Assumes coal price of \$1.70 per MMBtu and natural gas price of \$4.50 per MMBtu.

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

(b) High end incorporates 90% carbon capture and compression.

(c) Low end represents assumptions regarding GE 7FA. High end represents assumptions regarding GE LM6000PC.

(d) Based on advanced supercritical pulverized coal. High end incorporates 90% carbon capture and compression.

(e) Does not reflect decommissioning costs or potential economic impact of federal loan guarantees or other subsidies.

(f) While prior versions of this study have presented LCOE inclusive of the U.S. Federal Investment Tax Credit and Production Tax Credit, Version 6.0 presents LCOE on an unsubsidized basis, except as noted on the page titled "Levelized Cost of Energy—Sensitivity to U.S. Federal Tax Subsidies."

## Summary Considerations

*Lazard has conducted this study comparing the levelized cost of energy for various conventional and Alternative Energy generation technologies in order to understand which Alternative Energy generation technologies may be cost-competitive with conventional generation technologies, either now or in the future, and under various operating assumptions, as well as to understand which technologies are best suited for various applications based on locational requirements, dispatch characteristics and other factors. We find that Alternative Energy technologies are complementary to conventional generation technologies, and believe that their use will be increasingly prevalent for a variety of reasons, including government subsidies, RPS requirements, and continuously improving economics as underlying technologies improve and production volumes increase.*

*In this study, Lazard's approach was to determine the levelized cost of energy, 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, and economic life) 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 U.S. federal tax incentives on the levelized cost of energy. These inputs were developed with a leading consulting and engineering firm to the Power & Energy Industry, augmented with Lazard's commercial knowledge where relevant.*

*Lazard has not manipulated capital costs or capital structure for various technologies, as the goal of the study was to compare the current state of various generation technologies, rather than the benefits of financial engineering. The results contained in this study would be altered by different assumptions regarding capital structure (e.g., increased use of leverage) or capital costs (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 scale benefits or detriments, the value of Renewable Energy Credits ("RECs") or carbon emissions offsets, the impact of transmission costs, second-order system costs to support intermittent generation (e.g., backup generation, voltage regulation, etc.), and the economic life of the various assets examined.*