LAZARD'S LEVELIZED COST OF ENERGY ANALYSIS—VERSION 7.0

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 U.S. federal tax subsidies, fuel costs, geography and cost of capital, among other factors**
- **Illustration of how the cost of utility-scale solar-produced energy compares against generation rates in large metropolitan areas of the United States**
- **Illustration of utility-scale solar versus peaking generation technologies globally**
- **Illustration of how the costs of utility-scale and rooftop solar and wind vary across the United States, 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 and maintenance expense, variable operations and 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**

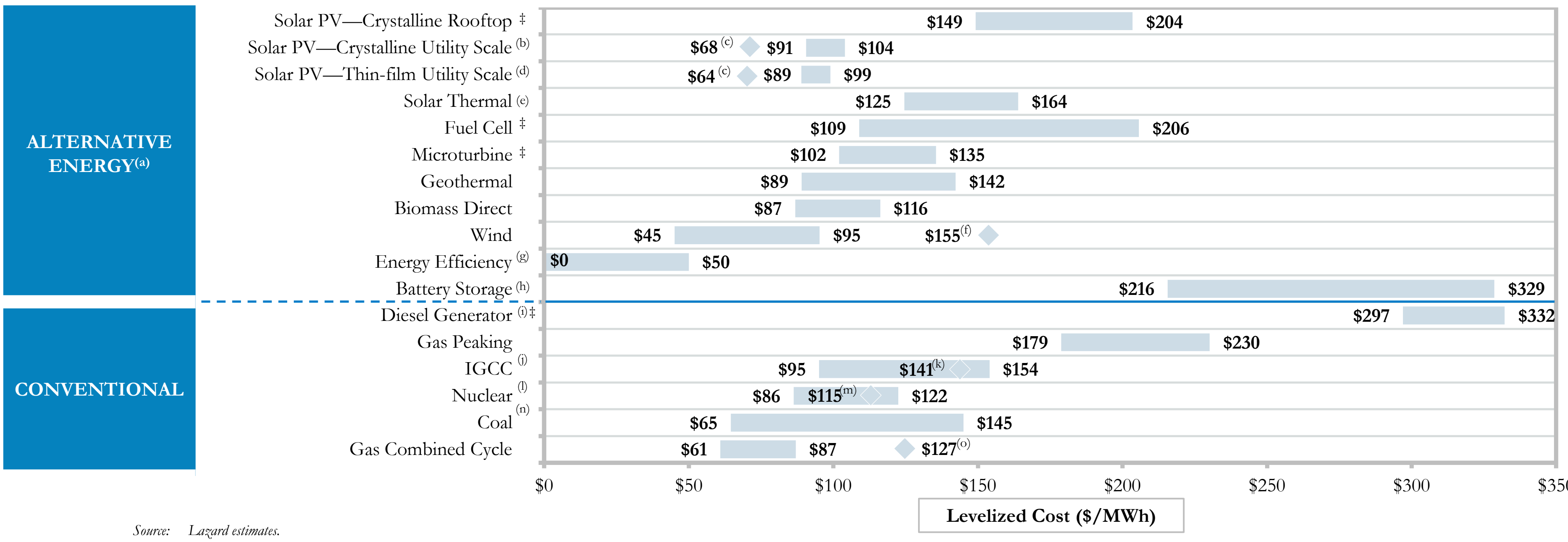
Other factors would also have a potentially significant effect on the results contained herein, but have not been examined in the scope of this current analysis. These additional factors, among others, could include: capacity value vs. energy value; network upgrade or congestion costs; integration costs; costs of adding emissions controls (e.g., selective catalytic reductions systems, etc.) to existing fossil power plants; and transmission costs. The analysis also does not address the potential stranded cost aspects of distributed generation solutions in respect of existing electric utility systems, nor does it account for the social costs or other externalities of the rate consequences for those who cannot afford distributed generation solutions

While prior versions of this study have presented the LCOE inclusive of the U.S. Federal Investment Tax Credit and Production Tax Credit, Versions 6.0 and 7.0 present the LCOE on an unsubsidized basis, except as noted on the page titled "Levelized Cost of Energy—Sensitivity to U.S. Federal Tax Subsidies"

Note: This study has been prepared by Lazard for general informational purposes only, and it is not intended to be, and should not be construed as, financial or other advice.

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% interest rate and 40% equity at 12% cost for conventional and Alternative Energy generation technologies. Assumes Powder River Basin coal price of $1.99 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.

‡ Denotes distributed generation technology.

(a) Analysis excludes integration costs for intermittent technologies. A variety of studies suggest integration costs ranging from $2.00 to $10.00 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.). Not directly comparable for baseload.

(c) Diamonds represent estimated implied levelized cost of energy in 2015, assuming $1.50 per watt for a crystalline single-axis tracking system and $1.50 per watt for a thin-film single-axis tracking system.

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

(e) Low end represents solar tower without storage. High end represents solar tower with storage capability.

(f) Represents estimated midpoint of levelized cost of energy for offshore wind, assuming a range of $3.10 – $5.00 per watt.

(g) Estimates per National Action Plan for Energy Efficiency; actual cost for various initiatives varies widely. Estimates involving demand response may fail to account for opportunity cost of foregone consumption.

(h) Indicative range based on current and future stationary storage technologies; assumes capital costs of $400 – $750/KWh for 6 hours of storage capacity, $60/MWh cost to charge, one full cycle per day (full charge and discharge), efficiency of 66% – 75% and fixed O&M costs of $5 to $20 per KWh installed per year.

(i) Low end represents continuous operation. High end represents intermittent operation. Assumes diesel price of $4.00 per gallon.

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

(k) Represents estimate of current U.S. new IGCC construction with carbon capture and compression. Does not include cost of transportation and storage.

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

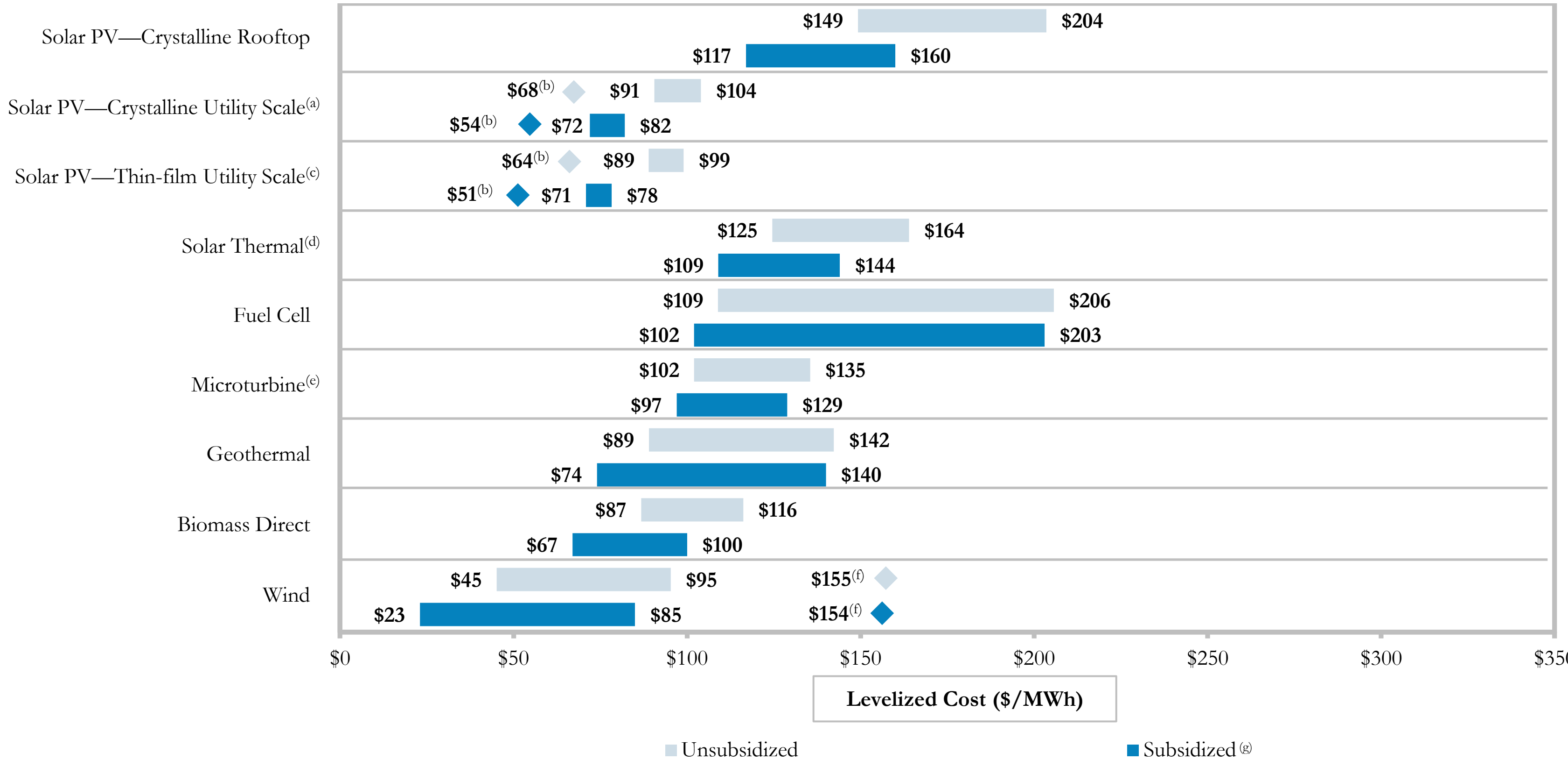
(m) Represents estimate of current U.S. new nuclear construction.

(n) Based on advanced supercritical pulverized coal. High end incorporates 90% carbon capture and compression. Does not include cost of transportation and storage.

(o) Incorporates 90% carbon capture and compression. Does not include cost of transportation and storage.

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 may currently reach "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. Assumes 10 MW system in high insolation jurisdiction (e.g., Southwest U.S.). Not directly comparable for baseload.

(b) Diamonds represent estimated implied levelized cost of energy in 2015, assuming $1.50 per watt for a crystalline single-axis tracking system and $1.50 per watt for a thin-film single-axis tracking system.

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

(d) Low end represents solar tower without storage. High end represents solar tower with storage capability.

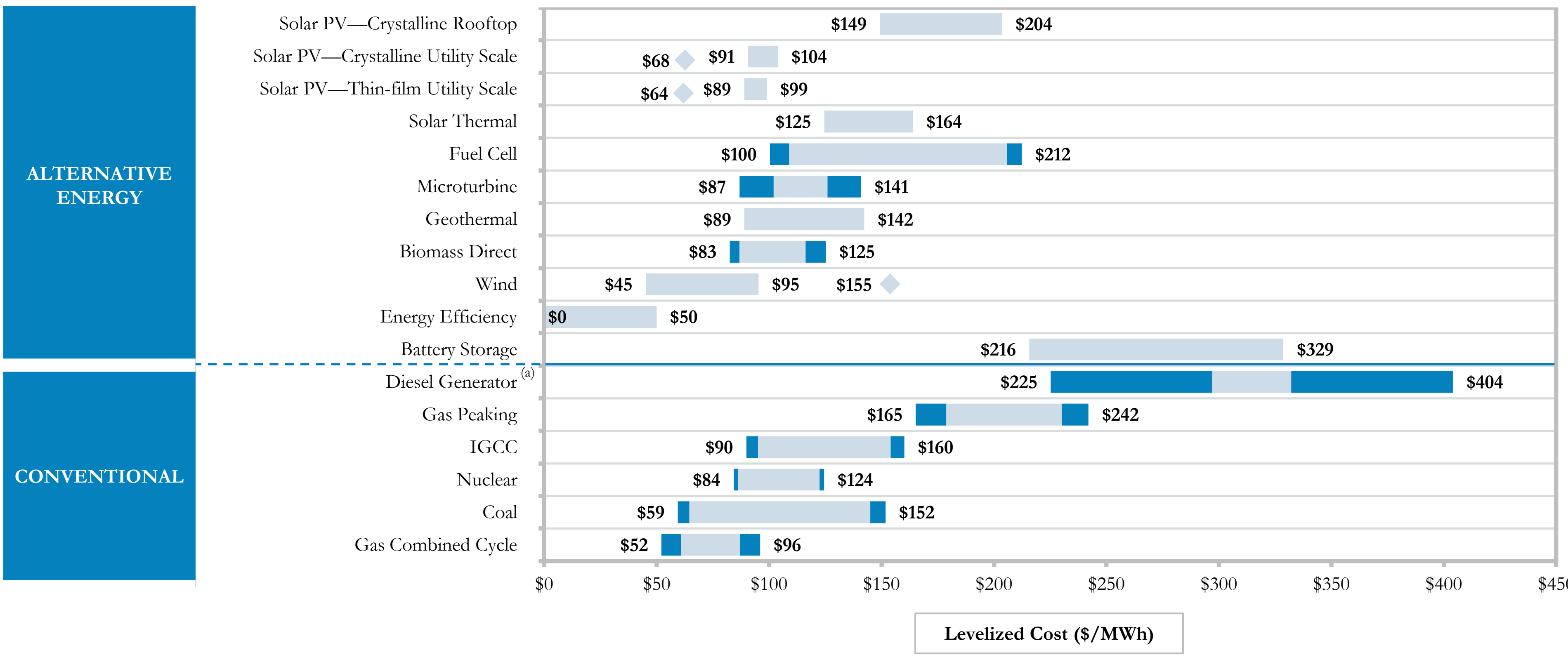
(e) Reflects 10% Investment Tax Credit. Capital structure adjusted for lower Investment Tax Credit; assumes 50% debt at 8.0% interest rate, 20% tax equity at 12.0% cost and 30% common equity at 12.0% cost.

(f) Represents estimated midpoint of levelized cost of energy for offshore wind, assuming a range of $3.10 – $5.00 per watt.

(g) Except where noted, reflects Investment Tax Credit. Assumes 30% debt at 8.0% interest rate, 50% tax equity at 12.0% cost and 20% common equity at 12.0% cost.

Levelized Cost of Energy Comparison—Sensitivity to Fuel Prices

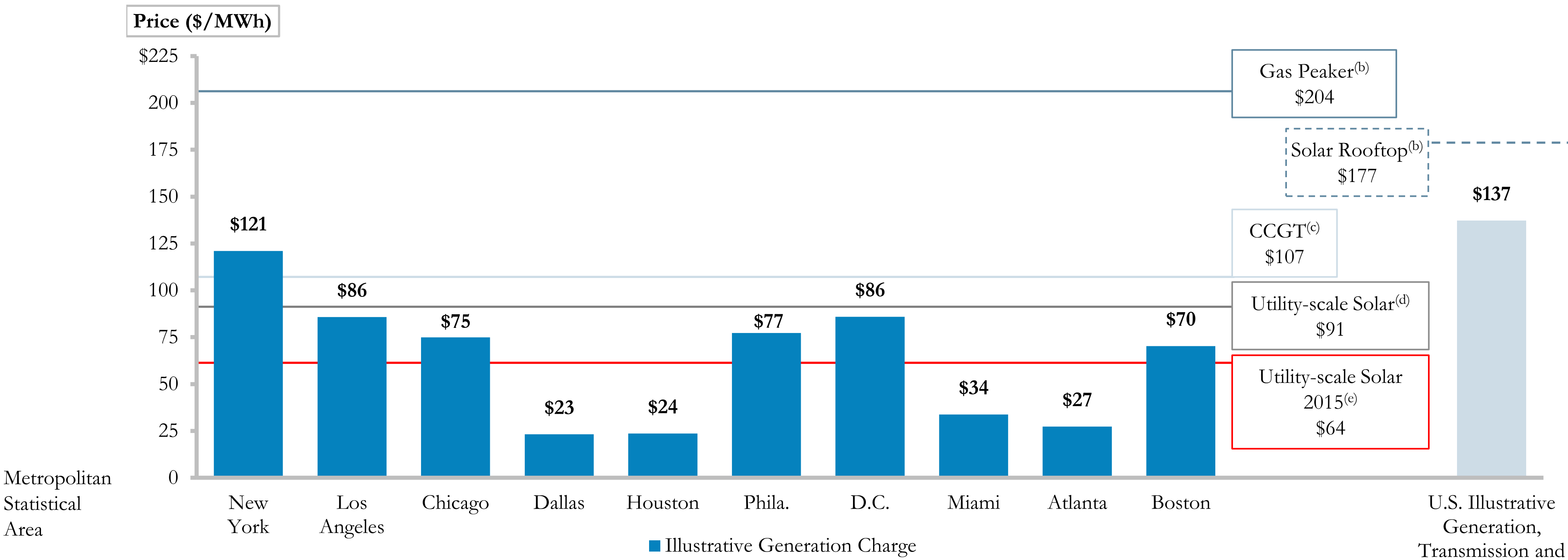
Variations in fuel prices can materially affect the levelized cost of energy for conventional generation technologies, but direct comparisons against "competing" Alternative Energy generation technologies must take into account issues such as dispatch characteristics (e.g., baseload and/or dispatchable 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.
(a) Low end represents continuous operation. High end represents intermittent operation.

Generation Rates for the 10 Largest U.S. Metropolitan Areas[a]

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, as well as the potential stranded cost aspects of distributed generation solutions in respect of existing electricity systems, nor does it account for the social costs or other externalities of the rate consequences for those who cannot afford distributed generation solutions

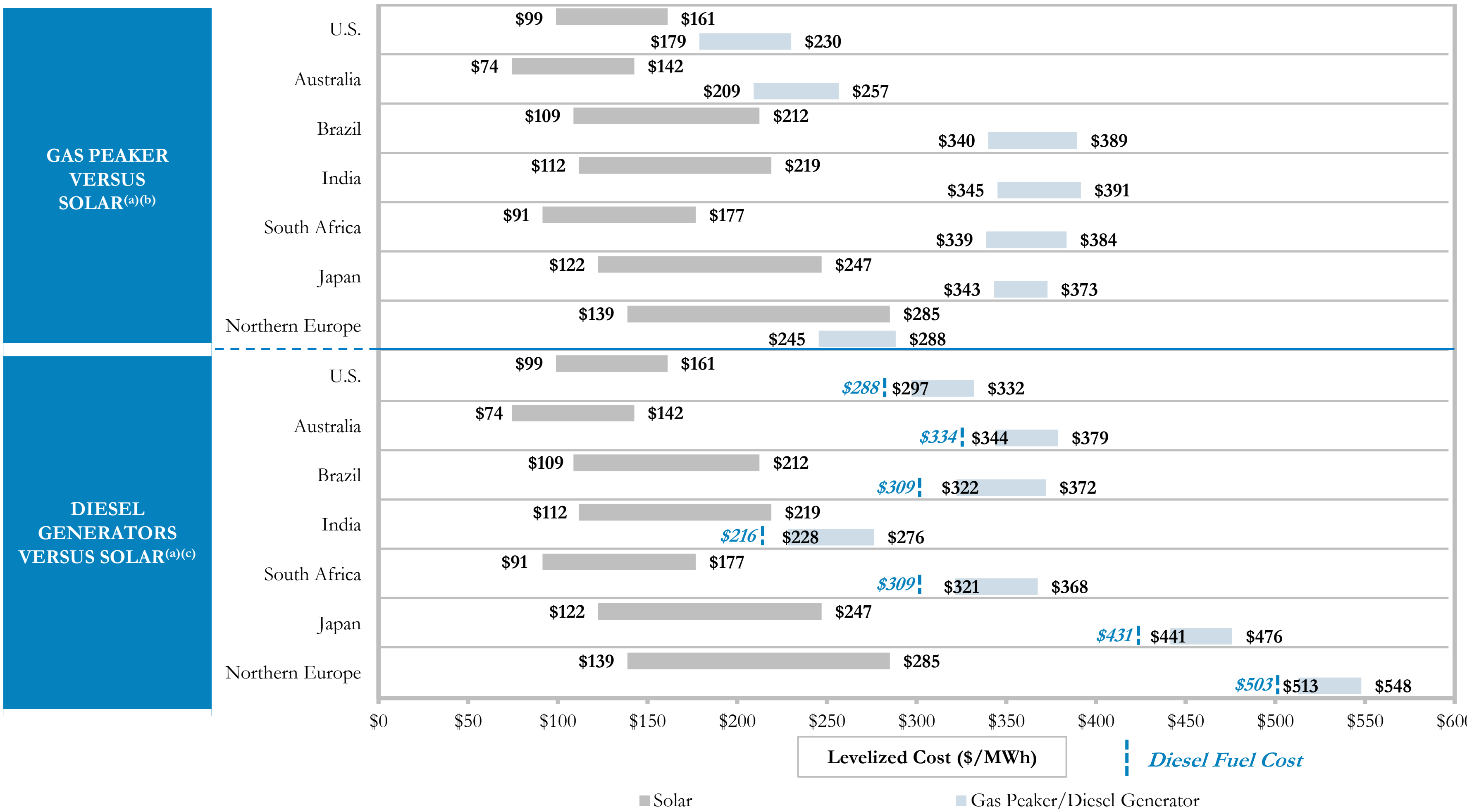


	New York	Los Angeles	Chicago	Dallas	Houston	Phila.	D.C.	Miami	Atlanta	Boston
Population (mm)	20	13	10	7	6	6	6	6	5	5
Cumulative % of U.S. population	7%	12%	16%	18%	21%	23%	25%	27%	29%	31%

Source: *EEI.*
Note: Actual delivered generation prices may be higher, reflecting historical composition of resource portfolio.
(a) Defined as 10 largest Metropolitan Statistical Areas per the U.S. Census Bureau for a total population of 83 million.
(b) Represents an average of the high and low levelized cost of energy.
(c) Assumes 25% capacity factor.
(d) Represents low end of crystalline utility scale. Excludes investment tax credit.
(e) Represents estimated implied levelized cost of energy in 2015, assuming $1.50 per watt for a thin-film single-axis tracking system. Excludes investment tax credit.

Solar versus Peaking Capacity—Global Markets

Solar PV can be an attractive resource relative to gas and diesel-fired peaking in many parts of the world due to high fuel costs; without storage, however, solar lacks the dispatch characteristics of conventional peaking technologies



Source: *World Bank, Waterborne Energy, Department of Energy of South Africa, Sydney and Brisbane Hub Trading Prices and Lazard estimates.*

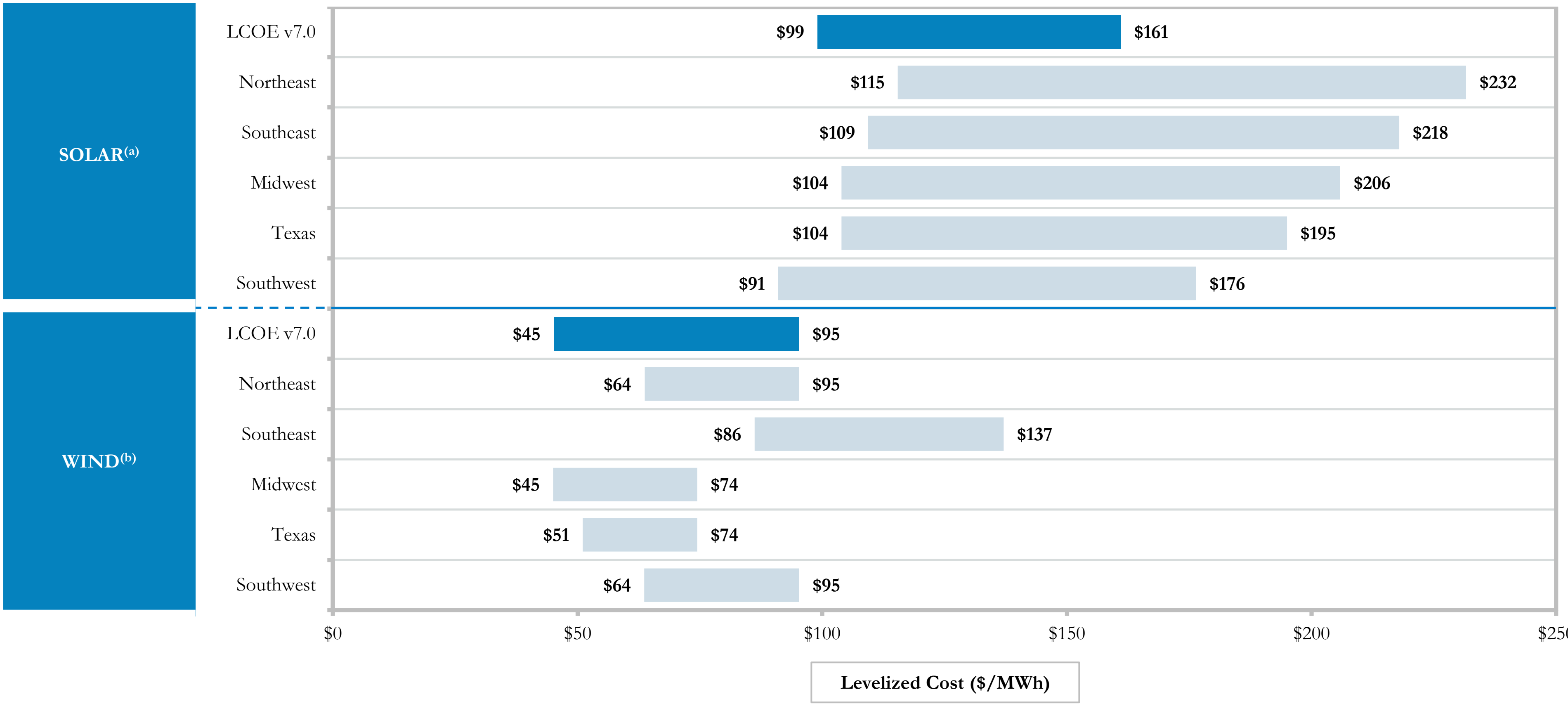
(a) Low end assumes a solar fixed-tilt thin-film utility scale system with per watt capital costs of $1.75. High end assumes a solar crystalline rooftop utility scale system with per watt capital costs of $3.25. Solar projects assume capacity factors of 26% – 28% for Australia, 25% – 27% for Brazil, 23% – 25% for India, 27% – 29% for South Africa, 15% – 17% for Japan and 13% – 15% for Northern Europe. Equity IRRs of 12% are assumed for Australia, Japan and Northern Europe and 18% for Brazil, India and South Africa; assumes cost of debt of 8% for Australia, Japan and Northern Europe, 14.5% for Brazil, 13% for India and 11.5% for South Africa.

(b) Assumes natural gas prices of $7 for Australia, $14 for Brazil, $15 for India, $15 for South Africa, $18 for Japan and $10 for Northern Europe (all in U.S.$ per MMBtu). Assumes a capacity factor of 10%.

(c) Diesel assumes high end capacity factor of 30% representing intermittent utilization and low end capacity factor of 95% representing baseload utilization, O&M cost of $15 per KW/year, heat rate of 10,000 Btu/KWh and total capital costs of $500 to $800 per KW of capacity. Assumes diesel prices of $4.65 for Australia, $4.30 for Brazil, $3.00 for India, $4.30 for South Africa, $6.00 for Japan and $7.00 for Northern Europe (all in U.S.$ per gallon).

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

The availability of wind and solar resource has a meaningful impact on the levelized cost of energy 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., transmission, back-up generation/system reliability costs, labor rates, permitting and other costs) that would also impact regional costs



Source: Lazard estimates.

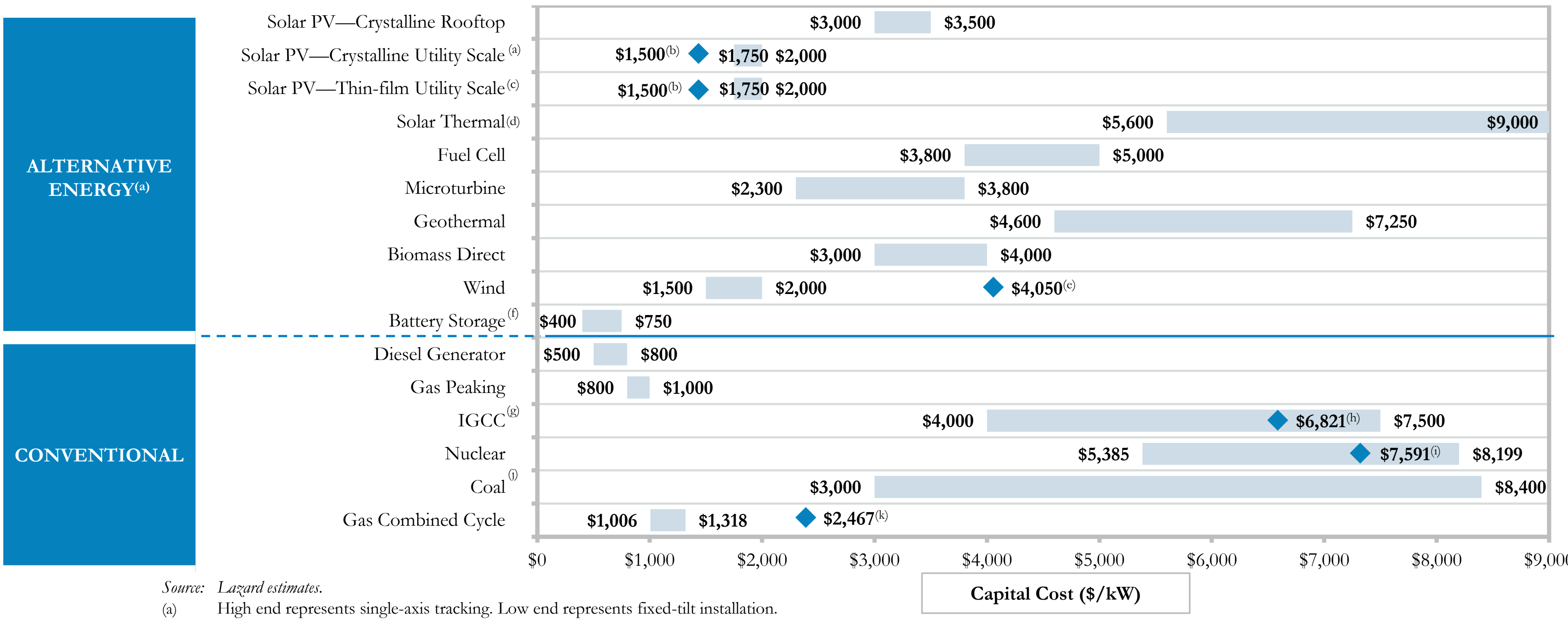
Note: Assumes solar capacity factors of 16% – 18% for the Northeast, 17% – 19% for the Southeast, 18% – 20% for the Midwest, 19% – 20% for Texas and 21% – 23% for the Southwest. Assumes wind capacity factors of 30% – 35% for the Northeast, 20% – 25% for the Southeast, 40% – 52% for the Midwest, 40% – 45% for Texas and 30% – 35% for the Southwest.

(a) Low end assumes a solar fixed-tilt thin-film utility scale system with per watt capital costs of $1.75. High end assumes a solar crystalline rooftop utility scale system with per watt capital costs of $3.25.

(b) Assumes an onshore 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 some conventional generation technologies (e.g., gas), 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

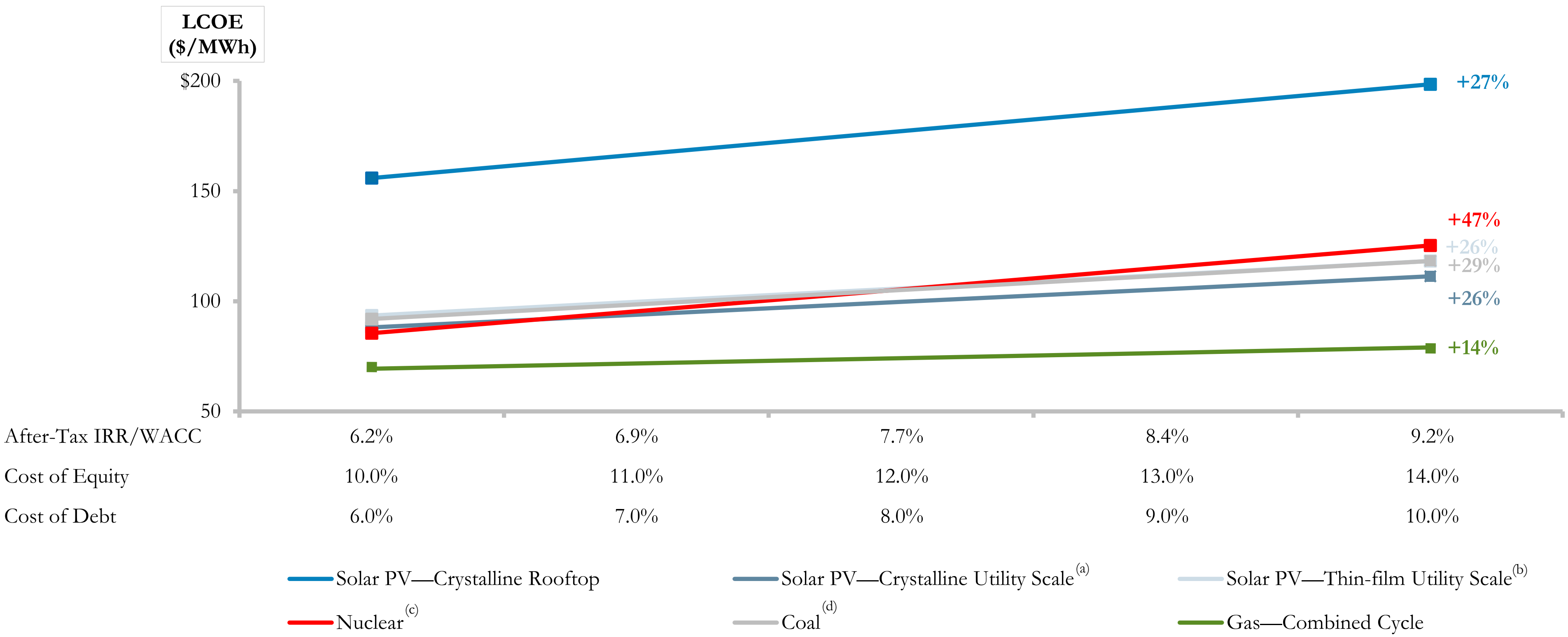


Source: Lazard estimates.

(a) High end represents single-axis tracking. Low end represents fixed-tilt installation.
(b) Diamonds represent estimated capital costs in 2015, assuming $1.50 per watt for a crystalline single-axis tracking system and $1.50 per watt for a thin-film single-axis tracking system.
(c) High end represents single-axis tracking. Low end represents fixed-tilt installation.
(d) Low end represents solar tower without storage. High end represents solar tower with storage capability.
(e) Represents estimated midpoint of capital costs for offshore wind, assuming a range of $3.10 – $5.00 per watt.
(f) Indicative range based on current and future stationary storage technologies.
(g) High end incorporates 90% carbon capture and compression. Does not include cost of transportation and storage.
(h) Represents estimate of current U.S. new IGCC construction with carbon capture and compression. Does not include cost of transportation and storage.
(i) Represents estimate of current U.S. new nuclear construction.
(j) Based on advanced supercritical pulverized coal. High end incorporates 90% carbon capture and compression. Does not include cost of transportation and storage.
(k) Incorporates 90% carbon capture and compression. Does not include cost of transportation and storage.

Levelized Cost of Energy—Sensitivity to Cost of Capital

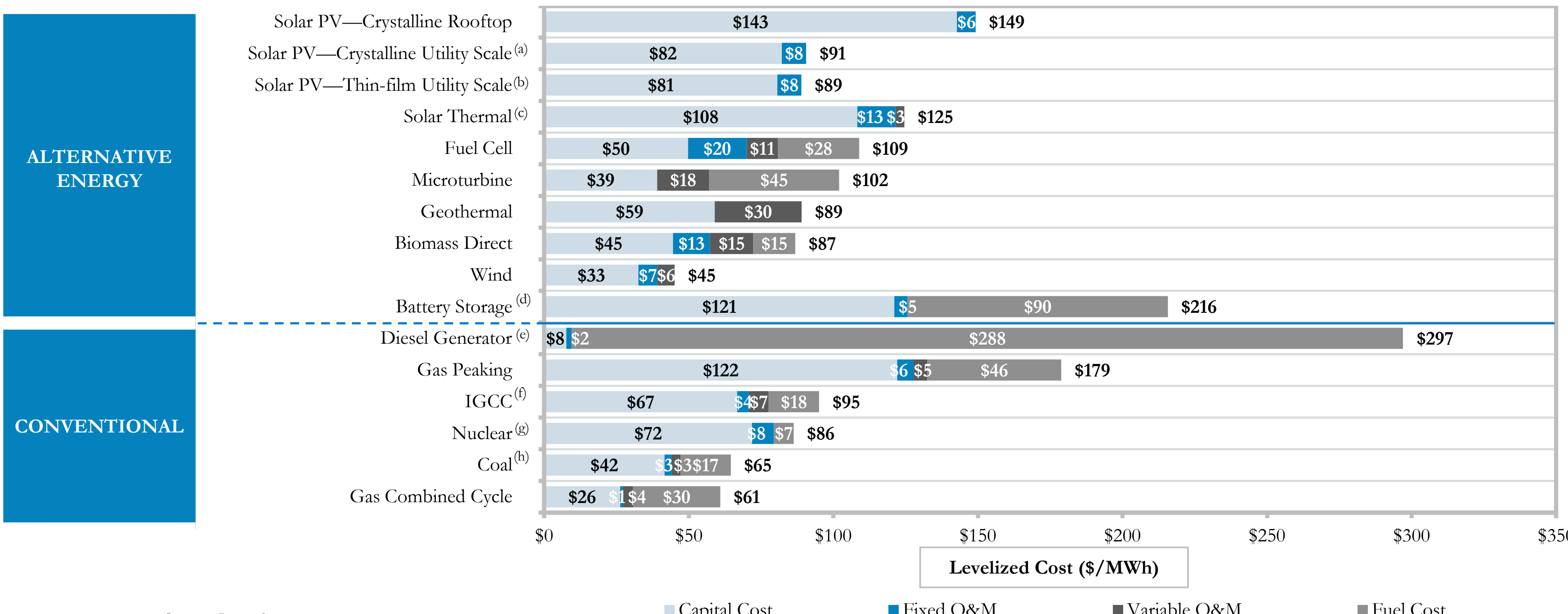
A key issue facing Alternative Energy generation technologies resulting from the potential for intermittently disrupted capital markets (and the relatively immature state of some aspects of financing Alternative Energy technologies) is the reduced availability, and increased cost, of capital; availability 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 $1.99 per MMBtu and natural gas price of $4.50 per MMBtu.
(a) Assumes a fixed-tilt crystalline utility scale system with capital costs of $1.75 per watt.
(b) Assumes a fixed-tilt thin-film utility scale system with capital costs of $1.75 – $2.00 per watt.
(c) Does not reflect decommissioning costs or potential economic impact of federal loan guarantees or other subsidies.
(d) 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 has been the case with solar PV and wind technologies)



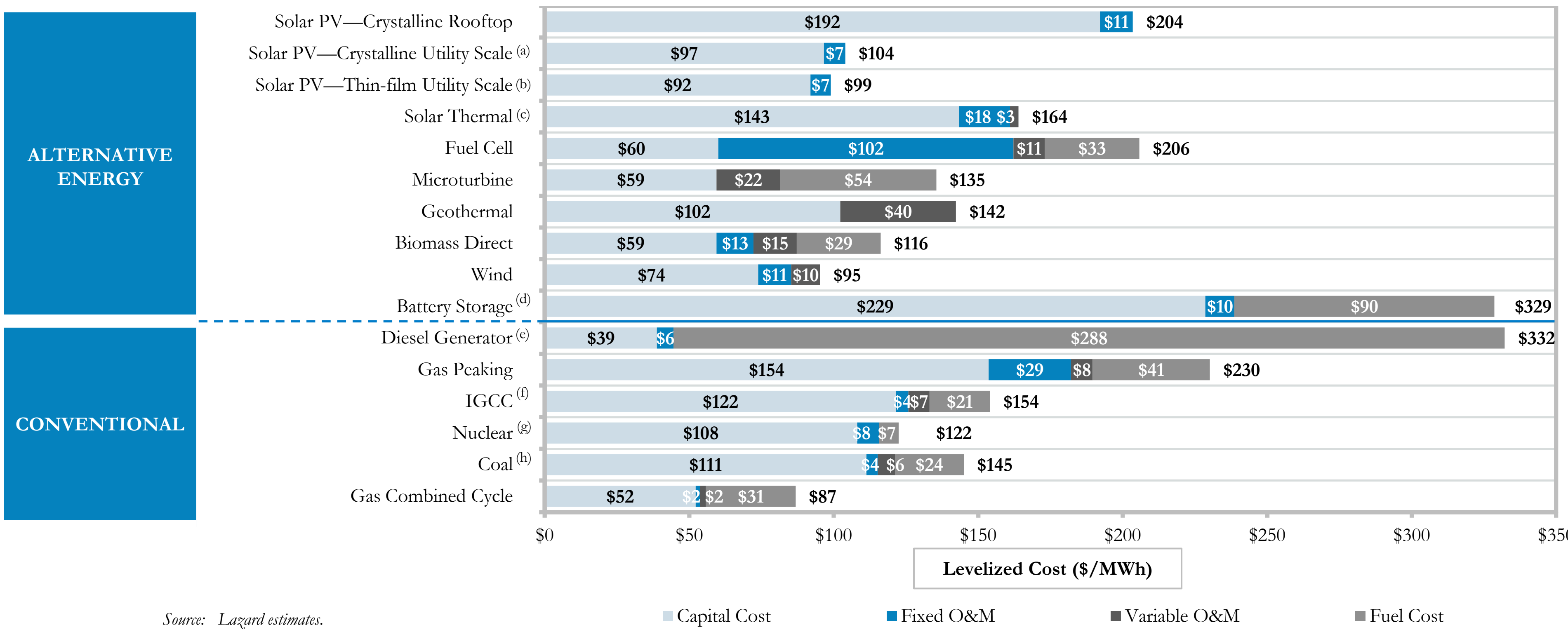
Source: Lazard estimates.

Note: Assumes 60% debt at 8% interest rate and 40% equity at 12% cost for conventional and Alternative Energy generation technologies. Assumes Powder River Basin coal price of $1.99 per MMBtu and natural gas price of $4.50 per MMBtu.

(a) Low end represents single-axis tracking.
(b) Low end represents single-axis tracking.
(c) Low end represents solar tower without storage capability.
(d) Low end represents flow battery.
(e) Low end represents continuous operation.
(f) Does not incorporate carbon capture and compression.
(g) Does not reflect decommissioning costs or potential economic impact of federal loan guarantees or other subsidies.
(h) 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 has been the case with solar PV and wind technologies)



Source: Lazard estimates.

Note: Assumes 60% debt at 8% interest rate and 40% equity at 12% cost for conventional and Alternative Energy generation technologies. Assumes Powder River Basin coal price of $1.99 per MMBtu and natural gas price of $4.50 per MMBtu.

(a) High end represents fixed-tilt installation.
(b) High end represents fixed-tilt installation.
(c) High end represents solar tower with storage capability.
(d) High end represents NaS technology.
(e) High end represents intermittent operation.
(f) High end incorporates 90% carbon capture and compression. Does not include cost of transportation and storage.
(g) Does not reflect decommissioning costs or potential economic impact of federal loan guarantees or other subsidies.
(h) Based on advanced supercritical pulverized coal. High end incorporates 90% carbon capture and compression. Does not include cost of transportation and storage.

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). This analysis also does not address the potential stranded cost aspects of distributed generation solutions in respect of existing electric utility systems, nor does it account for the social costs or other externalities of the rate consequences for those who cannot afford distributed generation solutions

		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	SOLAR PV	$89 – 204	✓	Commercial	✓	✓	Universal[(a)]	✓	✓		
	SOLAR THERMAL	$125 – 164	✓	Commercial		✓	Southwest	✓	✓	✓	
	FUEL CELL	$109 – 206	?[(b)]	Emerging/ Commercial	✓		Universal				✓
	MICROTURBINE	$102 – 135	?[(b)]	Emerging/ Commercial	✓		Universal				✓
	GEOTHERMAL	$89 – 142	✓	Mature		✓	Varies				✓
	BIOMASS DIRECT	$87 – 116	✓	Mature		✓	Universal			✓	✓
	ONSHORE WIND	$45 – 95	✓	Mature		✓	Varies	✓			
	BATTERY STORAGE	$216 – 329	✓	Emerging	✓	✓	Varies		✓	✓	
CONVENTIONAL	DIESEL GENERATOR	$297 – 332	×	Mature	✓		Universal	✓	✓	✓	✓
	GAS PEAKING	$179 – 230	×	Mature	✓	✓	Universal		✓	✓	
	IGCC	$95 – 154	×[(c)]	Emerging[(d)]		✓	Co-located or rural				✓
	NUCLEAR	$86 – 122	✓	Mature/ Emerging		✓	Co-located or rural				✓
	COAL	$65 – 145	×[(c)]	Mature[(d)]		✓	Co-located or rural				✓
	GAS COMBINED CYCLE	$61 – 87	×	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: Rooftop	Solar PV—Crystalline: Utility Scale[b]	Solar PV—Thin-film: Utility Scale[c]	Solar Thermal Tower[d]	Fuel Cell
Net Facility Output	MW	10	10	10	120 – 100	2.4
EPC Cost	$/kW	$3,000 – $3,500	$2,000 – $1,750	$2,000 – $1,750	$5,600 – $9,000	$3,000 – $5,000
Capital Cost During Construction	$/kW	included	included	included	included	included
Other Owner's Costs	$/kW	included	included	included	included	$800 – included
Total Capital Cost[a]	$/kW	$3,000 – $3,500	$2,000 – $1,750	$2,000 – $1,750	$5,600 – $9,000	$3,800 – $5,000
Fixed O&M	$/kW-yr	$13.00 – $20.00	$20.00 – $13.00	$20.00 – $13.00	$50.00 – $80.00	$169 – $850
Variable O&M	$/MWh	—	—	—	$3.00	$10.75
Heat Rate	Btu/kWh	—	—	—	—	6,239 – 7,260
Capacity Factor	%	23% – 20%	27% – 20%	28% – 21%	43% – 52%	95%
Fuel Price	$/MMBtu	—	—	—	—	$4.50
Construction Time	Months	3	12	12	24	3
Facility Life	Years	20	20	20	40	20
CO_2 Emissions	lb/MMBtu	—	—	—	—	0 – 117
Investment Tax Credit[e]	%	—	—	—	—	—
Production Tax Credit[e]	$/MWh	—	—	—	—	—
Levelized Cost of Energy[e]	$/MWh	$149 – $204	$91 – $104	$89 – $99	$125 – $164	$109 – $206

Source: Lazard estimates.

Note: Assumes 60% debt at 8% interest rate and 40% equity at 12% cost for conventional and Alternative Energy generation technologies. Assumes Powder River Basin coal price of $1.99 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.). Not directly comparable for baseload.

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

(d) Low end represents solar tower without storage. High end represents solar tower with storage capability.

(e) While prior versions of this study have presented LCOE inclusive of the U.S. Federal Investment Tax Credit and Production Tax Credit, Versions 6.0 and 7.0 present 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	Microturbine	Geothermal	Biomass Direct	Wind	Offshore Wind	Battery Storage[c]
Net Facility Output	MW	1	30	35	100	210	6
EPC Cost	$/kW	$2,300 – $3,800	$4,021 – $6,337	$2,622 – $3,497	$1,200 – $1,600	$2,500 – $4,120	$400 – $750
Capital Cost During Construction	$/kW	included	$579 – $913	$378 – $503	included	included	included
Other Owner's Costs	$/kW	included	included	included	$300 – $400	$600 – $880	included
Total Capital Cost[a]	$/kW	$2,300 – $3,800	$4,600 – $7,250	$3,000 – $4,000	$1,500 – $2,000	$3,100 – $5,000	$400 – $750
Fixed O&M	$/kW-yr	—	—	$95.00	$30.00	$60.00 – $100.00	$10.00 – $22.00
Variable O&M	$/MWh	$18.00 – $22.00	$30.00 – $40.00	$15.00	$6.00 – $10.00	$13.00 – $18.00	—
Heat Rate	Btu/kWh	10,000 – 12,000	—	14,500	—	—	—
Capacity Factor	%	95%	90% – 80%	85%	52% – 30%	43% – 37%	25% – 25%
Fuel Price	$/MMBtu	$4.50	—	$1.00 – $2.00	—	—	—
Construction Time	Months	3	36	36	12	12	3
Facility Life	Years	20	20	20	20	20	20
CO_2 Emissions	lb/MMBtu	—	—	—	—	—	—
Investment Tax Credit[b]	%	—	—	—	—	—	—
Production Tax Credit[b]	$/MWh	—	—	—	—	—	—
Levelized Cost of Energy[b]	$/MWh	$102 – $135	$89 – $142	$87 – $116	$45 – $95	$110 – $200	$216 – $329

Source: *Lazard estimates.*

Note: Assumes 60% debt at 8% interest rate and 40% equity at 12% cost for conventional and Alternative Energy generation technologies. Assumes Powder River Basin coal price of $1.99 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) While prior versions of this study have presented LCOE inclusive of the U.S. Federal Investment Tax Credit and Production Tax Credit, Versions 6.0 and 7.0 present LCOE on an unsubsidized basis, except as noted on the page titled "Levelized Cost of Energy—Sensitivity to U.S. Federal Tax Subsidies."

(c) Assumes capital costs of $400 – $750/KWh for 6 hours of storage capacity, $60/MWh cost to charge, one full cycle per day (full charge and discharge), efficiency of 66% – 75% and fixed O&M costs of $5 to $20 per KWh installed per year.

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

	Units	Diesel Generator[b]	Gas Peaking	IGCC[c]	Nuclear[d]	Coal[e]	Gas Combined Cycle
Net Facility Output	MW	2	216 – 103	580	1,100	600	550
EPC Cost	$/kW	$500 – $800	$580 – $700	$3,257 – $5,990	$3,750 – $5,250	$2,027 – $6,067	$743 – $1,004
Capital Cost During Construction	$/kW	induded	induded	$743 – $1,510	$1,035 – $1,449	$487 – $1,602	$107 – $145
Other Owner's Costs	$/kW	induded	$220 – $300	induded	$600 – $1,500	$486 – $731	$156 – $170
Total Capital Cost[a]	$/kW	$500 – $800	$800 – $1,000	$4,000 – $7,500	$5,385 – $8,199	$3,000 – $8,400	$1,006 – $1,318
Fixed O&M	$/kW-yr	$15.00	$5.00 – $25.00	$26.40 – $28.20	$60.00	$20.40 – $31.60	$6.20 – $5.50
Variable O&M	$/MWh	—	$4.70 – $7.50	$6.80 – $7.30	—	$3.00 – $5.90	$3.50 – $2.00
Heat Rate	Btu/kWh	10,000	10,300 – 9,000	8,800 – 10,520	10,450	8,750 – 12,000	6,700 – 6,900
Capacity Factor	%	95% – 30%	10%	75%	90%	93%	70% – 40%
Fuel Price	$/MMBtu	$4.00	$4.50	$1.99	$0.65	$1.99	$4.50
Construction Time	Months	3	25	57 – 63	69	60 – 66	36
Facility Life	Years	20	20	40	40	40	20
CO_2 Emissions	lb/MMBtu	0 – 117	117	169	—	211	117
Investment Tax Credit[f]	%	—	—	—	—	—	—
Production Tax Credit[f]	$/MWh	—	—	—	—	—	—
Levelized Cost of Energy[f]	$/MWh	$297 – $332	$179 – $230	$95 – $154	$86 – $122	$65 – $145	$61 – $87

Source: *Lazard estimates.*

Note: Assumes 60% debt at 8% interest rate and 40% equity at 12% cost for conventional and Alternative Energy generation technologies. Assumes Powder River Basin coal price of $1.99 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 continuous operation. High end represents intermittent operation. Assumes diesel price of $4.00 per gallon.

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

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

(e) Based on advanced supercritical pulverized coal. High end incorporates 90% carbon capture and compression. Does not include cost of storage and transportation.

(f) While prior versions of this study have presented LCOE inclusive of the U.S. Federal Investment Tax Credit and Production Tax Credit, Versions 6.0 and 7.0 present 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 RPS requirements, continually improving economics as underlying technologies improve, production volumes increase and government subsidies in certain regions.

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.), the economic life of the various assets examined, the potential stranded cost aspects of distributed generation solutions and social costs or other externalities of the rate consequences for those who cannot afford distributed generation solutions.