



UTILITY-SCALE RENEWABLE ENERGY: UNDERSTANDING COST PARITY

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Utility-scale renewable energy systems are typically larger than behind-the-meter systems and, thus, generally have the capability to generate more power. The most common utility-scale renewable electricity system technologies include hydroelectric, solar, biomass, and wind. Wind energy systems have seen tremendous growth globally, from 48GW in 2004 to 318GW in 2013. Solar energy systems – both solar photovoltaic (PV) and concentrated solar power (CSP) systems – have also seen tremendous global growth, from 3GW in 2004 to 142.4GW in 2013, with utility-scale solar PV systems experiencing the highest growth rates.¹

The economics of utility-scale renewable energy systems are highly specific to the electricity market dynamics of a given project. These systems typically sell power to utilities or other buyers through a power purchase agreement (PPA) – a fixed-price contractual agreement to purchase a power plant's energy – or through wholesale markets (in various forms). Conversely, utilities can also purchase these systems as new generation capacity using competitive procurement processes. The PPA price is typically calculated using levelized cost of energy (LCOE), that is, the projected total system and operating costs divided by total kWh produced over the lifetime of the project or contract. Several other variables may be considered in calculating LCOE, depending on the precision of the calculation, including subsidies, project finance, and fuel prices (depending on the technology).

1 REN21. 2014. Renewables 2014: Global Status Report. (Paris: REN21 Secretariat). 21. http://www.ren21.net/Portals/0/documents/Resources/GSR/2014/GSR2014_full%20report_low%20res.pdf.

Some markets set standard pricing for PPAs through a utility feed-in tariff. Other models for selling power exist, but the models presented here are the most prevalent. Many other models are simply variations on these basic models and entail the same comparisons.

Power Purchase Agreements (Large End-Use Consumers)

Large industrial and/or commercial electricity consumer have the option of entering directly into a PPA in some markets. With a typical, direct PPA, the price of electricity paid by end-use consumers includes the PPA price, charges for moving the power (transmission and distribution), and other system charges and considerations that differ by market (for example, interconnection fees, firming charges, etc.). This option replaces retail electricity supply for these large end-use consumers and can be compared to retail electricity prices. Currently, direct PPAs are allowed in only a limited number of markets globally.

Key Takeway:

A PPA option is cost-competitive for end-use consumers when the full price of electricity paid is lower than or equal to the retail electricity price over the lifetime of the project or the PPA contract.

Wholesale Market Generation

In the wholesale market, the utility or other buyer purchases electricity at the wholesale generation price (\$/MWh) — the price of the most expensive plant operating in a particular block of time in order to meet demand. In deregulated markets, this price is set by the marginal cost of production — the cost of producing each additional megawatt hour (MWh) — and often largely reflects conventional plants' fuel costs. This price is ultimately passed on to the end-use consumer through the retail electricity price.

The cost of utility-scale generation sold on the wholesale market should be compared in the short-term on the marginal cost of production in a given block of time and in the long-term on the average cost of energy (calculated from past projects or LCOE).

In wholesale markets, if a plant's marginal cost of production is lower than the wholesale price, or other available plants' marginal cost, in a particular block of time it is allowed to generate power for the grid. Since renewable energy has no fuel costs, its marginal cost of production is extremely low and often replaces more costly fossil fuel-based options.

Key Takeway:

Renewable energy projects can lower wholesale generation prices through a lower marginal cost of production and thus the retail electricity price paid by end-use consumers — which includes the wholesale generation price.

However, a renewable energy project is cost-competitive against the current wholesale market generation mix (that is, can generate profit for the owner) only when the average cost of energy of a project is lower than, or equal to, the average wholesale prices at times when the project generates power. When this is the case, wholesale buyers may lock in a fixed price through a PPA to limit the risk associated with wholesale price volatility. This, in turn, can also reduce the retail electricity price paid by end-use consumers.

Planned Capacity Additions

In traditional, regulated electricity markets, regulators determine whether a new power plant is necessary through capacity planning and competitive procurement processes. Specifically, electricity generation capacity additions are identified through Integrated Resource Planning (IRP) — a regional planning process for energy resources — and procured through utility Requests for Proposals (RFPs) — calls for competitive proposals for projects fitting specific characteristics.

In these cases, the utility is the purchaser of new generation capacity, either through purchasing new generation plant(s) or signing a contract for power (for example, PPAs). Regulators allow utilities to both recover their power plant investment costs and to earn a profit on those investments through the retail electricity price, paid ultimately by end-use consumers.

Key Takeway:

In the traditional market context, a renewable energy project is cost-competitive (that is, it presents economic savings) against another technology, that fills the same capacity need, when it has a lower or equal average cost of energy (past projects or LCOE) and/or a lower risk profile.

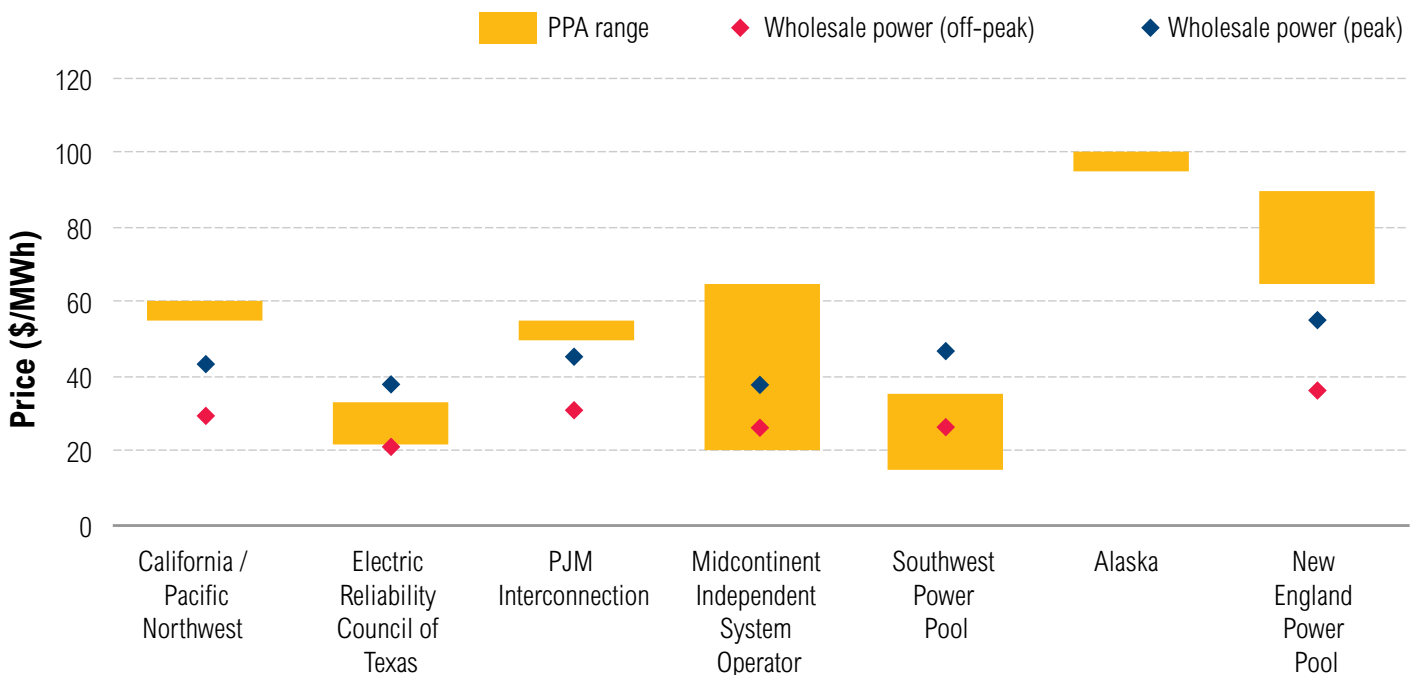
profile of the new generation plant(s). LCOE also does not take into account any protection that renewable energy generation might provide against electricity price fluctuations and costs of complying with planned and emerging environmental regulations, for example, EPA's Clean Power Plan, but an RFP process will.

Additional Factors

LCOE does not take into account benefits to the grid, such as power during peak loads and reduced transmission losses, or costs to the grid, such as grid infrastructure upgrades and other services. Regulated utilities performing an IRP will consider these factors, in addition to the risk

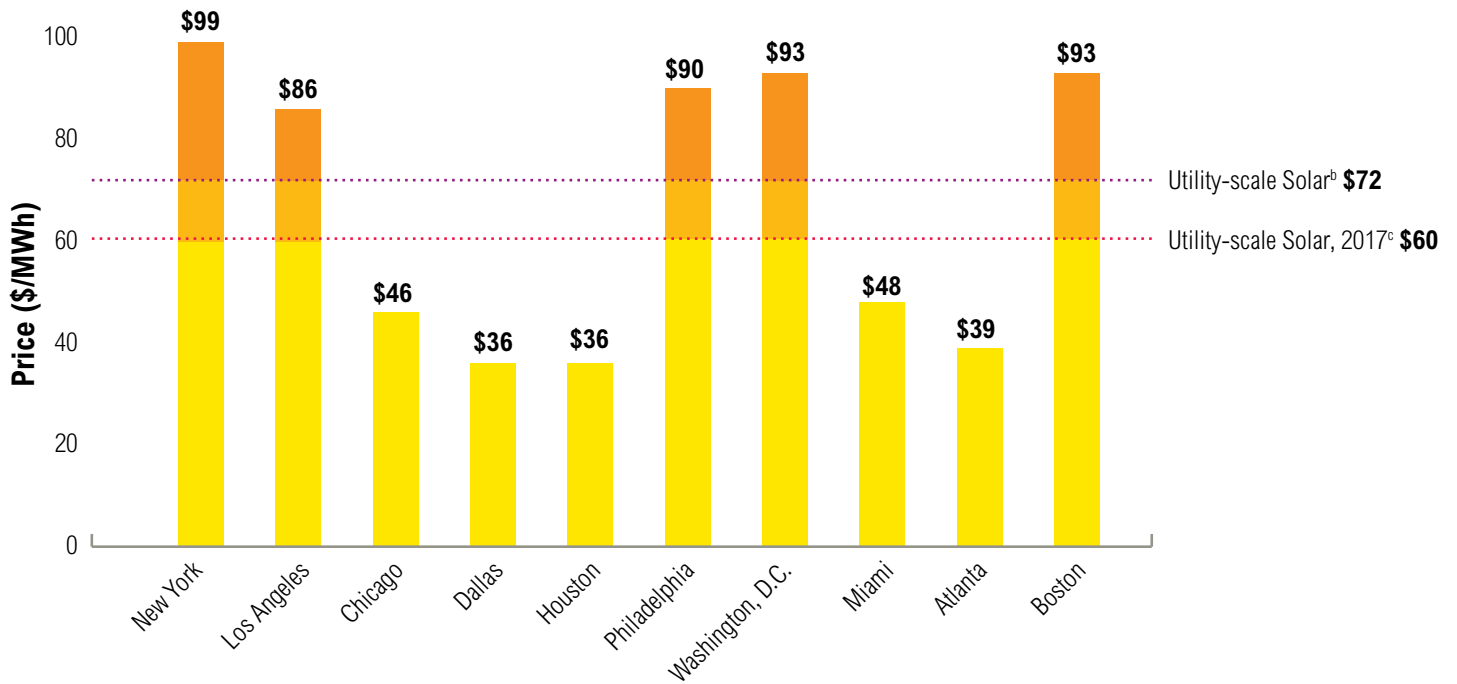
Figure 1 is a comparison of the average PPA prices for wind energy systems versus wholesale generation prices in seven U.S. markets. The figure shows that, in 2013, wind systems were potentially cost-competitive, with federal subsidies, against the average wholesale price in three markets. A more granular analysis would compare the PPA price to the average wholesale price at times when the specific wind plant was generating power.

Figure 1 | **BNEF: PPA Prices for Select U.S. Wind Markets²** (Alaska's wholesale power prices are above \$120/MWh)



2 Bloomberg New Energy Finance. 2014. "2014 Sustainable Energy in America: FACTBOOK." Sustainable Energy in America. The Business Council for Sustainable Energy.

Figure 2 | Lazard's LCOE: Generation Rates for the Ten Largest U.S. Metropolitan Areas³



Source: EEI, Ventyx.

Note: Actual delivered generation prices may be higher, reflecting historical composition of resource portfolio.

Defined as 10 largest Metropolitan Statistical Areas per the U.S. Census Bureau for a total population of 83 million.

a Represents low end of utility-scale solar. Excludes investment tax credit.

b Represents estimated implied levelized cost of energy in 2017, assuming \$1.25 per watt for a single-axis tracking system. Excludes investment tax credit.

Figure 2 is a comparison of the average cost of energy (using LCOE) for utility-scale solar PV systems, without subsidies, versus an estimated wholesale generation price (called generation rates) for ten U.S. cities. The figure shows that, in 2014, utility-scale solar PV systems were cost-competitive in the New York City, Los Angeles, Philadelphia, Washington D.C., and Boston markets

already. Comparing the PPA price to the average wholesale price at times when the specific solar plant was generating power would likely improve the system's cost-competitiveness because solar power often operates during periods of higher wholesale prices. However, this comparison does not account for transmission or distribution costs, or system constraints.

³ Lazard's Levelized Cost of Energy Analysis—Version 8.0. 2014. Lazard.

GLOSSARY

Cost parity: Cost-competitiveness between a renewable energy option and the comparable, traditional electricity supply option(s)

The Grid: The transmission and distribution system that connects generators and end-users

Average Cost of Energy: The cost of each unit of energy a project produces calculated using information from past projects or the levelized cost of energy (LCOE)

Levelized cost of energy (LCOE): The projected total system and operating costs divided by total kWh produced over the lifetime of the project or contract

Power Purchase Agreement (PPA): A fixed-price contractual agreement to purchase a power plant's energy, typically calculated using LCOE or set at the feed-in-tariff price

Wholesale Generation Price: The price (\$/MWh) of the most expensive plant operating in a particular block of time in order to meet demand

Integrated Resource Planning (IRP): Regional planning process for energy resources to help meet long-term energy demand with least-cost supply and energy efficiency while mitigating risk

Requests for Proposals (RFPs): Calls for competitive proposals for projects fitting specific characteristics

ADDITIONAL RESOURCES

WHOLESALE MARKET GENERATION

Ohio Public Utility Commission, Renewable Resources and Wholesale Price Suppression – Explanation of how low-marginal cost renewable energy can replace more costly generation in wholesale markets

PLANNED CAPACITY ADDITIONS

Northwest Power and Conservation Council, Sixth Northwest Conservation and Electric Power Plan – Example of a regional planning document considering levelized costs and risk-mitigation

ADDITIONAL FACTORS

LBNL, Revisiting the Long-Term Hedge Value of Wind Power in an Era of Low Natural Gas Prices – Compares average wind PPAs to current and future natural gas prices (a driver of wholesale prices)

DSIRE – Database of incentives and policies that support renewables and energy efficiency in the US

REN21 Policy databases – A global tool for tracking renewable energy policy frameworks

ABOUT THIS SERIES

WRI's Charge initiative has developed a factsheet series on "Renewable Energy Cost Parity" — a series of tools to help policymakers, journalists, corporations, and advocates breakdown the most cost-competitive ways to supply energy with greater clarity and precision.

These simple, go-to resource outlines which electricity supply options (renewable vs. traditional) can be compared and lays out what additional factors, like financial incentives or reduced transmission costs, must be considered. Each factsheet focuses on a particular market or technology to provide insight from this unique perspective.

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ABOUT WRI

WRI is a global research organization that works closely with leaders to turn big ideas into action to sustain a healthy environment—the foundation of economic opportunity and human well-being.

Our Challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our Vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.



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