UTILITY-SCALE BATTERY STORAGE: SOLVING THE INTERMITTENCY ISSUES OF WIND AND SOLAR POWER GENERATION

*Jay Blake**

I. INTRODUCTION

Despite the challenges posed by the COVID-19 pandemic, the United States is currently in the midst of an energy renaissance. Renewable energy generation methods like solar and wind are increasingly replacing fossil fuel-based sources for electricity

* The author graduated from the University of Houston Law Center, class of 2022, and is a *Houston Business & Tax Law Journal* alumnus. Prior to beginning his legal career, the author previously worked for five years as a natural gas trader at Citigroup Energy, Inc., rising to the level of Assistant Vice President. Currently, he is an associate attorney in the Real Estate, Energy, Land Use & Environmental Practice Group at Sheppard, Mullin, Richter and Hampton LLP in Houston, TX. The author regularly represents financial institutions, commodity trading companies, energy marketers, project developers, and other energy companies and investors in complex commodity and financing transactions that primarily cover the power and alternative energy sectors. A special thanks to the *Houston Business and Tax Law Journal* and its editorial team for their diligence in helping to prepare this article for publication.

generation.[1] The shift toward renewable energy stems from a combination of factors including: (1) robust state and federal tax credits incentivizing the development of renewable energy projects,[2] (2) deteriorating domestic demand for coal,[3] (3) aggressive state-mandated renewable energy standards,[4] and (4) dramatically more affordable lithium-ion battery storage systems.[5]

California's current aggressive renewable energy mandates have also caused system-wide electricity intermittency issues.[6] Unlike fossil fuel sources, wind and solar power generation is not dispatchable at all times.[7] Because the amount of electricity produced from wind and solar assets is dependent on the intensity of wind speeds and sunlight, California's utilities are beginning to struggle to meet peak demand on hot summer days.[8] In August 2020, California instituted rolling blackouts to stabilize its electricity grid when demand far exceeded supply.[9]

While California's grid currently remains susceptible to similar instability, several battery storage developers are working to install utility-scale battery storage in the state.[10] Utility-scale battery storage is a relatively new concept made possible by dramatically lower battery costs.[11] Battery developers, such as Elon Musk's Tesla, have invented cutting-edge battery storage solutions which allow utilities to store several hours of electricity to dispatch during periods of peak demand.[12]

California's rolling blackouts are a stark warning for policymakers who intend to set lofty renewable energy mandates. In order to maintain grid reliability, it is imperative that all levels of government incentivize lithium-ion battery development. Inadequate battery storage capacity places the renewable grid transformation movement at risk because critics might cite rolling blackouts and unreliable grids as reasons that states should continue to rely on fossil fuel-based generation.

Through a case study of California's August 2020 rolling blackouts, this paper will argue that more investment in utility-scale battery storage and offshore wind assets is required to maintain grid reliability.

---

1. *See generally, Electric Power Monthly: Net Generation by Energy Source*, U.S. ENERGY INFO. ADMIN., tab. 1.1., https://www.eia.gov/electricity/monthly/epm_table_grapher.php (last visited Aug. 30, 2020) (highlighting the increased use of solar and wind power in the United States).
2. *See infra* text accompanying notes 37-52.
3. *See infra* text accompanying notes 17-20, 31-34.
4. *See infra* text accompanying notes 86-106.
5. *See infra* text accompanying notes 130-36.
6. *See infra* text accompanying note 86.
7. *See infra* text accompanying note 55-60.
8. *See infra* text accompanying notes 56-59.
9. *See infra* text accompanying notes 94-105.
10. *See infra* text accompanying notes 134-152.
11. *See infra* text accompanying notes 134-136.
12. *See infra* text accompanying notes 137-157.

First, the paper will briefly explain how fossil fuels came to dominate the American electricity grid.[13] Next, it will analyze the federal tax programs and technology which helped the U.S. wind and solar industries experience tremendous growth.[14] Then, the paper will scrutinize California's rolling blackouts by investigating whether the California legislature's recommendations for more offshore wind and utility-scale battery storage will adequately solve the intermittency issues in California.[15] Lastly, the paper attempts to predict the Biden Administration's impact on the solar, wind, and battery storage industries.[16]

AUTHOR'S NOTE: This paper was submitted for publication just two weeks before Winter Storm Uri caused massive power outages across Texas. Initial indications are that several planning failures combined with historically cold weather led to the crisis. The power was still out when Governor Abbott sat for an interview in which he falsely attempted to attribute most of the blame to wind turbines and the Green New Deal.[17] *This attempt to label renewable energy sources as dangerously unreliable underscores the vital importance of quickly developing more battery storage.*

II. BACKGROUND

A. The Evolution of Fossil Fuels in the United States

The energy industry in the U.S. has evolved considerably since its founding in 1776. In its infancy, the U.S. relied on wood for nearly all its heating, cooking, and lighting needs.[18] However, since the early 1800s, fossil fuels such as coal, petroleum, and natural gas have played a dominant role in the U.S. economy.[19]

While the U.S. has enough coal reserves to last 250 years, it is a non-renewable energy source that takes millions of years to form.[20] In the early 1800s, James Watt's coal-powered steam engine enabled the first

13. *Infra* Part A.
14. *Infra* Part B–E.
15. *Infra* Part F.
16. *Infra* Part F.
17. Bryan Mena, *Gov. Greg Abbott and Other Republicans Blamed Green Energy for Texas' Power Woes. But the State Runs on Fossil Fuels*, TEX. TRIBUNE (Feb. 17, 2021, 7:00 PM), https://www.texastribune.org/2021/02/17/abbott-republicans-green-energy/.
18. *See generally Renewable Energy Explained*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/energyexplained/renewable-sources (last updated May 20, 2021)(discussing the evolution of the renewable energy industry in the United States from 1800 through 2020).
19. *Id.*
20. *Id.* at 1–2.

Industrial Revolution.[21] In 1961, coal became "the major fuel used to generate electricity" for residential, commercial, and industrial end-users.[22] By 2019, coal accounted for just 23.5% of utility-scale[23] electricity generation in the U.S.[24]

In the 1890s, the mass production of automobiles created a growing demand for gasoline, a product refined from crude oil.[25] Automobiles were initially an expensive luxury good available only to the wealthiest U.S. families.[26] Henry Ford's assembly line production technique helped Ford create the Model T, an affordable automobile for a much broader swath of the American populace.[27] The popularity of the Model T led to the presence of more than 9 million automobiles on the road by 1920,[28] and by 2016, only 8.6% of U.S. households lacked access to an automobile.[29] Nearly all of the 20.46 million barrels of petroleum consumed per day in the U.S. is in the form of refined products such as gasoline, diesel fuel, heating oil, and jet fuel.[30]

The first U.S. natural gas well was drilled in 1821 in New York by William Hart.[31] This led to the formation of the Fredonia Gas Light Company, which distributed natural gas via pipeline for use as a light source.[32] By the early 1900s, a sophisticated network of pipelines enabled distribution companies to provide natural gas for heating, cooking, ovens, manufacturing, and electricity.[33] By 2020, natural gas generated 36% of electric power in the U.S.[34]

---

21. *See Fossil Energy Study Guide: Coal*, U.S. DEPT. OF ENERGY 3, http://www.energy.gov/sites/prod/files/Elem_Coal_Studyguide.pdf (last visited Aug. 30, 2020).

22. *Id*.

23. *Renewable Energy: Utility-Scale Policies and Programs*, OFF. OF ENERGY EFFICIENCY & RENEWABLE ENERGY, http://www.energy.gov/eere/slsc/ renewable-energy-utility-scale-policies-and-programs (last visited Sept. 2020) ("Utility-scale renewable energy projects are typically defined as those 10 megawatts or larger. Utility-scale renewable energy projects can benefit from state and local policies and programs that help to address and overcome potential barriers to implementation.").

24. *FAQs: What is U.S. Electricity Generation by Energy Source?*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/tools/faqs/faq.php?id=427&t=3 (last visited Aug. 30, 2020).

25. *Fossil Energy Study Guide: Oil*, U.S. DEP'T OF ENERGY 1, 5, https://www.energy.gov/sites/prod/files/2013/04/f0/HS_Oil_Studyguide_draft2.pdf.

26. *Ford Motor Company Unveils the Model T*, HISTORY (last updated July 28, 2019), http://www.history.com/this-day-in-history/ford-motor-company-unveils-the-model-t.

27. *See id.*

28. *Id.*

29. Mike Maciag, *Vehicle Ownership in U.S. Cities Data and Map*, GOVERNING (Dec. 9, 2014), http://www.governing.com/gov-data/car-ownership-numbers-of-vehicles-by-city-map.html.

30. *FAQs: How much Oil is Consumed in the United States?*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/tools/ faqs/faq.php?id=33&t=6 (last updated Mar. 9, 2021).

31. *A Brief History of Natural Gas,* AM. PUB. GAS ASS'N, https://www.apga.org/apgamainsite/aboutus/facts/history-of-natural-gas/data-and-statistics.php (last visited Aug. 8, 2021).

32. *Id.*

33. *Id.*

34. *Natural Gas Explained: Data & Statistics*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/energyexplained/natural-gas/data-and-statistics.php (last visited Aug. 8, 2021).

While fossil fuels still account for 60.3% of the electricity generation in the U.S., the dominance of fossil fuels has come under pressure from a variety of renewable energy sources.[35] Since 2010, the following market share trends have emerged: coal generation has decreased by 48%, natural gas generation has increased by 60%, solar generation has increased by 5,800%, and other renewables generation has increased by 125%.[36] Renewables now account for 17.5% of electricity generation: hydropower (6.6%), wind (7.3%), biomass (1.4%), solar (1.8%), and geothermal (0.4%).[37] The dramatic growth of renewables can be attributed to a combination of factors, including energy price volatility, lower installation costs, government tax policies, and an increased focus on curbing climate change.[38]

B. The History of U.S. Wind Power Generation

The use of wind turbines in the U.S. significantly increased in the decades following the 1970s energy crisis.[39] In 1973, the Organization of Petroleum Exporting Countries ("OPEC") instituted production cuts and an embargo on oil exports to the United States.[40] In response, the U.S. created a series of state and federal incentives for wind turbine development in an attempt to reduce reliance on imported energy and reduce greenhouse gas emissions.[41]

One of the most influential of these programs is the Production Tax Credit ("PTC") for renewable energy generation. Enacted in 1992 (and extended and amended on twelve separate occasions), the PTC is a "per-kilowatt-hour (kWh) tax credit for electricity generated using qualified energy resources."[42] Some specialists credit the PTC with driving the recent "growth and development of renewable electricity resources" by incentivizing tax-equity investors to provide project financing to wind project developers.[43]

Under Internal Revenue Code ("I.R.C.") § 45, a qualifying wind facility that meets the requirements of the section will receive $0.025

35. U.S. ENERGY INFO. ADMIN., *supra* note 24.

36. U.S. ENERGY INFO. ADMIN., Elec. Power Monthly, *Net Generation by Energy Source* (July 28, 2021, 12:47 PM), https://www.eia.gov/electricity/monthly/epm_table_grapher .php?t=epmt_1_01.

37. *Id.*

38. CTR. FOR CLIMATE & ENERGY SOLS., *Renewable Energy*, https://www.c2es.org/content /renewable-energy/(last visited Aug. 8, 2021).

39. *U.S. ENERGY INFO. ADMIN., Wind explained, History of wind power, https:// www.eia.gov/energyexplained/wind/history-of-wind-power.php(last visited Mar. 17, 2021).*

40. DEPARTMENT OF STATE: OFF. OF THE HISTORIAN, *Oil Embargo, 1973-1974*, https:// history.state.gov/milestones/1969-1976/oil-embargo (last visited Aug. 13, 2021).

41. WIND EXPLAINED., *supra* note 39.

42. MOLLY F. SHERLOCK, CONG. RSCH. SERV., R43453 THE RENEWABLE ELECTRICITY PRODUCTION TAX CREDIT: IN BRIEF, (Apr. 29, 2020).

43. *Id.*

per kWh (a "Full PTC"), $0.01 per kWh (a "40% PTC"), or $0.015 per kWh (a "60% PTC").[44] The PTCs in all situations apply to the first ten years of wind energy production; however, the year construction began determines the PTC percentage allowed. If wind project construction began before 2017, the project is eligible for a Full PTC.[45] If wind project construction began after 2017, but before 2020, the project is eligible for a 40% PTC. And if construction began in 2020, the project may qualify for a 60% PTC.[46]

A quick analysis of average retail electricity costs in the U.S. demonstrates how influential a seemingly tiny PTC can be. The average retail electricity rate in Texas is $0.0848 per kWh.[47] It follows then that the value of a Full PTC for a wind turbine project in Texas would represent nearly 30% of the price of retail power. In California, where the average retail price of power is $0.1658 per kWh, a Full PTC represents 15% of the retail power price.[48] As the data suggests, the PTC program drives meaningful power price reductions. The Joint Committee on Taxation estimates that the Internal Revenue Service ("IRS ") is forgoing around $4.5 billion in annual tax revenue by allowing PTCs for wind project developers.[49]

Another of the most influential incentive programs is the Investment Tax Credit ("ITC") which is governed by I.R.C. § 48.[50] The ITC was first enacted in 1978 and, like the PTC, has been amended and extended for decades. The ITC provides a tax credit "determined as a percentage of the taxpayer's basis in the eligible property (generally the cost of acquiring or constructing eligible property)."[51] While the ITC primarily assists the solar industry, it is also available for wind projects.[52] The current ITC provision provides a 30% ITC for projects "that commenced construction in 2019 and are placed in service by 2023."[53] The ITC is reduced to "26% for projects commencing construction in 2020 that are placed in service by 2024," and is reduced further to 22% for projects that commence construction in 2021.[54] Any

44. I.R.C. § 45(b)–(c) (West 2021); I.R.S. Notice 2021-32, 2021-21 I.R.B. 1159, 1161.

45. *See* SHERLOCK, *supra* note 42, at 1.

46. *Id.*

47. *State Electricity Profiles for 2018*, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/electricity/state/archive/2018/ (last updated Mar. 23, 2020).

48. *Id.*

49. SHERLOCK, s*upra* note 42, at 7 tbl.3.

50. MOLLY SHERLOCK, CONG. RSCH. SERV., IF10479 THE ENERGY CREDIT: AN INVESTMENT TAX CREDIT FOR RENEWABLE ENERGY 1 (Nov. 02, 2018).

51. *Id.*

52. Bidisha Bhattacharyya, *Renewable Energy Tax Credits: The Case for Refundability*, CTR. AM. PROGRESS 2(May 28, 2020), https://cdn.americanprogress.org/content/uploads/2020/05/27054658/Refundable-Energy-Tax-Credits.pdf.

53. *Id.*

54. *Id.*

projects that commence construction after 2021 may claim an ITC of 10% for commercial projects and 0% for residential projects.[55]

C. The Advantages and Challenges of U.S. Wind Generation

There are numerous advantages to sourcing electricity from wind turbines instead of fossil fuels. The Wind Energy Technologies Office ("WETO") mentions the following wind-power benefits on their website:

(1) Wind power is cost-effective.
(2) Wind creates jobs.
(3) Wind enables US industry growth.
(4) Wind is a domestic source of energy.
(5) Wind is sustainable.
(6) Wind can be built on existing farms or ranches.[56]

However, the challenges presented by wind power are far more interesting. WETO lists the following challenges associated with wind power:

(1) Wind power must still compete with conventional generation sources on a cost basis.
(2) Good land-based wind sites are often located in remote locations, far from cities where the electricity is needed.
(3) Wind resource development might not be the most profitable use of the land.
(4) Turbines might cause noise and aesthetic pollution.
(5) Wind plants can impact local wildlife.[57]

While all these challenges are important considerations, the problem of wind generation intermittency is most relevant in the context of battery storage. When electricity production relies on natural gas as input fuel, the electricity is dispatchable, meaning it is possible to "adjust [the] power output supplied to the electrical grid on demand."[58] Wind power is not dispatchable because it is an intermittent fuel

55. *Id.*
56. *Advantages and Challenges of Wind Energy*, OFF. OF ENERGY EFFICIENCY & RENEWABLE ENERGY, https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy (last visited Sept. 2020).
57. *Id.*
58. Jordan Hanania, Kailyn Stenhouse & Jason Donev, *Dispatchable Source of Electricity*, ENERGY EDUC. https://energyeducation.ca/encyclopedia/Dispatchable_source_of_electricity (last visited Sept. 25, 2020).

source.[59] Intermittent fuel sources often give rise to the intermittency problem when fluctuations in supply and demand create a disconnect between electricity usage patterns and power generation capacity at any given time.[60] Electricity demand varies significantly based on the time of day and time of year,[61] yet, unfortunately for wind operators, wind patterns operate independently of American electricity demand patterns. This disconnect in supply and demand means that wind turbines might produce tremendous amounts of electricity during the night when electricity demand is low. More problematically, the wind might not be strong enough to satisfy peak electricity demand on a hot summer day.[62] These issues are traditionally solved by supplementing renewable energy generation with a backup, dispatchable fossil fuel source like natural gas.[63] More recently, utility-scale battery storage solutions are under development to address these concerns.[64]

D. The History of U.S. Solar Power Generation

The first known use of solar power for energy generation began in the 7th century B.C. when primitive magnifying glasses were used to start fires.[65] Centuries later, commercial solar-power development in the United States began with the invention of the silicon photovoltaic (PV) cell in 1954.[66] By 1982, utilities in California started to explore utility-scale PV cell electricity generation when Arco Solar built the first large power station powered exclusively by solar power in Hesperia, California.[67] One year later, in 1983, Arco Solar generated enough solar power to supply Pacific Gas & Electric Company ("PG&E") with enough energy to power 2,500 homes in central California.[68]

Since the early 1980s, utility-scale solar generation has continued to gain adoption in areas where sunlight intensity is strong, and fossil fuel-based generation is expensive. However, this success in the solar industry was not without significant impediments along the way. These challenges include the impact of the 2009 financial crisis on fossil fuel

---

59. Bethel Afework et al., *Non-dispatchable Source of Electricity*, ENERGY EDUC., https://energyeducation.ca/encyclopedia/Non-dispatchable_source_of_electricity (last updated June 25, 2018, 2:30 PM).

60. Andrew Farris, *The Intermittency Problem*, ENERGYBC, http://www.energybc.ca/intermittency.html (last updated April 2016).

61. *Id.*

62. *See generally* Robert Rapier, *When the Wind Doesn't Blow*, R-SQUARED ENERGY (June 9, 2014) https://www.rrapier.com/2014/06/wind-doesnt-blow/.

63. *Id.*

64. *Id.*

65. *The History of Solar*, U.S. DEP'T ENERGY 1, https://www1.eere.energy.gov/solar/pdfs/solar_timeline.pdf (last visited Aug. 11, 2021).

66. *Id.* at 3.

67. *Id.* at 6.

68. *Id.*

energy prices, financing availability, and a "flood of imports from Chinese solar-panel manufacturers."[69]

The 2009 financial crisis led to widespread declines in the cost of natural gas, a fuel that competes with solar energy. Between 2008 and 2009, natural gas prices declined from $13 per million British Thermal Units ("MMBtu") to just $3 per MMBtu.[70] This price decline made solar power significantly less competitive because "[h]ouseholds with the highest electricity rates from their local utilities [which offer fossil fuel-based electricity] are the ones who stand to save the most when they convert to power from the sun."[71] The energy demand destruction caused by the financial crisis was particularly harmful to the solar industry because it coincided with increased hydrocarbon production due to the Shale Revolution.[72]

The financial crisis also led to financing challenges that threatened to derail the progress of solar development. Before the 2009 financial crisis, solar projects enjoyed a combination of generous tax incentives (ITC and PTC) and the availability of debt financing from institutional lenders. Because the 2009 crisis was a banking crisis, lenders were "conserving capital and limiting their lending activities."[73] The lack of debt financing in the capital markets led to "increase[d] borrowing costs for project developers" thereby reducing the potential profitability of a proposed solar project.[74]

The US solar industry also faced challenges from foreign solar developers. US solar companies accused foreign developers, especially Chinese solar developers, of selling "solar panels in the United States at unfair discounts" while collecting "illegal government subsidies."[75] The United States Commerce Department conducted an investigation in

69. David Frankel et al., *The Disruptive Potential of Solar Power,* MCKINSEY & CO., https://www.mckinsey.com/business-functions/sustainability/our-insights/the-disruptive-potential-of-solar-power (last updated April 1, 2014).

70. *See* Clifford Krauss, *Natural Gas Prices Plummet to a Seven-Year Low*, NEW YORK TIMES, https://www.nytimes.com/2009/08/21/ business/energy-environment/21gas.html (last updated Aug. 20, 2009) (discussing the sharp decline of natural gas prices caused by increasing shale gas production and plummeting demand from residential and commercial customers related to the financial crisis).

71. *Top 10 Economic Benefits of Converting to Solar Energy*, GPSINC, https://www.gpsinc.solar/top-10-economic-benefits-of-convert (last visited Sept. 25, 2020).

72. Trey Strobel, *The Shale Gas Revolution,* STANFORD UNIV. http://large.stanford .edu/courses/2015/ph240/strobel1/ (last updated Nov. 14, 2015) (explaining that the "Shale Gas Revolution" was characterized by the emergence of unconventional drilling techniques like hydraulic fracturing and horizontal drilling technologies which led to greater production of hydrocarbons compared to previous conventional drilling techniques).

73. PAUL SCHWABE ET AL., NAT'L RENEWABLE ENERGY LAB'Y, NREL/TP-6A2-44930 RENEWABLE ENERGY PROJECT FINANCING: IMPACTS OF THE FINANCIAL CRISIS AND FEDERAL LEGISLATION V (July 2009).

74. *Id.*

75. Roberta Rampton, *U.S. Launches Dumping Probe into China Solar Panels,* REUTERS (NOV. 9, 2011, 2:17 PM), https://www.reuters.com/article/us-usa-solar-trade/u-s-launches-dumping-probe-into-china-solar-panels-idUSTRE7A870M20111109.

2011[76] that found that Chinese solar manufacturers were indeed engaging in "dumping" and other anticompetitive, unfair trade practices.[77] The imposed remedy consisted of 31% anti-dumping duties and 4.73% countervailing duties.[78] In sum, Chinese solar panel imports are now subject to nearly 35% import duties which provide much-needed relief for the U.S. solar manufacturing industry.[79]

E. The Advantages and Challenges of U.S. Solar Generation

Sourcing electricity from solar PV cells instead of fossil fuels is advantageous in numerous ways. Energy Sage, an online marketplace for clean energy solutions, lists the following benefits of PV sourced solar electricity on their website:

(1) Solar lowers your electric bill.
(2) Solar improves the value of your home.
(3) Solar reduces your carbon footprint.
(4) Solar combats rising electricity costs.
(5) Solar allows you to earn back on your investment.[80]

However, much like wind power, the challenges presented by energy produced via solar PV cells are far more interesting. Energy Sage mentions the following challenges with a solar power supply:

(1) Solar doesn't work for every roof type.
(2) Solar is not ideal for property owners who do not intend to retain ownership for a long period of time.
(3) Solar panels can be expensive.
(4) Lower wholesale electricity costs from traditional fossil fuel sources translate into lower savings provided by solar.
(5) Finding local solar installers can be difficult.[81]

While the solar industry in the United States has faced many challenges, it has shown remarkable resilience in overcoming them. The U.S. financial system eventually recovered from the 2009 financial crisis,

---

76. *Id.*

77. Eric Wesoff, *Breaking News: Commerce Dept. Chinese Solar Panel Dumping Verdict Is Now In*, GREENTECH MEDIA (May 17, 2012), https://www.greentechmedia.com/articles/read/Breaking-News-Commerce-Dept-Chinese-Solar-Panel-Dumping-Verdict-Is-Now-In.

78. *Id.*

79. *Id.*

80. *See The Pros and Cons of Solar Power: What Are the Advantages and Disadvantages of Going Solar?*, ENERGY SAGE, https://news.energysage.com/advantages-and-disadvantages-of-solar-energy/ (last updated Oct. 9, 2019).

81. *Id.*

thanks in part to controversial bank bailouts of institutions deemed "too big to fail."[82] These measures helped stabilize the banking system, allowing solar developers to tap a more robust debt market. Additionally, The Commerce Department delivered an effective blow to Chinese solar manufacturing competitors, effectively shoring up U.S. investments.[83] The Obama administration also extended federal tax incentives such as the PTC and ITC in 2016 via the Consolidated Appropriations Act.[84] Finally, and arguably most importantly, the dramatic cost decline for solar PV systems made solar energy more economical.

Relatively high costs associated with manufacturing solar panels muted solar power expansion from 2000 to 2010. From 2010 to 2020, those costs dramatically declined. By 2020 the International Renewable Energy Agency reported that "the cost of energy has dropped by 82% for photovoltaic solar, [and] by 47% for . . . concentrated solar energy," and the cost of energy generated by large scale solar plants dropped from $0.378 in 2010 to roughly $0.068/kWh in 2020.[85] These dramatic cost reductions were reportedly due to "improved technology, economies of scale, supply chain competitiveness and the growing experience of developers"[86] The solar industry now enjoys the cost benefits of a developed industry while maintaining its tax-advantaged status under the ITC and PTC.

F. State-Mandated Renewable Energy Standards

While the United States has made significant progress in the renewables area, the renewables industry faces perhaps its largest challenge yet – aggressive state energy mandates, combined with unsolved intermittency issues. In recent years, state legislatures have begun passing laws requiring utility companies to use more renewable energy sources to generate power. For example, in California, the "state legislature passed Senate Bill 350 in fall 2015, which require[ed] all utilities in the state to source half of their electricity sales from clean, renewable sources such as wind, solar, geothermal, and biopower, by

82. *See FACTBOX: Keys to House Panel's "Too Big to Fail" Bill,* REUTERS (Nov. 19, 2009, 8:07 PM), https://www.reuters.com/article/us-financial-regulation-house-factbox/factbox-keys-to-house-panels-too-big-to-fail-bill-idUSTRE5AJ0CB20091120.

83. Wesoff, *supra* note 77.

84. *President Signs Extender Package for PTC and ITC - Renewable Energy Tax Credits,* MCGUIREWOODS (Dec. 28, 2015), https://www.mcguirewoods.com/ client-resources/Alerts/2015/12/President-Signs-Extender-Package-for-PTC-and-ITC-Renewable-Energy-Tax-Credits.

85. Catherine Rollet, *Solar costs have fallen 82% since 2010,* PV MAGAZINE (June 3, 2020), https://www.pv-magazine.com/2020/06/03/solar-costs-have-fallen-82-since-2010/.

86. *Id.*

2030."[87] This mandate applied to both investor-owned utilities and municipal utilities.[88] California was undeniably a "natural gas state" before adopting Bill 350 in 2015.[89] That year, California received 59.9% of its electricity from natural gas-fired turbines and 24.5% from renewables.[90] The problem was that California produced very little natural gas within the state. 95% of its natural gas was supplied "via interstate pipelines from the Southwest, Rocky Mountains, and Canada,"[91] giving California the unenviable designation as the United States largest electricity importer.[92] This reliance on imported natural gas increased gas prices until "Californians [paid] 60 percent more, on average, than the rest of the nation, for residential, commercial and industrial electricity."[93]

By 2019, California had progressed in its endeavor to shift utility power generation away from fossil fuels and towards more renewable energy sources. By the end of 2019, natural gas sourced energy comprised 42.97% of California's electricity generation.[94] At the same time, renewable energy increased its market share, accounting for 32% of the state's electricity generation.[95] Ultimately, it appears that California is making progress on its 50% renewable energy by 2030 goal, but at what cost? Are there unintended consequences of aggressive state renewable energy mandates with intermittent renewable energy sources?

Unintended consequences arose on August 14, 2020, when peak electricity demand exceeded the available electricity supply, and The California Independent System Operator ("CAISO") initiated rolling

---

87. *California's Renewables Portfolio Standard (RPS) Program,* UNION OF CONCERNED SCIENTISTS (Mar. 6, 2016), https://www.ucsusa.org/resources/californias-renewables-portfolio-standard-program.

88. *State Renewable Portfolio Standards and Goals,* NAT'L CONF. STATE LEGISLATURES (April 17, 2020), https://www.ncsl.org/research/ energy/renewable-portfolio-standards.aspx.

89. Jude Clemente, *Why California Is A Natural Gas State*, FORBES (JULY 12, 2015, 06:49 PM), https://www.forbes.com/sites/judeclemente/2015/07/12/why-california-is-a-natural-gas-state/#70ad4cc15250.

90. *2015 Total System Electric Generation*, CAL. ENERGY COMM'N, https:// www.energy.ca.gov/(choose "DATA AND REPORTS" from top selections; then choose "Energy Almanac"; select "California Electricity Data"; then select "2020 Total System Electric Generation"; scroll down and click "2019 Total System Electric Generation and previous years"; and select "2015 Total System Electric Generation") (last updated July 11, 2016).

91. *Id.*

92. Clemente, *supra* note 89.

93. Mark Nelson & Michael Shellenberger, *Electricity Prices in California Rose Three Times More in 2017 than they did in the Rest of the United States*, ENV'T PROGRESS (Feb. 12, 2018), https://environmentalprogress.org/big-news/2018/2/12/electricity-prices-rose-three-times-more-in-california-than-in-rest-of-us-in-2017.

94. Michael Nyberg, *2019 Total System Electric Generation*, CAL. ENERGY COMM'N, https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2020-total-system-electric-generation/2019(last visited Jan. 8, 2020).

95. *Id.*

blackouts:[96] "systematic, temporary power outages, that help bring balance to the supply and demand of electricity in the market."[97] Due to rolling blackouts, "491,600 electricity customers statewide lost power between 6:30 p.m. and 7 p.m." while temperatures exceeded 100 degrees.[98] Demand for power was so high that electricity prices near Lake Tahoe "spiked into the thousands of dollars per megawatt-hour, far above the typical costs of under $100."[99] Yet, the most baffling aspect of this power shortage was that "the peak electricity use over the [August 14, 2020] weekend fell below peaks in other years, when [California] utilities were able to [successfully] handle the demand" without having to resort to rolling blackouts.[100]

As soon as the power went down in California, politicians and industry experts began blaming the lack of electricity supply on various culprits. Some media outlets (likely inspired by Enron's 2000 manipulation scheme) wondered whether energy traders caused an artificial electricity shortage in the state.[101] Others blamed a "1-in-35 year [heat wave] event" caused by ineffective climate change policies.[102] Still others pointed fingers at an "increasingly expensive, unreliable" grid featuring more intermittent generation that is "unavailable when the people of California need it the most."[103] In October 2020, CAISO's preliminary root-cause analysis report left the industry with more questions than answers. CAISO, the same agency that had previously promised they "absolutely [had] a plan" to *reliably* adopt renewable energy alternatives across California, reported that "no one single thing led to the outages" and blamed the failure on "a combination of factors [that] were exacerbated by the extreme heat."[104] It is nearly impossible to analyze this issue without encountering political spin on either side of the debate.

While assigning blame for the blackouts may make for entertaining media coverage, determining the primary cause of the electricity shortage is of relatively minimal importance. The more relevant inquiry

---

96. Ivan Penn, *Rolling Blackouts in California Have Power Experts Stumped*, NEW YORK TIMES, https://www.nytimes.com/2020/08/16/business/california-blackouts.html (last updated June 23, 2021).

97. *Rolling Blackouts,* DIRECT ENERGY,https://www.directenergy.com/learning-center/rolling-blackouts (last visited Oct. 17, 2020).

98. Tribune News Serv., *Lawmakers Question Batjer on PG&E's Rolling Blackouts,* TECHWIRE (Oct. 14, 2020), https://www.techwire.net/news/ lawmakers-grill-batjer-on-pges-rolling-blackouts.html.

99. Penn, *supra* note 96.

100. *Id.*

101. *See* Naureen S Malik, *Conoco, Mercuria Cashed In on Power Trades During Heat Wave*, BLOOMBERG NEWS, https://www.bloomberg.com/news/ articles/2020-10-08/conoco-mercuria-cashed-in-on-power-trades-during-west-heatwave (last updated Oct. 8, 2020, 7:37 AM).

102. Tribune News Serv., *supra* note 98.

103. *Id.*

104. *Id.*

is what California should do to prevent future blackouts during peak demand days. Representative Jordan Cunningham argued for less intermittent wind generation by accelerating "development of offshore wind farms along the coast of Central and Northern California."[105] Representative Bill Quirk claimed that "state organizations are moving too slowly on long-term storage projects."[106] Many other officials point to increased battery storage as "key to preventing future power shortfalls."[107] Each of these proposals are examined below.

1. Accelerating Development of Offshore Wind Farms

Offshore wind farms "have the potential to generate more electricity at a steadier rate than their onshore counterparts" as they take advantage of naturally stronger, more consistent, oceanic wind speeds.[108] According to studies conducted by the National Renewable Energy Laboratory (NREL), "areas off the West Coast and Hawaii have the potential of generating more than 1.5 trillion watts of energy."[109] This untapped potential begs the question: if so much potential energy is available just off the coast of California, why has it remained largely untapped?

The first issue inhibiting offshore wind development in California is cost. The cost of offshore wind farms "can be 20% higher than onshore" due to transmission issues and technical challenges associated with complex construction in the Pacific Ocean.[110] In an ironic twist, California may be uniquely situated to absorb these higher costs. From 2011 to 2017, retail electricity prices in California rose five times more than in the rest of the United States.[111] Because California's generation costs are so high, the state is well positioned to see meaningful economic benefits from adopting offshore wind farms – despite the high installation costs.

The second issue inhibiting offshore wind development is the challenge of identifying sovereignty of submerged land in the Pacific Ocean. In 1953, the Submerged Lands Act ("SLA") granted states the

---

105. *Id.*

106. *Id.*

107. Will Wade & Brian Eckhouse, *California Doomed to Frequent Blackout Risk by Battery Shortage*, BLOOMBERG NEWS, https://www.bloomberg.com/news/articles/2020-08-19/california-doomed-to-frequent-blackout-risk-by-battery-shortage (last updated Aug. 19, 2020, 10:06 AM).

108. Joel Jacob Colby, *Wind Power: Onshore vs Offshore Wind Farms*, ARCGIS (Nov. 29, 2019) https://storymaps.arcgis.com/stories/b96f4db23c4449849deb60c0953b2509/print.

109. *Offshore Renewable Energy*, CAL. ENERGY COMM'N, https://www.energy.ca.gov/programs-and-topics/topics/renewable-energy/offshore-renewable-energy (last visited Oct. 17, 2020).

110. *Onshore vs Offshore Wind Power: Need to Know for 2021*, THE ENERGY FIX, https://www.theenergyfix.com/onshore-vs-offshore-wind-power (last visited Aug. 20, 2021).

111. *See generally* Nelson & Shellenberger, *supra* note 93 (discussing how retail electricity prices in California rose 10% between 2011 and 2017 while retail electricity prices in the rest of the United States remained largely unchanged).

rights to "the natural resources of submerged lands from the coastline to no more than 3 [sic] nautical miles (5.6 km) into the Atlantic, Pacific, the Arctic Oceans, and the Gulf of Mexico."[112] The SLA "[r]eaffirmed the Federal claim to the lands of the Outer Continental Shelf (OCS), which consists of those submerged lands seaward of State jurisdiction."[113] While the SLA established a clear, three-mile standard, offshore wind farms will almost always need to be built more than 5.6 km off the shoreline for wind efficiency purposes. This 6 km optimal distance means that California must obtain approval from the federal government for any proposed offshore wind farm.

In 2005, Congress passed the Energy Policy Act which authorized the Bureau of Ocean Energy Management ("BORM") to "issue leases, easements, and rights of way to allow for renewable energy development on the Outer Continental Shelf (OCS)."[114] The OCS includes the submerged land in waters greater than 5.6 km off the shoreline of a U.S. state, meaning that any proposed offshore wind farms will be subject to the BOWM five-year-long approval process.[115]

The requirement to obtain federal approval from BOEM is a significant hurdle to overcome in developing offshore wind farms, but not only due to the delayed approval process. BOEM is the same agency that oversees the approval process for offshore oil and gas development,[116] and BOEM receives its general funding from the federal budget.[117] Depending on which political party possesses a congressional majority, BOEM funding may be cut or expanded to fit the political goals of the time. Once appropriated, BOEM must allocate this finite resource amongst offshore oil and gas drilling permits and offshore wind farm permits.

The federal government has a strong tradition of subsidizing domestic oil and gas drilling. For example, I.R.C. § 613 allows for

---

112. *Federal Offshore Lands*, BUREAU OF OCEAN ENERGY MGMT., https://www.boem.gov/oil-gas-energy/leasing/federal-offshore-lands (last visited Oct. 17, 2020).

113. *Id. See, e.g. See Our Offshore Wind Projects in the U.S.*, ORSTED, https://us.orsted.com/wind-projects (last visited Aug. 30, 2021)(discussing the company's portfolio of offshore wind projects located in excess of 5.6 km from the shoreline). These projects include (1) Coastal Virginia Offshore Wind (27 miles), (2) Revolution Wind (15 miles), (3) South Fork Wind (35 miles), (4) Sunrise Wind (30 miles), (5) Ocean Wind 1 (15 miles), (6) Ocean Wind 2 (15 miles), (7) Skipjack Wind 1 (19 miles), and (8) Bay State Wind (25 miles).

114. *Regulatory Framework and Guidelines*, BOEM, https://www.boem.gov/renewable-energy/regulatory-framework-and-guidelines(last visited Oct. 17, 2020).

115. *Id*. *(*outlining the Planning, Leasing, Site Assessment, and Construction phases of the approval process which can each independently take more than two years depending on BOEM resources).

116. Iulia Gheorghiu, *BOEM Needs Staffing Help With Offshore Wind Permitting Regardless of Election Results, Experts Say,* UTILITY DIVE (Oct. 15, 2020), https://www.utilitydive.com/news/boem-interior-staffing-help-with-offshore-wind-permitting-election/587092/.

117. *Id.*

percentage depletion deductions for domestic oil and gas drilling projects.[118] Some experts and developers worry that these oil and gas tax subsidies reflect lopsided resource allocation at BOEM, especially as the well-established U.S. oil and gas industry has "already been appropriated funding, and it's unlikely that money can be re-allocated toward permitting for the more nascent offshore wind industry."[119]

In July 2020, Offshore Wind California announced that it was seeing progress in the BOEM federal approval process.[120] For example, three proposed offshore sites at Morro Bay, Diablo Canyon, and Humboldt Bay received BOEM approval to begin the auction process in 2021 after the 2020 administration change.[121] These efforts had previously been delayed due to objections from Trump-appointed Department of Defense officials who complained that the offshore wind farms "could interfere with radar and low-altitude flights and conflict with live-fire drills and rapid-deployment missions in Southern and Central California."[122] California's continued success on offshore wind development is likely contingent on adequate BOEM funding and maintaining renewable energy sympathetic agency leadership.

2. Accelerating Development of Battery Storage

Some officials are also calling for more energy storage projects in addition to accelerating offshore wind development off the coast of California. These energy storage projects are a necessity for states with aggressive renewable energy goals, like California, especially because intermittent renewable energy sources frequently replace non-intermittent fossil-fuel-based power generation. Energy storage can "provide flexibility and balancing services, frequency control, voltage control in addition to acting as a backup for variable renewables generation."[123] Luckily for California, the costs of "lithium-ion batteries, are declining."[124] In 2019, the CAISO published a working paper

---

118. I.R.C. § 613 (2020). Under § 613, qualifying producers may deduct depletion expenses from taxable income to reflect declining reserves over time. *Percentage Depletion*, ENERGY TAX FACTS,(last visited Aug. 20, 2021, 12:41 PM), https://energytaxfacts.com/issues/percentage-depletion/.

119. Gheorghiu, *supra* note 116.

120. Stas Margaronis, *California Offshore Wind Farm Auction Could Begin in 2021 Creating Economic Development for Ports,* AM. J. TRANSP. (July 23, 2020), https://ajot.com /insights/full/ai-california-offshore-wind-farm-auction-could-begin-in-2021-creating-economic-development-for-ports.

121. *Id.*

122. *Id.*

123. ENERGY STORAGE: PERSPECTIVES FROM CALIFORNIA AND EUROPE, CAL. INDEP. SYS. OPERATOR CORP. 6 (Oct. 2019) https://www.caiso.com/Documents/EnergyStorage-PerspectivesFrom California-Europe.pdf.

124. *Id.* at 6.

describing some of the benefits associated with energy storage projects. Listed benefits include:

(1) Storing and smoothing renewables generation – enabling the integration of variable renewables.
(2) Reduce greenhouse gas emissions.
(3) Improve the reliable operation of transmission and distribution grids.
(4) Balancing grid supply and demand.
(5) Defer costly investments in transmission, and distribution or generation infrastructure.
(6) Reduce demand for peak electricity generation.
(7) Lower wholesale electricity prices – peek shaving and price arbitrage opportunities.
(8) Reduce end-use consumer demand charges.
(9) Provide backup power.[125]

There are many different kinds of energy storage. Mechanical energy storage systems "use kinetic energy technologies to store energy when the demand for electricity is low and transform that kinetic energy back to electricity when demand is high."[126] Mechanical storage systems have existed since the early 1900s.[127] Thermal storage systems "store energy in water, rock, concrete, phase change materials, molten salts or other fluids, which can be later used to generate heat or electricity."[128] Chemical energy storage systems "store energy in chemical fuels (such as hydrogen) that can be used for power generation."[129] Finally, electrochemical energy storage systems—battery storage systems—are the most commonly referenced form of energy storage. Before delving into the latest energy storage technology, it is necessary to understand the evolution of energy storage.

Electrochemical energy storage technologies have advanced tremendously in the past few decades. Most consumers are very familiar with alkaline batteries, as they are commonly used to power household devices like television remote controls. In contrast, electrochemical energy storage batteries are far more complex. Utility-scale energy storage systems typically use lithium-ion batteries, which are "lighter and significantly more energy-dense than their alkaline

125. *Id.* at 7–8.
126. *Id.*
127. M. Stanley Whittingham, *History, Evolution, and Future Status of Energy Storage*, 100 PROCEEDINGS OF THE INST. OF ELEC. & ELEC. ENG'RS ASS'N 1518–19, (2012).
128. ENERGY STORAGE, supra note 123, at 10.
129. *Id.* at 9.

counterparts."[130] Lithium-ion batteries are a type of flow battery which are "well-suited to grid-scale storage due to their relatively low energy density and power output."[131] Consumers may be familiar with rechargeable lithium-ion batteries, as they have been widely used in laptops and cellular phones for decades.

In the 1970s, Exxon Mobil chemist Stanley Whittingham started exploring the concept of a new battery that "could recharge on its own in a short amount of time and perhaps lead to fossil-free energy one day."[132] Wittington's work led to the development of the lithium-ion battery, which granted him and his partners—John Goodenough and Akira Yoshino—the 2019 Nobel Prize in Chemistry. The Nobel Committee highlighted the lithium-ion battery as a step towards "a fossil fuel-free society."[133] Whittingham's prototype 1970s battery technology is now fully capable of delivering on his fossil-fuel-free energy ambitions.

While lithium-ion batteries have existed for decades, the technology has only recently been economically viable for utility-scale storage projects. This, in large part, is due to tremendous manufacturing efficiencies developed by companies such as Elon Musk's Tesla Motors. According to Bloomberg New Energy Finance, lithium-ion battery pack prices were $1,100 per kWh in 2010.[134] By 2020, the cost of these battery packs had fallen to just $137 per kWh.[135] Bloomberg expects these cost reductions to continue, and projects a $100 per kWh price by 2023.[136]

In order to meet its goal of using renewable energy sources to provide 60% of electricity demand, California has recently embraced several large utility-scale battery storage projects, which should help reduce intermittency issues.[137] Many of these battery projects were spurred by the 2013 passage of Energy Storage Decision (AB 2514); California's legislative directive that "requires investor-owned utilities to provide a total of at least 1,325 MW of operational energy storage

---

130. ENERGY STORAGE, supra note 123, at 9.

131. *Id.*

132. Zhao Liu, *The History of the Lithium-Ion Battery*, THERMO-FISHER SCIENTIFIC (Oct. 11, 2019), https://www.thermofisher.com/blog/microscopy/the-history-of-the-lithium-ion-battery/.

133. Liu, *supra* note 132.

134. *Battery Pack Prices Cited Below $100/KWh for the First Time in 2020, While Market Average Sits at $137/KWh*, BLOOMBERG NEW ENERGY FIN. (Dec. 16, 2020), https://about.bnef.com/blog/battery-pack-prices-cited-below-100-KWh-for-the-first-time-in-2020-while-market-average-sits-at-137-KWh/.

135. *Id.*

136. *Id.*

137. ENERGY STORAGE, *supra* note 123, at 12.

capacity by 2024."[138] These projects are expected to alleviate some of the issues that led to the rolling blackout conditions that occurred in August 2020. The fact that the state legislature felt compelled to pass such a bill indicates that California was aware that grid reliability needed to be addressed as the state aggressively mandated more renewable energy generation. S&P Global Market Intelligence "forecasts 24.3 GW of solar, 8.3 GW of wind and 4.2 GW of battery storage will be constructed by 2025 and 31.2 GW of solar, 13.8 GW of wind, and 6.1 GW of battery storage by 2030 in the California ISO."[139]

The Gateway Energy Storage Project in San Diego County is one of the recent battery storage projects expected to alleviate some of the grid reliability issues facing California[140] LS Power, a New York-based private equity developer focusing on generation assets, brought the Gateway Energy Storage Project online in September 2020.[141] The 250-megawatt (MW) project is considered the largest battery storage project in the world[142] and is expected to increase grid reliability and reduce energy costs for customers.[143] Currently, the Gateway Energy Storage Project can offer one hour of energy storage, but LS Power projects that the project will be capable of delivering three hours of energy storage by 2021, with the possibility of four-hour energy storage later on.[144] Southern California Edison (SoCal Edison) and PG&E—the two largest investor-owned utilities in California—have also signed 15-year power offtake agreements and plan to use these agreements to offer more reliable electricity service to residential, commercial, and industrial customers.[145]

The Moss Landing energy storage system in Monterey, California is another battery storage project that creators Tesla and PG&E expect to see online in 2021.[146] This project is "expected to be one of the world's largest utility-owned, lithium-ion storage systems."[147] While the 182.5

---

138. Darrell Proctor, *PG&E, Tesla Team on Milestone Battery Storage System,* POWER MAG. (July 29, 2020), https://www.powermag.com/pge-tesla-team-on-milestone-battery-storage-system/.

139. Katherine McCaffrey, *CAISO Electric Forecast Brightens for Wind & Storage*, S&P GLOB. MKT. INTEL., (Oct. 30, 2020), https://www.spglobal.com/marketintelligence/en/news-insights/blog/caiso-electricity-forecast-brightens-for-wind-and-storage.

140. *See* Darrell Proctor, *World's Largest—For Now—Battery Storage Project Online in California*, POWER MAG., (Sept. 1, 2020), https://www.powermag.com/worlds-largest-for-now-battery-storage-project-online-in-california/.

141. *See LS Power Energizes Largest Battery Storage Project in the World, The 250 MW Gateway Project in California*, LS POWER, (Aug. 19, 2020), https://www.lspower.com/ls-power-energizes-largest-battery-storage-project-in-the-world-the-250-mw-gateway-project-in-california-2/.

142. *Id.*

143. *Id.*

144. POWER MAG., *supra* note 140.

145. Proctor, *supra* note 138.

146. *Id.*

147. *Id.*

MW capacity is already impressive, the project's future potential is even more exciting. At project completion in 2021, the project is projected to have the capacity to store four hours worth of energy.[148] The project utilizes Tesla's Megapack lithium-ion battery technology, described as a "sustainable alternative to natural gas 'peaker' power plants."[149]

The Tesla Megapack lithium-ion battery storage product is an exciting development in the evolution of utility-scale battery storage. Tesla Megapacks require "40% less space and 10x fewer parts than current systems on the market."[150] This is particularly important in California, where the average value per acre of land is $39,092—the 8th highest average land cost in the United States.[151] By reducing space requirements, Tesla's Megapack allows storage developers in California to shave 40% off of land acquisition costs alone. Furthermore, by using 10x fewer parts than other battery storage systems, the Megapack can also be constructed "10x faster than current systems."[152]

In addition to manufacturing, land, and installation savings, Tesla's Megapack lithium-ion technology offers its proprietary Powerhub operating system software. The Powerhub operating system is Tesla's in-house software which monitors, controls, and monetizes the Megapack battery installations. The Powerhub operating system presents an innovative opportunity to continuously enhance and upgrade the system over time, ensuring that these large battery storage projects do not become obsolete as technology improves. The Powerhub system also allows Tesla to develop an ecosystem that should lead to economies of scale as Tesla expands its Megapack battery installation capacity.

Additionally, the Powerhub software seamlessly integrates with Tesla's Autobidder software: a "machine learning platform for automated energy trading."[153] Autobidder optimizes battery storage capacities by buying and selling power in the wholesale electricity market and allows investor-owned utility companies to do so without keeping human energy trader employees on the payroll. Autobidder eliminates the need to hire costly human energy traders, and potentially delivers better trading decisions free of human emotion and error.

---

148. *Id.*

149. *Id.*

150. *Massive Energy Storage Megapack*, TESLA, https://www.tesla.com/megapack (last visited Aug. 15, 2021).

151. *Id.* Thomas C. Frohlich & Michael B. Sauter, *Here's How Much an Acre of Land is Worth in Each of Contiguous 48 States in the US*, USA TODAY, https://www.usatoday.com/story/money/2019/05/08/the-most-and-least-valuable-states/39442329/ (last updated June 28, 2019, 12:55 PM). The cheapest cost of land is found in Wyoming which has an average value per acre of just $1,558.

152. TESLA, *supra* note 150.

153. *Id.*

Autobidder integration is a key aspect of PG&E's projected $100 million in cost savings over the twenty year life of the project.[154]

The electricity trading opportunity in California's unreliable grid should not be understated. For example, during the August 2020 rolling blackouts, power prices hit nearly $1,000 per MW. Storage operators capitalized on the spike by "aggressively dispatching [power] during the two-hour price run, and then re-charging when prices dropped."[155] Meanwhile, CAISO's off-peak power prices can drop as low as $20 per MW or even *negative* $6.00 per MW in some oversupplied locations.[156] A well-positioned energy storage operator could have captured a wide price spread by optimizing its storage capacity during the blackouts.

Autobidder's artificial intelligence software is expected to enable PG&E to capture these large pricing spreads between off-peak and on-peak electricity prices. Autobidder will buy cheap, off-peak wholesale electricity in the overnight electricity market, store the electricity in Moss Landing Megapack batteries, and then use the stored supply to offset higher demand during on-peak hours when businesses begin using more electricity, and wholesale electricity prices tend to rise. Autobidder would be able to sell electricity from the Moss Landing Megapack batteries, and PG&E would be able to capture the pricing spread between off-peak and on-peak electricity prices in the wholesale electricity market. These trading profits derived from optimizing Moss Landing will allow PG&E to ultimately provide lower electricity costs to customers.[157]

In addition to cutting-edge software developed by Tesla, the Moss Landing project also has an exciting scaling capability. Upon initial completion in the second quarter of 2021, there will be 256 Tesla Megapack battery units.[158] These Megapacks will deliver 182.5 MW of capacity. However, PG&E's offtake contract with Tesla includes an option to "upsize" the project. If PG&E exercises the upsize option, Tesla "can increase the capacity of the system up to six hours, or 1.1 gWh in total."[159] This upsize option would enable PG&E to grow its battery storage capacity as its renewables portfolio develops over time. It also nicely complements PG&E's residential battery storage program, which

154. *Id.*

155. POWER MAG., *supra* note 140.

156. *Market price maps*, CAL. ISO,Illus. (updates in real-time, last visited Jan. 6, 2021), http://www.caiso.com/PriceMap/Pages/default.aspx.

157. *Id.*

158. *Id.*

159. PG&E*, Tesla Break Ground on Landmark Battery Energy Storage System, PG&E* (*July 29, 2020), https://www.pge.com/en/about/newsroom/newsdetails/index.page ?title=20200729_pge_tesla_break_ground_on_landmark_battery_energy_storage_system.*

touts over 10,000 behind-the-meter residential battery storage installations in residential California homes.[160]

As the transition to renewable energy and the development of battery storage systems continue to progress in California, Congress continues to pass legislation favorable to the effort to develop sustainable renewable energy generation. For example, in late 2020, Congress passed a "massive spending bill that include[ed] $35 billion in energy research and development programs, a two-year extension of the Investment Tax Credit for solar power, a one-year extension of the Production Tax Credit for wind power projects, and an extension through 2025 for offshore wind tax credits."[161] These billions of dollars designated for green energy research should further additional technological developments that make wind, solar, and battery investment even more financially attractive to tax equity project finance investors. It is worth mentioning that Congress, at the time, was a nearly hopelessly divided government yet was still able to pass this green energy bill, despite the Trump administration's largely anti-climate change agenda.

A casual analysis of the Trump administration's rhetoric (circa 2016-2020) could lead an observer to conclude that the administration was against green energy initiatives. For example, in April 2019 President Trump claimed that the noise from wind turbines "causes cancer" in those who live near wind farms.[162] The American Cancer Society quickly dismissed these false claims by saying that it "is unaware of any credible evidence linking the noise from windmills to cancer."[163] In October 2020, President Trump reiterated his strong support for turning around the failing U.S. coal industry.[164] Despite his efforts to assist the coal industry, the nation's electricity derived from coal has fallen from 38.6% in 2014 to just 19% in 2020.[165] Contrarily, the nation's electricity derived from renewable energy sources surpassed coal in 2020.[166] Industry observers cite this trend as incredibly positive for the development of green energy because the renewable energy industry

---

160. *Id.*

161. Jeff St. John, *Congress Passes Spending Bill With Solar, Wind Tax Credit Extensions and Energy R&D Package*, GREEN TECH. MEDIA (Dec. 22, 2020), https://www.greentechmedia.com/articles/read/solar-and-wind-tax-credit-extensions-energy-rd-package-in-spending-bill-before-congress.

162. Brad Plumer, *We Fact-Checked President Trump's Dubious Claims on the Perils of Wind Power*, N.Y. TIMES (Apr. 3, 2019), https://www.nytimes.com/2019/04/03/climate/fact-check-trump-windmills.html.

163. *Id.*

164. James Murray, *Has Trump Lived Up to His Promise to Revive the US Coal Industry?*, NS ENERGY (Oct. 5, 2020), https://www.nsenergybusiness.com/features/trump-us-coal-industry.

165. *Id.*

166. *Id.*

was able to take a large market share even with an unfriendly administration at the helm.

The results of the November 2020 presidential election and January 2021 Georgia Senate run-off elections are expected to have far-reaching implications for the development of wind, solar, and battery storage projects. In fact, on the first day of President Biden's presidency, Biden signed an executive order to "ensure the US achieves a 100% clean energy economy and reaches net-zero emissions no later than 2050."[167] If this executive order is any indication of Congress' near-term legislative ambitions, then the Biden administration's climate-friendly initiatives should be a tremendous boon to the renewable energy industry's efforts to systematically transform the country's electricity grid through solar, wind, and lithium-ion battery storage development.

167. *The Biden Plan for a Clean Energy Revolution and Environmental Justice*, BIDEN HARRIS, https://joebiden.com/climate-plan/ (last visited Feb. 2, 2021).