Transitioning Montana to a Renewable Energy Future: The Social and Economic Impacts

Table of Contents

Transitioning Montana to a Renewable Energy Future: The Social and Economic Impacts

Abstract

Montana is home to the second-largest coal-fired power plant in the West, the Colstrip Generating Station. The value and demand for coal both domestically and globally is quickly diminishing, while the renewable energy industries of wind and solar are booming. As utilities in the Northwest transition their investments from coal to renewable energy, Montana faces a critical decision on the future of its energy system that will impact the lives of generations of Montanans to come.

This five-part report aims to aid in the discussion and decision-making process by reviewing the most up-to-date economic data on renewable energy; discussing the social and economic impacts of the Colstrip community's transition out of the coal industry; and highlighting the perspectives of some of the most directly-impacted stakeholders in Montana's energy industry.

Part 1 is a summary of Montana's vast renewable energy potential and the urgent need to invest in these technologies for its long-term social and economic wellbeing. Part 2 is an analysis of the economic benefits of investing in a renewable energy economy, particularly the technologies of wind and solar energy. Part 3 is a discussion of the current trajectory of the Colstrip Generating Station in Colstrip, MT, and the social, environmental and economic impacts of plant closure on the local community. Part 4 is a literature review of recent academic literature (2010-present) on the economics of solar and wind energy. This section is separated from the data presented in Part 2 to maintain a distinction from industry-based information. Finally, Part 5 of the report respectfully provides suggestions for its target organization, 350 Montana, for moving forward in the push for the statewide energy transition.

Part 1: Montana's Great Renewable Energy Potential

With over 90 million acres of land that boasts dramatic mountain peaks, sweeping plains and dense diverse forests, Montana's expansive natural beauty is surely its greatest treasure. Yet as the summers become hotter and devastating wildfires rip throughout the state, glacial melt escalates and fisheries suffer depletion, climate change is already impacting the livelihoods of thousands of Montanans. Montana is predicted to experience an average statewide temperature rise of 4-5 degrees (F) by 2055,[1] with northeastern Montana facing an increase of up to 6.5 degrees (F) during winter months.[2] Depending on location, areas of Montana will experience 20-40 fewer days where the winter temperature drops below 32 degrees (F), increased winter precipitation in the form of rain, and decreased winter precipitation in the form of snow.[3] Montana is predicted to experience 5-15 more days where the temperature exceeds 95 degrees (F) and a decrease in precipitation during summer months.[4] Warmer winters with

1Power and Power, "The Impact of Climate Change on Montana's Outdoor Economy" *Montana Wildlife Federation.* December 2015. Retrieved from: https://montanawildlife.org/wp-content/uploads/2015/12/Impact-of-Climate-Change-on-the-Montana-Outdoor-Economy-Dec-2015-Final-Report.pdf

2 For example, the town of Havre, MT has an average high of 28.8 degrees F in January. By 2055, Havre's average January high temperature could reach above 35 degrees F. Averages provided by U.S. Climate Data. 2017. Retrieved from: http://www.usclimatedata.com/climate/havre/montana/united-states/usmt0159

3 For example, between the years of 1939 to 2013, the town of Whitefish, MT has an average high temperature of 30.4 degrees F, an average low of 15.4 degrees F, and average of 20.2 inches of total snowfall in January. Source: Western Regional Climate Center. 2017. Retrieved from: https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?mt8902.

4 For example, the town of Missoula, MT has an average high temperature of 86 degrees F and 0.98 inches of total precipitation in July. Source: US Climate Data. 2017. Retrieved from: http://www.usclimatedata.com/climate/missoula/montana/united-states/usmt0231

increased rain and hotter summers with less rain will cause significant plant stress, alter wildlife migration patterns, increase the frequency, size and intensity of wildfires, and change the timing of native fish life cycles.

This is not a distant issue—climate change is currently devastating both public and private land across the state. The largest wildfire of 2017 in the U.S. burned through more than a quarter-million acres of rangeland in eastern Montana.[5] The 2017 summer months were the hottest and driest on record in the state, and wildfires have consumed over 1 million acres.[6] Native bull trout in the Bitterroot River are abandoning low-elevation habitats with warmer temperatures, and up to 92 percent of natal bull trout habitat are imperiled by climate change.[7] Montana's most cherished and economically important industries, including agriculture, fisheries, wildlife tourism, and winter recreation are under enormous threat if these climate trends continue.[8] With disastrous effects of climate change already under way, Montana cannot afford to continue down its current energy path. While climate change mitigation requires the unified actions of the world's biggest GHG emitters, policy changes at the state level are imperative in cases of federal ineptitude. The time has come for Montana to make a full transition away from carbon-emitting coal production and towards a renewable energy-powered future.

The town of Colstrip, Montana is home to the second-largest coal-fired power plant in the West, the Colstrip Generating Station. Emitting between 17 and 20 million metric tons of greenhouse gases per year, the Colstrip plant has been listed as the 8th largest producer of greenhouse gas emissions in the U.S.[9] Renewable energy legislation signed

---

5 Four fires—Bridge Coulee, Barker, South Breaks, and Square Butte—comprised the Lodgepole Complex fire, which scorched over 270,000 acres in 2017.

6 Rogge, Dana. "A Million Acres Scorched by Montana Wildfires," *U.S. Department of Agriculture.* October 3, 2017. Retrieved from: https://www.usda.gov/media/blog/2017/10/03/million-acres-scorched-montana-wildfires

7 Eby, Lisa A. et al. "Evidence of Climate-Induced Range Contractions in Bull Trout *Salvelinus confluentus* in a Rocky Mountain Watershed, U.S.A," *PLOS ONE*, 9 (6). June 2014. Retrieved from: http://www.tu.org/sites/default/files/offline/climate/eby_et_al_2014_climate_reduces_bull_trout.pdf

8 A report prepared for the Montana Wildlife Federation by Power Consulting estimates that climate change threatens the loss of 11,000 jobs and $281 million in income in Montana's outdoor industry by 2050. Source: Power and Power, "The Impact of Climate Change on Montana's Outdoor Economy," *Montana Wildlife Federation.* December 2015. Retrieved from: https://montanawildlife.org/wp-content/uploads/2015/12/Impact-of-Climate-Change-on-the-Montana-Outdoor-Economy-Dec-2015-Final-Report.pdf

9 In 2010, the EPA ranked Colstrip as the 8th largest GHG emitter in the U.S. In addition, the plant is ranked among the top 15 coal-fired polluters of mercury in the nation, with 1,590 pounds of mercury released in 2009.

in 2016 by both Washington state Governor Jay Inslee[10] and Oregon Governor Kate Brown[11] signify the rapid phase-out of coal from two of Colstrip's largest consumers. In 2017, mayors of 14 cities in King County, Washington signed a "strategic climate action plan" to completely phase out coal-fired electricity by 2025.[12] Pressure from environmental activist groups is building the movement to end societal dependence on fossil fuels. Since 2010, Sierra Club's Beyond Coal campaign has advanced the retirement of 256 coal-burning power plants, shutting down a total of 724 coal units.[13] Montana's Northwest neighbors are retiring their dependence on fossil fuels as well, transitioning to a future powered by renewable energy. The value and demand for coal both domestically and globally is quickly diminishing.[14] Coal has a long history in Montana, but as utilities in the Northwest transition their investments from coal to renewables, Montana risks being left behind.

The Colstrip plant employs about 360 workers—a significant portion of Colstrip's population of approximately 2,300 people. Of the six companies that own Colstrip's Generating Station, only one—Northwestern Energy—has an office in Montana.[15] A coal town with families of multi-generational industry workers, the hard working and devoted community of Colstrip deserves to work for sustainable, Montana-owned industries. The livelihoods of Colstrip's industry workers are at stake. Units 1 and 2 are scheduled for closure by 2022, and Units 3 and 4 could close by 2027, if not sooner.[16] Policymakers have yet to provide a comprehensive plan for how to ensure an

10 Governor Jay Inslee signed Senate Bill 6248, which authorized Puget Sound Energy to file a plan to decommission Colstrip Units 1 and 2. Read more here: http://www.seattletimes.com/seattle-news/environment/state-senate-passes-bill-involving-colstrip-plants/

11 The Clean Electricity and Coal Transition Bill (SB1547) eliminates the use of coal power in Oregon by 2035 and requires 50 percent of electricity to come from renewable sources by 2040. The law requires PacifiCorp to end coal-supplied power to the state by 2030 and Portland General Electric by 2035. Read the details of the plan here: http://oeconline.org/wp-content/uploads/2016/01/Oregon-Clean-Electricity-Coal-Transition-Plan-Summary_Final.pdf

12 King County Executive Office. "Strategic Climate Action Plan: 2015 Annual Report" June 2016. Retrieved from: http://your.kingcounty.gov/dnrp/climate/documents/2015-annual-report-scap-06-2016.pdf

13 Sierra Club. "Beyond Coal Victories." Retrieved from: http://content.sierraclub.org/coal/victories

14 International Energy Agency. "Coal 2017." December 18, 2017. Retrieved from: https://www.iea.org/coal2017/

15 The co-owners of Colstrip include Washington state utilities Puget Sound Energy and Avista Corp.; Oregon utilities Portland General Electric and PacifiCorp; Pennsylvania based Talen Energy; and Montana-based NorthWestern Energy, which serves half of the state's population.

16 In a September 2017 legal settlement, Puget Sound Energy agreed to pay a minimum of $10 million for the economic transition of Colstrip. In addition, PSE will pay down all debts on the plant by 2027—which could help the community transition away from coal over a decade sooner than previously anticipated. Details of the legal settlement found here: https://dojmt.gov/wp-content/uploads/UE-170033-UG-170034-SP-Multiparty-SettAgmt-2017.09.15.pdf

economically and socially-just transition for the Colstrip community.

Fortunately, there are long-term solutions for this problem. The renewable energy industries of wind and solar are booming, both domestically and globally. Globally, 2016 marked a year of record-setting new additions of installed renewable energy capacity, rapidly falling solar PV and wind power costs, and the third consecutive year of the decoupling of economic growth and energy-related carbon dioxide emissions.[17] A new energy system powered by wind, water and solar can help provide a cleaner, safer and economically-sustainable future for Montana.

Not only is the technology for these systems readily available, but jobs in renewable energy industries are soaring. A 2016 U.S. Department of Energy study reported that 373,807[18] Americans now work in the solar industry, while there are 160,119 jobs left in the coal industry.[19] The U.S. wind industry employs more than 100,000 workers[20] and wind turbine technician is among the top two fastest growing occupations in the country—with the other being solar PV installer.[21] America is reducing its reliance on fossil fuels and investing in clean energy sources that benefit both the environment and the economy. Yet Montana is lagging in renewable energy production and falling behind its neighboring states. Despite the immense potential for solar energy in this state, as of 2016, Montana ranks 42nd in the nation for solar installations and 47th for solar jobs per capita.[22] In 2016, Montana had 695 MW of wind capacity installed, with an

---

17 Renewable Energy Policy Network (REN21). "Renewables 2017 Global Status Report" Retrieved from: http://www.ren21.net/wp-content/uploads/2017/06/17-8399_GSR_2017_Full_Report_0621_Opt.pdf

18 There are 373,807 Americans that "spend some portion of their time working to manufacture, install, distribute, or provide professional services to solar technologies across the nation." Of those spending at least half of their work hours in the solar industry, there are 260,077 workers. Source: U.S. Department of Energy. *U.S. Energy and Employment Report.* January 2017. Retrieved from: https://energy.gov/sites/prod/files/2017/01/f34/2017percent20USpercent20Energypercent20andpercent20Jobspercent20Report_0.pdf

19 This includes both coal electric generation and coal fuel support jobs. Of coal mining and support jobs, there are fewer than 54,000 left in the U.S. as of 2017. Source: U.S. DOE. *U.S. Energy and Employment Report.* January 2017.

20 American Wind Energy Association. "Made-in-the USA wind power jobs." 2017. Retrieved from: https://www.awea.org/jobs

21 US Bureau of Labor Statistics. "Thirty fasting growing occupations projected to account for 19 percent of new jobs from 2016 to 2026." US Department of Labor. October 2017. Retrieved from: https://www.bls.gov/opub/ted/2017/thirty-fastest-growing-occupations-projected-to-account-for-19-percent-of-new-jobs-from-2016-to-2026.htm

22 Solar Energy Industries Association 2016 report. Retrieved from: http://www.seia.org/research-resources/solar-market-insight-report-2016-year-review; Solar Jobs Census 2016. Retrieved from: http://www.thesolarfoundation.org/solar-jobs-census/factsheet-2016-mt/

estimated potential capacity of up to 940,000 MW.[23] Though the state lags behind its Northwest neighbors, a 2016 poll indicates that the majority of residents support more renewable energy development.[24] Investing in solar and wind energy has the potential to provide a major boost for Montana's economy and provide thousands of jobs for energy workers, while simultaneously taking direct action against climate change.

Montana is now facing a critical decision on the future of its energy system that will impact the lives of generations to come. With the inevitable and fast-approaching closure of the Colstrip power plant, it's time for Montanans to choose an energy path forward for a long-term, sustainable future. This five-part report aims to aid in the discussion and decision-making process by reviewing the most up-to-date economic data on renewable energy; discussing the social and economic impacts of the Colstrip community's transition out of the coal industry; and highlighting the perspectives of some of the most directly-impacted stakeholders in Montana's energy industry.

Part 2: Economic Benefits of Transitioning Montana to Renewables

The increasingly favorable economics of renewable energy is undeniable. Renewable energy generation is quickly becoming cheaper than the conventional fossil fuel systems of coal, oil and gas-fired power stations.[25] Solar and wind energy systems are more affordable and accessible than ever before. Experts predict that renewable energy costs will continue to decline, as fossil fuel prices are expected to rise.[26] One useful metric for measuring growth over multiple periods of time is the compound annual

---

23 Hurlbut, David, Joyce McLaren, and Rachel Gelman. "Beyond Renewable Portfolio Standards: An Assessment of Regional Supply and Demand Conditions Affecting the Future of Renewable Energy in the West." *National Renewable Energy Laboratory.* August 2013. Retrieved from: https://www.nrel.gov/docs/fy13osti/57830-1.pdf

24 Lundquist, Laura. "Poll finds Montanans shifting to renewable energy, more public access." *Montana on the Ground.* September 22, 2016. Retrieved from: http://www.montanaotg.com/blog-native/2016/9/22/poll-finds-montanans-shifting-to-renewable-energy

25 In a 2018 report, the International Renewable Energy Agency states that renewable energy will fall within the cost range of fossil fuels by 2020. Source: Foehringer Merchant, Emma. "IRENA: Global Renewable Energy Prices Will Be Competitive With Fossil Fuels by 2020." *Green Tech Media.* January 16, 2018. Retrieved from: https://www.greentechmedia.com/articles/read/irena-renewable-energy-competitive-fossil-fuels-2020#gs.DU8UL1s

26 In addition to the increasingly favorable economics of renewable energy over fossil fuels, a 2017 study published by the Universal Ecological Fund found that weather extremes and air pollution from burning fossil fuels cost the U.S. $240 billion per year over the last decade. Fossil fuel-based air pollution has amounted to an average of $188 billion each year in costs to human health. The report: The Universal Ecological Fund."The Economic Case for Climate Action in the United States." September 2017. Retrieved from: https://drive.google.com/file/d/0B9whT-2Ezzu7UUNUS3ZielhROFk/view

growth rate (CAGR). The CAGR compares an end investment to its initial investment, based on a rate that compounds over that time period due to factors such as variable interest rates. Since 2012, renewable energy jobs in the U.S. have grown at a CAGR of 6 percent.[27] In comparison, annual growth rates in oil and gas extraction, coal mining and processing jobs combined have ranged from 9 to -22 percent in the past 5 years, amounting to a CAGR of -4.25 percent.[28] Solar and wind jobs have both increased at a rate of about 20 percent annually in recent years, creating jobs at a rate 12 times faster than the rest of the U.S. economy.[29] As fossil fuel power generation becomes more costly for both the economy and the environment, renewable energy is quickly proving to be the safest, cleanest and most cost competitive energy source in the country.

The month of March 2017 marked a new renewable energy milestone in the U.S. According to a report by the U.S. Energy Information Administration (EIA), for the first time ever, wind and solar energy exceeded 10 percent of the total monthly electricity generation in the nation.[30] Homes, buildings and cities powered solely from renewable resources is not some far-fetched dream; it's a reality. As of June 2017, mayors of 120 cities have signed the Sierra Club's pledge to support a community-wide transition to 100 percent renewable energy.[31] Five U.S. cities—Aspen, CO, Burlington, VT, Greensburg, KS, Kodiak Island, AK, and Rock Port, MO—have already hit their targets, generating 100 percent of community-used energy from non-polluting, renewable sources.[32]

In addition, American jobs in solar and wind energy are booming. According to a 2017 report by the Environmental Defense Fund, "Solar and wind jobs have grown at rates of about 20 percent annually in recent years and are each creating jobs at a rate 12 times faster than that of the rest of the U.S. economy."[33] In the year of 2016 alone, the solar workforce increased by 25 percent, while employment in the wind energy industry increased by 32 percent.[34] The U.S. Bureau of Labor Statistics Employment Projections program expects jobs for wind turbine technicians to increase by 108 percent by 2024.[35]

---

27 Environmental Defense Fund Climate Corps and Meister. "Now Hiring: The Growth of America's Clean Energy & Sustainability Jobs." 2017. Retrieved from: http://edfclimatecorps.org/sites/edfclimatecorps.org/files/the_growth_of_americas_clean_energy_and_sustainability_jobs.pdf
28 *Ibid*.
29 *Ibid.*
30 U.S. DOE. "Today in Energy" June 14, 2017. Retrieved from: https://www.eia.gov/todayinenergy/detail.php?id=31632
31 Sierra Club. "Mayors for 100percent Clean Energy." 2017. Retrieved from: http://www.sierraclub.org/ready-for-100/mayors-for-clean-energy
32 Sierra Club. "Is Your City #ReadyFor100?" 2017. Retrieved from: http://www.sierraclub.org/ready-for-100/cities-ready-for-100
33 EDF Climate Corps and Meister "Now Hiring: The Growth of America's Clean Energy & Sustainability Jobs." 2017.
34 U.S. Department of Energy. "U.S. Energy and Employment Report." January 2017.

While hydropower is another important renewable resource, its expected growth is much more limited than solar and wind energy. Together, solar PV and onshore wind make up 75 percent of global renewable electrical capacity growth.[36] Still, electricity from hydropower comprises a significant portion of the energy generated from renewable sources. In 2016, about 7 percent of electricity generation in the U.S. came from hydropower—about 44 percent of the total electricity generation from renewable energy sources.[37] Although its growth has slowed over time, hydropower production remains an important complement to wind and solar power.

As renewable energy becomes more cost competitive and states set rigorous goals for the phasing out of energy generated by fossil fuels, energy systems are dramatically changing—this is especially true in the Pacific Northwest. Oregon increased its renewable energy portfolio standard targets to 50 percent by 2040[38] and Washington state lawmakers have supported the creation of a fund to cover retirement costs of Colstrip Units 1 and 2.[39] In 2018, Washington Governor Jay Inslee and Democratic lawmakers are supporting a bill that would place a $10 per ton tax on carbon dioxide from sources including power plants fired by coal.[40] If Montana leaders take advantage of the existing infrastructure to set up a more dynamic, renewables-based system of electricity generation, all Montanans can capitalize on the state's abundant renewable resources for long-term economic benefit.

Economics of Solar Energy

The cost of installed solar energy has steadily declined over the past 25 years. Since

---

35 Meisler, Laurie. "Biggest Job Growth Expected in Health Care & Renewable Energy." *Bloomberg News*. June 8, 2017. Retrieved from: https://www.bloomberg.com/graphics/2017-job-projections-2024/

36 International Energy Agency, "Renewable Energy Medium-Term Market Report 2016 Executive Summary." 2016. Retrieved from: http://www.iea.org/Textbase/npsum/MTrenew2016sum.pdf

37 U.S. Energy Information Administration. "Electricity Explained: Electricity in the United States." 2016. Retrieved from: https://www.eia.gov/energyexplained/index.cfm?page=electricity_in_the_united_states

38 U.S. Energy Information Administration. "Higher Oregon renewable portfolio standard targets likely to boost wind power." April 2016. Retrieved from: https://www.eia.gov/todayinenergy/detail.php?id=25932

39 In 2016, Washington Governor Jay Inslee signed Senate Bill 6248, which allowed Puget Sound Energy to create a fund that covers the decommissioning and cleanup costs of units 1 and 2. Sources: Le, Phuong. "Against Montana governor's wishes, Inslee signs bill to fund coal plant shutdown" *The Seattle Times.* April 1, 2016. Retrieved from: https://www.seattletimes.com/seattle-news/environment/gov-jay-inslee-signs-colstrip-coal-plant-bill-with-partial-veto/ ; Lutey, Tom. "Colstrip edges toward complete closure" *The Billings Gazette.* September 15, 2017. Retrieved from: http://billingsgazette.com/news/government-and-politics/colstrip-edges-toward-complete-closure/article_d4575cbf-70a8-5fab-81c8-0171790b9408.html

40 The carbon tax would affect two of the Colstrip plant's owners, Puget Sound Energy and Avista Corp. Source: Lutey, Tom. "Washington state carbon tax could bring more challenges to Colstrip" *The Billings Gazette.* February 8, 2018. Retrieved from: http://billingsgazette.com/news/government-and-politics/washington-state-carbon-tax-could-bring-more-challenges-to-colstrip/article_2967ae7a-a942-534f-82c4-5c055952ef58.html#tracking-source=home-top-story-1

2010, the cost of a solar electric system has dropped by about 50 percent.[41] Between 2010 and 2015, the average cost of solar PV panels dropped 72 percent, driving a tenfold increase in solar installation in that period.[42] There are two main types of solar energy technology that can be employed to generate solar power electricity: photovoltaic solar power and solar thermal energy. Photovoltaic (PV) technology directly converts sunlight into electricity using panels made of semiconductor cells. Solar thermal technology captures the sun's heat to generate thermal energy, which is then used directly or converted into electricity; this form is often referred to as concentrated solar power, or CSP. Solar PV systems are utilized on small and large scales, while CSP is generally employed on larger, utility scales.

The installed costs of solar power systems generally include the panels, an inverter, mounting hardware, a performance monitoring system and the installation labor. Though not yet prevalent, an increasing number of residential and business solar users are investing in a solar-plus-storage system, which allows them to convert and store energy produced by solar panels for later use.[43] Solar batteries also offer short-term backup power in the case of a power outage.

While the cost of solar panels has remained fairly steady since 2012, the installed costs for distributed solar PV have followed a steep downward trajectory.[44] This trend is largely due to cheaper inverter and racking equipment, and the decline in "soft costs," such as installation labor, maintenance, and regulatory compliance.[45] In addition, all forms of energy require integration costs when introducing them to the power system.[46] Calculating integration costs for wind and solar is complex; there is no universal method for measuring them directly, due to the interactive nature between generation resources that have adjusted outputs to maintain load balance.[47] Total power system costs with and without wind and solar generation is a more useful measure for comparison.[48]

---

41 Barbose, Galen and Naim Darghouth. "Tracking the Sun VII: The Installed Price of Residential and Non-Residential Photovoltaic Systems in the United States." *Lawrence Berkeley National Laboratory.* August 2015. Retrieved from: http://emp.lbl.gov/sites/all/files/lbnl-188238_0.pdf

42 EDF Climate Corps and Meister. 2017. pp.7.

43 EnergySage. "Storing solar energy: how solar batteries work." April 2018. Retrieved from: https://www.energysage.com/solar/solar-energy-storage/how-do-solar-batteries-work/

44 Barbose, Galen and Naim Darghouth. "Tracking the Sun IX: The Installed Price of Residential and Non-Residential Photovoltaic Systems in the United States."

45 *Ibid.*

46 Milligan, Michael; Erik Ela; Bri-Mathias Hodge; Brendan Kirby; Debra Lew. "Cost-Causation and Integration Cost Analysis for Variable Generation." *National Renewable Energy Laboratory.* June 2011. Retrieved from: https://www.nrel.gov/docs/fy11osti/51860.pdf

47 *Ibid*, p.6.

48 *Ibid.*

In 2017, the average size for solar panel installations in the U.S. was a 5kW solar system.[49] Total power system costs differ based on specific system features, including the type of equipment chosen, the state you live in, and the total system size.[50] According to data from the EnergySage Solar Marketplace, as of January 2017, the average cost of a 5kW solar system in the U.S. was $11,410—which includes the 30 percent Federal Investment Tax Credit (ITC) discount but not any additional state rebates or incentives.[51] Some states provide solar incentives and rebates, such as the Residential Solar Energy Credit that Arizona offers homeowners to reduce costs of their solar system.[52] Most American homeowners are paying between $2.87 and $3.85 per watt to install solar in 2017.[53] The amount of electricity generated by a 5kW rooftop solar system is dependent on several factors, ranging from direction and angle of the roof to air temperature.[54] Predictably, the most significant factor is how much sun the system receives, which dramatically varies from state-to-state.

Another cost associated with power system operators are the costs for energy reserves, which are important for ensuring grid reliability. Reserves are necessary for managing the variability and uncertainty of demand, generator outputs, and possible equipment failure.[55] Like fossil fuel plants, which require reserves in case of outages or other factors, variable renewable energy sources like wind and solar also require reserves. These can come from a mix of sources like hydroelectric power that can respond rapidly to demand or output changes. The total costs of operating reserves are a function of the interaction of multiple power plants, and is difficult to quantify due to differing fuel prices, generator mixes, and other power system changes that occur over time.[56] Solar forecasts use weather patterns and solar production estimates to form predictions on how much solar energy will be generated on a given day. Improvements in solar forecasting is a developing research area that will allow utilities to avoid unnecessary reserve operations—saving ratepayers millions of dollars in avoided solar reserve costs.[57]

---

49 EnergySage. "What Does a 5,000 Watt (5kW) Solar System Cost in the U.S. in 2017?" Accessed July 2017. Retrieved from: http://news.energysage.com/5kw-solar-systems-compare-prices-installers/

50 *Ibid.*

51 *Ibid.*

52 Sunrun. "Solar Rebates and Tax Incentives for Arizona." Accessed June 2017. Retrieved from: https://www.sunrun.com/solar-by-state/az/arizona-solar-tax-incentives

53 EnergySage. "How Much Do Solar Panels Cost in the U.S. in 2017?" Accessed July 2017. Retrieved from: http://news.energysage.com/how-much-does-the-average-solar-panel-installation-cost-in-the-u-s/

54 Solar City. "Solar energy production: How is solar energy produced?" Accessed August 2017. Retrieved from: http://www.solarcity.com/residential/solar-energy-faqs/solar-energy-production

55 Milligan, Michael et al. "Operating Reserves and Wind Power Integration: An International Comparison" *National Renewable Energy Laboratory.* October 2010. Retrieved from: https://www.nrel.gov/docs/fy11osti/49019.pdf

56 Hummon et al. "Fundamental Drivers of the Cost and Price of Operating Reserves." *National Renewable Energy Laboratory.* July 2013. Retrieved from: https://www.nrel.gov/docs/fy13osti/58491.pdf

57 U.S. Office of Energy Efficiency & Renewable Energy, "Accurate Solar Energy Forecasting Could Save Ratepayers Millions." December 23, 2016. Retrieved from: https://energy.gov/eere/articles/accurate-

As solar systems become increasingly more affordable, more Americans are investing in this clean source of energy. Since 2008, solar installation in the U.S. has increased seventeen-fold, from 1.2 GW to 30 GW today—enough to power an estimated 5.7 million average American homes.[58] Experts predict that there will be over 100 GW of installed solar in the U.S. by 2021.[59]

As the demand for solar energy technology soars, the solar industry is experiencing massive employment growth. In 2016, the solar industry employed 260,077 workers in the U.S—nearly a 25 percent increase from 2015.[60] According to the U.S. Department of Energy (DOE), the solar industry employed 43 percent of the Electric Power Generation sector workforce in 2016.[61] Jobs in the fossil fuel industry accounted for 22 percent. Unlike many jobs in the fossil fuel sector, solar jobs tend to be local jobs. In the solar industry, 80 percent of jobs are demand-side services, such as installation and sales. Most of these jobs require local residency and cannot be outsourced.[62]

Economics of Wind Energy

The cost competitiveness of wind energy is surging as the economics of wind technology are driving this industry's rapid growth. By the end of 2016, the U.S. had 82,143 MW of installed wind capacity—an amount that could power 25 million average American homes for a year.[63] The 8,208 MW of wind power installed in 2016 alone accounts for $14 billion in new investment.[64] Over the past decade, the wind industry has invested more than $143 billion domestically.[65] The U.S. wind industry invests heavily in rural regions of the country, as the vast majority of landowner lease

---

solar-energy-forecasting-could-save-ratepayers-millions

58 U.S. Office of Energy Efficiency & Renewable Energy. "Solar Energy in the United States." 2017. Retrieved from: https://energy.gov/eere/solarpoweringamerica/solar-energy-united-states

59 Solar Energy Industries Association. "Solar Industry Data: Solar Industry Growing at a Record Pace." Accessed July 2017. Retrieved from: http://www.seia.org/research-resources/solar-industry-data

60 This number accounts for workers who spend at least half of their working time in the solar industry. Of Americans that spend "some portion of their time working to manufacture, install, distribute, or provide professional services to solar technologies across the nation," there are 373,807 workers. Source: The Solar Foundation, "Solar Jobs Census." 2016. Retrieved from: https://solarstates.org/#states/solar-jobs/2016

61 U.S. DOE. "U.S. Energy and Employment Report." January 2017.

62 The Solar Foundation, "National Solar Jobs Census." 2015. Retrieved from: http://www.thesolarfoundation.org/wp-content/uploads/2016/10/2015-Census-Factsheet-FINAL.pdf

63 AWEA. "Wind Energy Facts at a Glance" Accessed July 2017. Retrieved from: http://www.awea.org/wind-energy-facts-at-a-glance

64 AWEA. "Wind Brings Jobs and Economic Development to All 50 States." March 2017. Retrieved from: http://awea.files.cms-plus.com/AWEApercent20Economicpercent20Developmentpercent20Impactspercent20ofpercent20Windpercent20Energypercent20FINAL.pdf

65 *Ibid.*

payments made by wind projects go to rural farmers and ranchers.[66] In 2016, wind project owners paid $245 million in landowner lease payments, and an additional $1.2 billion are expected over the next four years.[67]

Technology advancements have increased overall performance in the wind industry, as structures become taller and more mechanically-efficient. These improvements are pushing down the costs of wind energy development. Since 2008, wind turbine prices have declined by up to 40 percent, significantly dropping project-level costs.[68] In 2016, the average installed cost of wind projects in the U.S. was $1.59/MWh—a substantial drop from the 2009 peak of $2.12/MWh.[69]

Wind energy is a resource that can be quickly deployed; without fuel costs, turbine operators can often dispatch energy faster than they can with coal and gas.[70] In areas with new wind energy integration for conventional power plants, integration costs are paid by the wind farm owners, not by consumers. This differs from conventional power plants, where integration costs are paid by ratepayers across consumer electricity bills.[71] Changes in wind output are gradual and can be predicted, whereas conventional power plants can fail without warning.[72] Expensive reserves must therefore be in place to accommodate for conventional power plant failures.[73] With efficient operating practices in place, wind energy reserve costs barely impact electricity consumers' monthly electricity bill. The total wind reserve cost for the average Texas electricity customer—a state with more than 10,000 MW of wind generation—is calculated at 4.3 cents per month.[74]

The wind industry is adding jobs faster than any other energy industry in the United States. Wind turbine technician is the nation's fastest growing profession.[75] There are

---

66 *Ibid.*
67 Navigant Consulting. "Economic Development Impacts of Wind Projects." March 2017. Retrieved from: http://awea.files.cms-plus.com/Economicpercent20Developmentpercent20Impactspercent20ofpercent20Windpercent20Projectspercent202017percent20FINAL.pdf
68 U.S. DOE. "Wind Technologies Market Report: Report Highlights." 2016. Retrieved from: https://emp.lbl.gov/wind-technologies-market-report/
69 *Ibid.*
70 U.S. DOE. "Wind Vision: A New Era for WInd Power in the United States." April 2015. Retrieved from: https://www.energy.gov/sites/prod/files/wv_chapter2_wind_power_in_the_united_states.pdf
71 AWEA. "Wind Brings Jobs and Economic Development to All 50 States," March 2017.
72 Kumer, N. Besuner, P., Lefton, S., Agan, D., and D. Hilleman. "Power Plant Cycling Costs." *U.S. DOE National Renewable Energy Laboratory.* April 2012. Retrieved from: https://www.nrel.gov/docs/fy12osti/55433.pdf
73 Goggin, Michael. "Fact Check: Wind's integration costs are lower than those for other energy sources." *AWEA*. July 25, 2014. Retrieved from: http://www.aweablog.org/fact-check-winds-integration-costs-are-lower-than-those-for-other-energy-sources/
74 *Ibid.*
75 U.S. Bureau of Labor Statistics. "Employment Projections." Accessed July 2017. Retrieved from: https://www.bls.gov/emp/ep_table_103.htm

approximately 102,500 full-time wind energy workers in the U.S. today.[76] An American consulting firm, Navigant Consulting, predicts domestic employment in the wind industry to reach 248,000 jobs by 2020.[77] The intricate nature of modern wind turbine technology requires manufacturing of roughly 8,000 components; high manufacturing demands resulted in more than 25,000 American manufacturing jobs in 2016.[78] Though not currently an area of high wind project development, the Southeast is a manufacturing hub for the wind industry, with more than 100 wind industry-supplying facilities in the region.[79] There are over 500 wind industry manufacturing facilities across 43 states, producing equipment from wind turbine blades to power converters.[80]

By the end of 2016, wind generating capacity surpassed hydropower generating capacity, which had long held the title of the nation's largest renewable electricity source.[81] Wind energy contracts signed in 2016 are expected to be more cost competitive than the estimated fuel costs of gas-fired generation extending through 2040.[82] Current projections for the domestic market show wind power capacity additions averaging more than 9,000 MW/year from 2017 to 2020.[83] And the U.S. Department of Energy estimates that wind energy can supply 10 percent of U.S. electricity by 2020, 20 percent by 2030, and 35 percent by 2050.[84] As economic incentives for wind energy improve, this clean and abundant resource will comprise an increasingly larger portion of the nation's electricity production.

Economics of Hydropower

Hydropower is the largest renewable energy source utilized both in the U.S. and worldwide, producing over 15 percent of the world's total electricity.[85] It is considered one of the most reliable and flexible forms of renewable power generation, as hydropower systems can respond to demand fluctuations within minutes and be designed to meet large shares of peak electricity demand.[86] Hydropower can be

---

76 AWEA. "Wind Brings Jobs and Economic Development To All 50 States." March 2017.
77 Navigant Consulting. "Economic Development Impacts of Wind Projects." March 2017.
78 U.S. DOE. "U.S. Energy and Employment Report." January 2017.
79 AWEA. "Wind Brings Jobs and Economic Development to All 50 States." March 2017.
80 *Ibid.*
81 U.S. Energy Information Administration. "U.S. wind generating capacity surpasses hydro capacity at the end of 2016." *Today in Energy.* March 6, 2017. Retrieved from: https://www.eia.gov/todayinenergy/detail.php?id=30212
82 U.S. DOE. "Wind Technologies Market Report: Report Highlights." 2016. Retrieved from: https://emp.lbl.gov/wind-technologies-market-report/
83 *Ibid.*
84 U.S. DOE. "Wind Vision: A New Era for WInd Power in the United States." April 2015.
85 International Renewable Energy Agency. "Renewable Energy Technologies: Cost Analysis Series: Hydropower" June 2012. Retrieved from: https://www.irena.org/documentdownloads/publications/re_technologies_cost_analysis-hydropower.pdf
86 U.S. Bureau of Reclamation. "Managing Water in the West: Hydroelectric Power." *U.S. Department of the Interior.* July 2005. Retrieved from: https://www.usbr.gov/power/edu/pamphlet.pdf

implemented on both large, centralized and small, isolated grid systems. Its cost efficiency and reliability makes hydropower an important complementary renewable resource to wind and solar energy.

There are two major cost components for creating hydropower systems: the civil costs of plant construction, including infrastructure required to access the site and project development costs; and the cost of electro-mechanical equipment to operate the system. Total costs for hydropower projects are site-specific and depend on project scale.[87] Yet total installed costs for large-scale hydropower projects generally range between $1,000/kW to $3,500/kW. A cost analysis study of over 2,155 potential hydropower projects in the U.S. determined an average capital cost of $1,650/kW.[88] Compared with other energy sources, the maintenance and operation of hydropower is relatively low-cost throughout its lifetime.[89]

The greatest economic benefit of hydropower systems are the relatively low electricity costs that they provide for consumers. Additionally, most of the country's hydropower projects were built through the mid-20th century, when construction costs were much lower. Powered by the renewable resource of moving water, hydropower electricity prices are not dependent on the fluctuating market prices of fuel.[90]

One particular social issue of concern surrounding the construction of new hydropower projects around the world is the involuntary displacement and relocation of indigenous peoples and local populations. Dam construction results in the flooding and dramatic alteration of the land—disrupting the social networks, people-place connections, and livelihoods of adjacent communities.[91] Millions of peoples in indigenous, tribal, and peasant communities have lost their land and homes for the sake of reservoir, canal, irrigation schemes, roads, power lines and other industrial development related to dam construction.[92] By 2000, an estimated 40-80 million people were displaced by dam construction—a figure that is likely a significant underestimate, as it only accounts for

---

87 IRENA 2012; IPCC. "Renewable Energy Sources and Climate Change Mitigation: Summary for Policymakers and Technical Summary." *Potsdam Institute for Climate Impact Research.* 2011. Retrieved from: https://www.ipcc.ch/pdf/special-reports/srren/SRREN_FD_SPM_final.pdf

88 Hall, Douglas, Richard Hunt, Kelly Reeves, and Greg Carroll. "Estimation of Economic Parameters of U.S. Hydropower Resources." *Idaho National Engineering and Environmental Laboratory.* June 2003. Retrieved from: https://www1.eere.energy.gov/water/pdfs/doewater-00662.pdf

89 A 2009 Navigant Consulting study estimated the average lifespan of hydro projects at 50 years. Source: Navigant Consulting. "Job Creation Opportunities in Hydropower" September 2009. Retrieved from: http://www.hydro.org/wp-content/uploads/2010/12/NHA_JobsStudy_FinalReport.pdf

90 U.S. Bureau of Reclamation. "Managing Water in the West: Hydroelectric Power." July 2005.

91 Roquetti, D.R., Moretto, E.M., and S.M.P. Pulice. 2017. "Dam-forced Displacement and Social-Ecological Resilience: The Barra Grande Hydropower Plant in Southern Brazil." *Ambiente & Sociedade*, 20(3). Retrieved from: http://www.scielo.br/scielo.php?pid=S1414-753X2017000300115&script=sci_arttext

92 Internal Displacement Monitoring Centre. "Case Study Series: Dams and Internal Displacement."April 2017. Retrieved from: http://www.internal-displacement.org/assets/publications/2017/20170411-idmc-intro-dam-case-study.pdf

large dam development projects.[93]

While hydropower projects provide a cleaner source of electricity in comparison to fossil fuels, they are not ecologically benign—many critics point to dams' impacts on biodiversity, habitat loss, and aquatic migration patterns as a case for dam removal. Growing concern over the negative ecological impacts of dams have contributed to the removal of over 1,300 dams in the U.S. from 1912 through 2016.[94] However, in terms of total GHG emissions, hydropower is still considered a cleaner option to conventional energy sources.[95] In comparison to electricity generated by the fossil fuel sources of coal and oil, hydropower is a relatively low-carbon, reliable and cost competitive source of energy.

Renewable Energy Storage Options

One of the most promising advances in renewable energy is the technological development of long-term storage for these forms of energy. As wind and solar are both renewable energy technologies with variable outputs, storage from these sources is an important factor in creating a more flexible and reliable grid system. Storing reserves of renewable energy is also valuable for rapid discharge to the grid when unexpected demand surges occur. Renewable energy storage is particularly important for energy customers that are farther from the transmission grid, as these homes are more vulnerable to electricity disruption than homes in higher density areas.[96]

Battery electricity storage is an important technology for transitioning to sustainable energy systems. Batteries convert electricity from renewable sources into chemical potential energy, then store that converted energy and transform it back into electrical energy when needed for use. Batteries are becoming increasingly cost-effective, as battery lifetimes and performance continue to improve.[97] The price of batteries for energy storage has dropped considerably over the last decade—by 2030, total installed costs for battery electricity storage could fall to 50-60 percent their current cost.[98]

---

93 An estimate by the independent organization, World Commission on Dams. Source: Internal Displacement Monitoring Centre. "Case Study Series: Dams and Internal Displacement."April 2017.
94 American Rivers. "72 Dams Removed to Restore Rivers in 2016." 2016. Retrieved from: https://s3.amazonaws.com/american-rivers-website/wp-content/uploads/2017/02/15104536/DamsRemoved_1999-2016.pdf
95 Union of Concerned Scientists. "How Hydroelectric Energy Works." Accessed February 2018. Retrieved from: https://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-hydroelectric-energy.html#.WtzHt9Pwai4
96 Union of Concerned Scientists. "How Energy Storage Works" Accessed August 2017. Retrieved from: http://www.ucsusa.org/clean-energy/how-energy-storage-works#.WaXfoZN969Y
97 IRENA. "Electricity storage and renewables: Costs and markets to 2030." October 2017. Retrieved from: http://www.irena.org/publications/2017/Oct/Electricity-storage-and-renewables-costs-and-markets
98 *Ibid.*

Mike Sudik, president of Big Sky Solar and Wind in Missoula, Montana, views advances in battery technology as a game changer for renewables. "Batteries are the future. Envision where the smokestacks currently are. The grid is already connected there, so that's a great place to put in solar panels and batteries for storage,"[99] he said.

Another exciting development in renewable energy storage is the technology of pumped storage hydro. Pumped storage hydro is a process that involves pumping water from a lower body of water to an upper body of water, thereby creating stored energy that is available for future use.[100] To access that stored energy, the water is released from the upper water body and pumps are reversed to run the water through energy-generating hydroelectric turbines.[101] Pumped storage hydro increases the efficiency of the transmission grid, operating a steady state to allow the utility to generate power when demand is high and store excess energy when demand is low. Inexpensive power generated during low-demand night hours is used to pump water to the upper water body and generate electricity during daytime, when electrical demand is high. Pumped storage hydro is a valuable technology that can ensure a reliable and steady state system with the use of more variable energy generation sources, such as solar and wind power.[102]

The Bozeman, Montana-based energy development company, Absaroka Energy, LLC, is currently developing the Gordon Butte Pumped Storage Hydro Project in Meagher County, Montana. This new closed-loop pumped storage hydro storage facility will "provide ancillary and balancing capabilities to Montana's emerging renewable energy industry, as well as, provide multiple services to facilitate stability, reliability, growth and longevity to existing energy infrastructure and resources in the state and region."[103] The facility will have two reservoirs of water, each approximately 4,000 feet long and 1,000 feet wide, with depths of 50 to 75 feet. Each reservoir will hold more than 1.3 billion gallons of water, with one on top of Gordon Butte sitting 1,000 feet above the other. With three proposed turbine generators, an estimated installed capacity of 400 MW, and an average annual energy generation of 1300 GWh, the system will serve as a giant battery that can both store energy and generate electricity from renewable sources. The Gordon Butte pumped hydro storage facility has great potential to increase the capacity of renewable energy storage in Montana.

Jeff Fox, Montana Policy Manager at Renewable Northwest, is optimistic about the

---

99 Mike Sudik, Personal interview. Missoula, Montana. July 2017.
100 U.S. DOE. "Pumped Storage Hydropower." *Office of Energy Efficiency & Renewable Energy.* Accessed August 2017. Retrieved from: https://energy.gov/eere/water/pumped-storage-hydropower
101 U.S. DOE. "Pumped Storage Projects." *Federal Energy Regulatory Commission.* August 5, 2014. Retrieved from: https://www.ferc.gov/industries/hydropower/gen-info/licensing/pump-storage.asp
102 U.S. DOE. "Pumped Storage Projects." August 5, 2014.
103 "Gordon Butte Pumped Storage Hydro Facility Description, Project Overview." Accessed August 2017. Retrieved at: http://www.gordonbuttepumpedstorage.com/project-overview/

development of renewable energy storage options, particularly the Gordon Butte Pumped Hydro facility. "Were that project to go forward, it would guarantee that Montana is a renewable energy power exporting powerhouse in the new economy," said Fox.

As of February 2018, the company had secured most of the project's engineering, permits, licenses and water rights. They're waiting for the utilities to purchase storage capacity and commit to a lease. Absaraoka's President and CEO, Carl Borgquist, sees pumped storage hydro as a key part of Montana's energy future. "We'll get there. Even oil and gas people love this project. It's so simple and sensible," said Borgquist. "This is the cleanest, most efficient battery you can build—no mining or weird chemicals. You can cycle it for thousands of years."

Energy Efficiency

Another under-implemented tool in energy-related sustainability is the concept of energy efficiency. Increasing the energy efficiency of our public and private institutions offers immense potential for a low-cost energy resource, but certain challenges must be addressed for large-scale implementation. Energy efficiency policies and regulations remain a low priority for state, local and public utility commissions. Without these policies in place, most energy businesses prioritize investments in shorter-term profits, as the amount of energy saving projects is relatively small in comparison to other projects.[104]

Energy efficiency improvements typically require highly technical knowledge and skill, and informational barriers prevent many energy companies from realizing the significant long-term financial benefits that energy efficiency projects can provide. Perhaps the greatest barrier to investing in energy efficiency advancements is access to financial capital. High upfront financial investment of energy efficiency technologies can be difficult for smaller businesses to access. Instituted in 2006, the Residential Energy Efficiency Tax Credit was a federally-issued tax credit for residential energy efficiency improvements of existing homes and the purchase of high-efficiency heating, cooling and water-heating equipment.[105] This federal incentive expired at the end of 2017; energy equipment installed on or after January 1, 2018 is not eligible for the tax credit.[106]

---

104 World Economic Forum. "Why energy efficiency is key to sustainable development." June 2015. Retrieved from: https://www.weforum.org/agenda/2015/06/why-energy-efficiency-is-key-to-sustainable-development/

105 The efficiency improvements had to serve a building in the U.S. that was owned and occupied by the taxpayer as their primary residence. The maximum tax credit for all improvements made between 2011-2016 was $500. Source: U.S. DOE. "Residential Energy Efficiency Tax Credit," Accessed April 2018. Retrieved from: https://www.energy.gov/savings/residential-energy-efficiency-tax-credit

The lack of economic incentives to invest in this long-term resource, as well as the uncertainty surrounding future policies in federal tax and environmental policy, are significant deterrents and obstacles to the growth of energy efficiency investments in the U.S. Yet energy efficiency investments are not only beneficial for investors and business owners, they offer long-term public benefits with lower greenhouse gas emissions, increased employment, and a reduced dependence on fossil fuel-based energy sources.

Net Metering

Net metering allows residential and commercial customers who generate their own solar energy to supply excess electricity back to the grid, crediting them for their grid-fed electricity. For example, residential customers with rooftop solar PV systems may generate more electricity than their home uses during the day. Under net-metering, that excess electricity is sent out to the grid and the home's electricity meter will run backwards to give credit for nighttime use or when the home requires more energy than the PV system can produce. Most solar customers produce more electricity than they consume.[107] Net metering is an efficient and cost effective way to take advantage of surplus electricity produced by residential and commercial solar PV systems.

Montana instituted a net metering policy in 1999, which set limits on capacity for net metering systems. Nearly all 50 states have authorized net metering or a net metering program, though regulations differ from state to state.[108] For example, states differ in how long customers can maintain bill credits for net-metered electricity. In Montana, the utility eliminates the credit balance at the end of an annual billing cycle without compensation. Some states also allow electricity generating sources to be connected to multiple meters—a policy called aggregate net metering. Aggregate net metering allows one or more customers to combine their electrical meters on the same billing arrangement of net metering.[109] Multiple meters on the same or adjacent property streamlines on-site renewable energy projects and cuts costs.[110] Net metering laws vary significantly from state-to-state on characteristics including the types of eligible technologies to net meter, individual system capacity limits for net-metering systems,

---

106 NC Clean Energy Technology Center. "Residential Energy Efficiency Tax Credit," Feburary 28, 2018. Retrieved from: http://programs.dsireusa.org/system/program/detail/1274

107 Solar Energy Industries Association (SEIA). "Net Metering." 2017. Retrieved from: http://www.seia.org/policy/distributed-solar/net-metering

108 Everts, Todd, Sonja Nowakowski, and Nadine Spencer. "Net Metering in Montana: A Report to the 65th Legislature." *Energy and Telecommunications Interim Committee.* September 2016. Retrieved from: http://leg.mt.gov/content/Publications/Committees/interim/2015-2016/SJ12DraftReport-net-metering.pdf

109 Barnes, Chelsea. "Aggregate Net Metering: Opportunities for Local Governments," U.S. DOE Sun Shot. July 2013. Retrieved from: http://icleiusa.org/wp-content/uploads/2015/11/Aggregate-Net-Metering-Opportunities-for-Local-Governments.pdf

110 *Ibid.*

and the methods for calculating and reimbursing Net Excess Generation credits.[111] Montana law allows for individual net metering—connecting a generating source to a single meter--and does not observe aggregate net metering.

Net metering is offered on both NorthWestern Energy (NWE) and Montana-Dakota Utilities (MDU) systems. On NWE's system, renewable installations of less than 50kW are eligible. There are currently about 1,500 net-metered customers on NWE's system—approximately 0.07 percent of all Montanans in NWE's service territory. MDU's net metering program is also limited to a capacity of 50 kW and credits can carry over for a one year period. There are currently four net-metered customers on MDU's Montana system.

Mike Sudik of Big Sky Solar believes that NWE is approaching net metering in a way that ultimately hurts their bottom line. "Solar (energy) and net metering is actually very helpful for NWE—they're trying to manage a centralized grid. Every time we decentralize the grid we reduce efficiency loss," Sudik said.[112] According to Sudik, taking advantage of a decentralized grid can help NWE better manage the ups and downs of electricity demand.

There are multiple bills on net metering currently moving through the legislative process in Montana. Renewable energy advocates are working to modernize the net metering law to improve the economics of renewable energy systems and ensure existing benefits for current net metered customers. However, NorthWestern Energy continues to lobby for bills that would make net metering too expensive for its customers. In June 2017, House Bill 219 was passed by the Montana Legislature and signed by Governor Bullock, instructing the Montana Public Service Commission to oversee a NWE cost-benefit analysis on utility customer net metering. The study may significantly impact several factors of net metering in Montana, including the value of credits provided to customers and the billing process for net metered customers.[113] Renewable energy proponents were disappointed by the passage of the bill, as its economic effects may discourage the growth of solar and wind energy in Montana.

2018 Solar Tariff

On January 23, 2018, President Trump imposed a 30 percent tariff on imported solar panel components to the U.S. The tariff includes both imported solar cells and solar modules (solar panels).[114] The percentage-based tariff—which begins after the first 2.5

111 *Ibid.*
112 Mike Sudik, Personal Interview. Missoula, Montana. July 2017.
113 Montana Renewables. "Net Metering Cost-Benefit Analysis Process Underway." June 28, 2017. Retrieved from: http://montanarenewables.org/policy/
114 Presidential Proclamation 9693 under Section 201 of the Trade Act of 1974 created a tariff rate quota (TRQ) for Crystalline Silicon Photovoltaic (CSPV) cells. There is an additional tariff for modules composed

gigawatts of imported capacity—is scheduled to last four years and will fall by 5 percent annually.[115] According to solar industry market experts at EnergySage, the tariff will raise the cost of a typical home solar installation by $500 to $1000.[116]

The tariff was co-petitioned by Suniva and SolarWorld Americas—two solar manufacturing companies that argue that lower-priced imported solar components undermine U.S. manufacturers. Presently 95 percent of the solar panels used in the U.S. are imported.[117] Yet solar installers, clean energy advocates, and notable politicians including Michael Bloomberg say the tariff is detrimental to the U.S. solar industry, consumers, and the environment.[118] President and CEO of the Solar Energy Industries Association, Abigail Ross Hopper, predicted that the tariffs will result in the loss of approximately 23,000 American jobs in 2018.[119]

2017 Tax Cuts and Job Act

Tax reform provisions under the Trump Administration are complicating the economic trajectory of renewable energy production and manufacturing facilities in the U.S. The 2017 Tax Cuts and Jobs Act (TCJA) includes several provisions that could have significant impacts on renewable energy sector stakeholders. TCJA includes a federal corporate tax rate reduction from 35 to 21 percent; a new transition tax imposed on foreign earnings from subsidiaries of U.S. companies; the repeal of Section 199, which allowed a taxpayer a deduction for qualified energy production; and an amended version of the base erosion anti-abuse tax (BEAT).[120]

The BEAT is a tax aimed at limiting multinational investment by penalizing their

---

of CSPV cells, effective starting February 7, 2018. Source: U.S. Customs and Border Protection. "QB 18-111 2018 Solar Cell/Modules" February 1, 2018. Retrieved from: https://www.cbp.gov/trade/quota/bulletin/qb-18-111-2018-solar-cellmodules

115 The tariff is scheduled to drop to 15 percent in 2021. Source: U.S. Trade Representative. "Section 201 Cases: Imported Large Residential Washing Machines and Imported Solar Cells and Modules" January 2018. Retrieved from: https://ustr.gov/sites/default/files/files/Press/fs/201%20Cases%20Fact%20Sheet.pdf

116 EnergySage. "How the 2018 U.S. Solar Tariff Will Impact the Price You Pay" Accessed January 25, 2018. Retrieved from: https://news.energysage.com/2018-us-solar-tariff-impact-prices/

117 Swanson, Ana and Brad Plumer. "Trump's Solar Tariffs Are Clouding the Industry's Future," *The New York Times.* January 23, 2018. Retrieved from: https://www.nytimes.com/2018/01/23/us/politics/trump-solar-tariffs.html

118 Milman, Oliver. "Donald Trump's tariffs on panels will cost US solar industry thousands of jobs," *The Guardian*. January 24, 2018. Retrieved from: https://www.theguardian.com/environment/2018/jan/23/donald-trump-tariffs-solar-panels

119 SEIA. "President's Decision on Solar Tariffs is a Loss for America" January 22, 2018. Retrieved from: https://www.seia.org/news/presidents-decision-solar-tariffs-loss-america

120 Foehringer Merchant, Emma. "Final Tax Bill Amends BEAT Provision to Keep Some PTC and ITC Value." *Green Tech Media.* December 15, 2017. Retrieved from: https://www.greentechmedia.com/articles/read/final-tax-bill-amends-beat-provision-to-keep-ptc-and-itc-value#gs.B15b4rM

payments to foreign parent entities from U.S. subsidiaries. The amendment kept 80 percent of the value of both federal Investment Tax Credit and Production Tax Credit, which support credits for technologies such as carbon capture, energy efficiency, and microturbines.[121]

While tax lawyers and clean energy advocates predict the bill to have a mixed impact on renewable energy industry, its full implications remain uncertain. However, the 2018 Federal Budget increased the Department of Energy's funding from 2017, and protected legislation that supports clean energy.[122]

Renewable Energy Tax Incentives in Montana

Currently, Montana's primary solar rebate program is through NorthWestern Energy, which is provided in either a lump sum payment or taken off of the final installed price by the system installer.[123] Homeowners who install a solar power system are also eligible for several tax benefits, including tax credits and a property tax exemption. As of December 2001, the Montana solar power tax credit (also known as the Residential Renewable Energy Tax Credit) allows 100 percent credit on the price of a solar power system installation up to $500 for an individual or $1,000 for two taxpayers.[124] Excess credit may be carried over and applied for state taxes for up to four years.

The Alternative Energy Investment tax credit is a personal tax credit of up to 35 percent for commercial and net metering renewable energy investments of $5,000 or more. The credit is applied for taxes on renewable energy equipment or facilities, and is available to taxpayers purchasing existing facilities as well as those building a new facility. The credit is also available for net metering systems with a generating capacity of 50 kW or less, but can only go towards the income generated by the system. Tax credits that exceed the amount of owed taxes can be carried over and applied for state tax liability for up to 7 years.[125]

Montana's solar property tax exemption allows residents who install a home solar

121 Foehringer Merchant, Emma. "Trump Signs Budget Bill With Relief for 'Orphan' Energy Technologies." *Green Tech Media.* February 9, 2018. Retrieved from: https://www.greentechmedia.com/articles/read/senate-passes-budget-bill-with-relief-for-orphan-energy-technologies-and-pu#gs.72plIn8

122 Foehringer Merchant, Emma. "The President's Own Party Still Doesn't Back His Attempts to Dismantle Clean Energy." *Green Tech Media.* March 26, 2018. Retrieved from: https://www.greentechmedia.com/articles/read/the-presidents-own-party-still-doesnt-back-his-energy-strategy#gs.F0T2Oig

123 Dasolar Energy. "Montana - Energy Tax Credit, Solar Rebates and Incentives." Accessed August 2017. Retrieved from: https://www.dasolar.com/energytaxcredit-rebates-grants/montana.

124 DSIRE. "Residential Alternative Energy System Tax Credit" Last Updated October 2016. Retrieved from: http://programs.dsireusa.org/system/program/detail/366.

125 DSIRE. "Alternative Energy Investment Tax Credit (Personal)" Last Updated October 2016. Retrieved from: http://programs.dsireusa.org/system/program/detail/2770.

power system a 10 year period free of additional property taxes, worth up to $20,000 for a single-family residence.[126] All other buildings are exempt from property taxes up to $100,000 for 10 years following installation.[127] Home Solar PV systems can increase property values significantly; a 5kW system increases home value by approximately $17,000.[128] Property tax exemptions help to make the investment of installing a solar system on a residential or commercial property pay off economically in the long-run.

Solar Power Performance Payments, also called production incentives, provide renewable energy system owners small cash payments based on the number of kilowatt-hours (kWh) or BTUs their system generates. These payment schemes are more effective than rebates or tax credits, because they are made according to the system's actual performance, rather than the system's rated capacity.[129] Electricity produced is credited as Solar Renewable Energy Credits (SRECs), which can greatly reduce the cost of a Solar PV system. Unfortunately, Montana does not currently offer Solar Power Performance Payments to renewable energy system owners.

While Montana's tax credits do make renewable energy systems more affordable, the state is still behind other states for renewable energy economic incentives. For example, in Colorado, utilities and local organizations offer cash rebates for home solar installations of up to $4,500 for a 6kW system.[130]

Dan Brandborg—Renewable Energy Specialist and General Manager at SBS Solar in Hamilton, Montana—sees that as one of the largest setbacks to the growth of solar energy in the state. "In Montana, it's hard to take the cost of a (solar energy) system and electricity and see it as making sense in the short term."

Even with the desire to buy solar, Brandborg says that initial costs are still too high for many Montanans. "Our clients are environmentally oriented, but if the cost is too high, it's pretty hard to convince them to go solar. In other places like California where you have a one or two year payback, it's going crazy because it makes more economic sense. Here in Montana, it makes sense when you look at 10, 20, 25 years but not before then."[131]

---

126 Montana Department of Environmental Quality. "Tax and Other Incentives: Montana Incentives for Renewable Energy." Accessed August 2017. Retrieved from: http://deq.mt.gov/Energy/montanasenergy/taxincentrenew.

127 *Ibid.*

128 Dasolar Energy. "Montana - Energy Tax Credit, Solar Rebates and Incentives." Accessed August 2017. Retrieved from: https://www.dasolar.com/energytaxcredit-rebates-grants/montana.

129 Zientara, Ben. "What are SRECs and solar performance payments?" Accessed August 2017. Retrieved from: https://solarpowerrocks.com/affordable-solar/what-are-solar-performance-payments-srec-pbi/

130 EnergySage. "Colorado has some of the best solar incentives and rebates in the country." Accessed September 2017. Retrieved from: https://www.energysage.com/solar-rebates-incentives/co/

131 Dan Brandborg. Personal Interview. Missoula, Montana. August 2017.

Expanding Renewable Energy in Montana

Montana is a state that receives abundant sunshine and is one of the highest for wind energy generation capabilities in the country. While Montana has slowly increased its installed capacity of wind energy and grid connected photovoltaics, there remains enormous untapped potential for renewable energy. As other states shift their energy resources towards renewables, Montana is lagging behind in both installed solar and wind energy capacity. If policymakers and stakeholders work to support greater renewable energy development, Montana can capitalize on its vast renewable resources to foster a more robust, community-oriented and sustainable economy.

Montana's Renewable Energy Standard required that investor-owned state utilities source 15 percent of their electricity from renewable energy by 2015.[132] The policy included all eligible renewable energy facilities that have operated since January 1, 2005. In addition, the law includes a provision that requires utilities to purchase a small portion of their electricity from Community Renewable Energy Projects (CREPs). Aimed at promoting sustainable local and regional jobs, the CREPs must be majority-owned by Montana residents and 25 MW or less in size.[133] In January 2017, NWE was not in full compliance with the CREP provision and requested that the Montana Public Service Commission repeal it from the Renewable Energy Standard law.[134] In April 2017, Governor Bullock vetoed SB 032—Repeal of Community Renewable Energy Projects—supporting this important clean energy provision.

The decision to utilize renewable energy resources does not fall along political party lines—some of the most historically Republican states in the country are the biggest generators of renewable energy. In 2016, Texas ranked 1st in installed wind capacity with 21,044 MW[135], and 6th in new solar installed with 1,215 MW[136] of cumulative solar

132 American Council on Renewable Energy. "Renewable Energy in the 50 States: Western Region." September 2014. Retrieved from: http://www.acore.org/files/pdfs/states/Montana.pdf

133 The six-turbine, 10-megawatt Fairfield Wind Farm, located in Fairfield, MT is an example of smaller, community scale wind project classified as a CREP operating in NWE's service area. Source: Puckett, Karl. "Governor visits wind farm near Fairfield," *Great Falls Tribune.* May 31, 2016. Retrieved from: https://www.greatfallstribune.com/story/news/local/2016/05/31/governor-visits-wind-farm-near-fairfield/85216336/

134 As of April 2017, NorthWestern had only purchased 25 of the required 65 Megawatts of CREPs. Source: MEIC. "Expanding Clean Energy in Montana!" January 23, 2017. Retrieved from: http://meic.org/wp-content/uploads/2017/01/CapMonitor2-2017-8X14.pdf

135 Office of Energy Efficiency & Renewable Energy. "Wind Energy in Texas." WINDExchange. 2017. Retrieved from: https://windexchange.energy.gov/states/tx

136 Texas Solar Energy Society. "Solar Energy Data." 2017. Retrieved from: http://txses.org/data-on-solar-in-texas-and-the-u-s/

electric capacity. Iowa had the highest proportion of renewable energy sources comprising total electricity generation, with 37 percent of total generation coming from wind and solar in 2016.[137]

The neighboring states of Idaho, Oregon, Washington and Wyoming are far surpassing Montana with their investments in renewable energy.[138] According to the Solar Energy Industries Association (SEIA), in 2016, Idaho ranked 16th in the nation for solar installations, with solar energy comprising 0.61 percent of Idaho's electricity.[139] Idaho ranked 20th in the nation for installed wind capacity, with 973 MW installed, comprising 15.2 percent of in-state electricity production.[140] In 2016, Oregon ranked 18th for solar installations, comprising 0.32 percent of Oregon's electricity.[141] Oregon ranked 8th for installed wind capacity, with 3,213 MW installed, comprising 12.05 percent of in-state electricity production.[142] In 2016, Washington ranked 28th for solar installations, comprising 0.08 percent of Washington's electricity.[143] Washington ranked 9th for installed wind capacity, with 3,075 MW installed, comprising 7.13 percent of in-state electricity production.[144] And while Wyoming only ranked 46th for solar installations (0.01 percent of the state's electricity) in 2016[145], it ranked 15th for installed wind capacity, with 1,489 MW installed.[146] That constitutes 9.42 percent of Wyoming's in-state electricity production.

Montana, however, falls behind all four neighbor states in both solar and wind energy installations. In 2016, Montana ranked 42nd for solar installations, comprising 0.04 percent of Montana's electricity.[147] Montana ranked 22nd for installed wind capacity in 2016, with 695 MW installed[148], comprising 7.6 percent of in-state electricity production. These distressing rankings are not the result of political indifference to renewable development—they are the consequence of willful decisions by Montana's policymakers to limit the growth of solar and wind energy in the state. As the Republican-led states of Idaho and Wyoming are following an energy path more similar to that of Oregon and Washington than to Montana, energy policies are clearly not a

137 Walton, Robert. "EIA: Wind, solar composed 10% of March generation." *Utility Dive*. June 15, 2017. Retrieved from: http://www.utilitydive.com/news/eia-wind-solar-composed-10-of-march-generation/445069/

138 Solar Energy Industries Association. "Solar Market Insight Report 2016 Year In Review." 2016. Retrieved from: https://www.seia.org/research-resources/solar-market-insight-report-2016-year-review

139 *Ibid.*

140 AWEA. "U.S. Wind Energy State Facts." Accessed July 2017. Retrieved from: https://www.awea.org/state-fact-sheets

141 Solar Energy Industries Association. "Solar Market Insight Report 2016 Year In Review." 2016.

142 AWEA. "U.S. Wind Energy State Facts." Accessed July 2017.

143 Solar Energy Industries Association. "Solar Market Insight Report 2016 Year In Review." 2016.

144 AWEA. "U.S. Wind Energy State Facts." Accessed July 2017.

145 Solar Energy Industries Association. "Solar Market Insight Report 2016 Year In Review." 2016.

146 AWEA. "U.S. Wind Energy State Facts." Accessed July 2017.

147 Solar Energy Industries Association. "Solar Market Insight Report 2016 Year In Review." 2016.

148 AWEA. "U.S. Wind Energy State Facts." Accessed July 2017.

Republican vs. Democrat issue.

State	2016 Solar % of Total Electricity Generated	2016 Ranking for Solar Installations	2016 Wind % of Total Electricity Generated	2016 Ranking for Installed Wind
Montana	0.04%	42nd	7.6%	22nd
Idaho	0.61%	16th	15.2%	20th
Oregon	0.32%	18th	12.05%	8th
Washington	0.08%	28th	7.13%	9th
Wyoming	0.01%	46th	9.42%	15th

Table 1.0 State Solar and Wind Energy Comparisons

The 2016 rankings for jobs in the solar industry follows a similar trend. While Montana ranked 47th for solar jobs per capita in 2016, Idaho ranked 36th, Oregon ranked 11th, Washington ranked 24th, and Wyoming ranked 42nd. The exact numbers of wind energy workers per state are not currently available, but according to the American Wind Energy Association Montana supported between 501 and 1,000 direct and indirect wind energy jobs in 2016. Montana does not have any wind energy manufacturing facilities. However, wind power in Montana averages 100 new jobs per year and $17 million added to gross state product.[149]

Solar productivity is dependent on the available solar radiation and ambient temperature; year to year variability in productivity is small.[150] Cities in Montana have an average solar productive output that is relative to other U.S. cities, with solar resources in the cities of Billings and Miles City producing about 7 percent more energy per year than resources in Missoula.[151] Experts estimate that Montana has an estimated potential for 6 GW (6000 MW) in urban utility scale photovoltaics and an additional

149 Inbody, Kristen. "Generating the Future." *Great Falls Tribune.* May 21, 2015. Retrieved from: http://www.scigaia.com/private_html/wp-content/uploads/2013/02/Great-Falls-Tribune-20150521-Generating-the-future.pdf

150 Norris, Benjamin L. and Philip M. Gruenhagen. "Montana Solar Market Assessment." Montana Department of Environmental Quality. January 2018. Retrieved from: http://mtsolarcommunity.mt.gov/Portals/185/Documents/Montana_Solar_Market_Assessment_Final_Update.pdf

151 *Ibid.*

4,403 GW in rural utility scale photovoltaics.[152] Solar has also become a much more affordable option for Montana families over the past decade. The wholesale cost of solar panels has dropped by two-thirds since 2008, leading to almost three times as many net-metered solar energy systems in Montana.[153] However, certain utilities are trying to limit rooftop solar by lobbying against progressive net metering policies, thwarting renewable energy development in Montana.[154]

About 37 percent of Montana's electricity is generated from hydropower, placing it 5th in the nation for states with utility scale hydroelectric generation in 2016.[155] Hydropower is an important addition to Montana's renewable energy portfolio. However, the state has already effectively reached capacity for renewable energy from hydropower. Hydropower dams with large reservoirs can be used for long-term energy storage, to be accessed during times of high demand. As other forms of grid energy storage—including solar batteries—continue to improve in efficiency, hydropower is the most economically viable large-scale storage technology available.[156] Greater investment in pumped storage hydro will allow Montana to increase its renewable energy storage capacity, which would produce significant economic savings for the state well into the future.

According the American Wind Energy Association, Montana is "one of the top states in the country for potential wind generation."[157] Montana has an estimated wind potential of over 940,000 MW per year—an amount that if realized would place Montana as one of the country's wind energy leaders.[158] According to a report by the U.S. DOE's National Renewable Energy Laboratory, Montana ranks 3rd in the nation for states with the greatest wind capacity potential, and 5th for states with the most potential for wind power generation.[159] Wind power can provide for more than 240 times Montana's

---

152 National Renewable Energy Laboratory. "U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis." July 2012. Retrieved from: https://www.nrel.gov/docs/fy12osti/51946.pdf

153 Montana Renewable Energy Association (MREA). "Local Energy & Montana Jobs" Accessed August 2017. Retrieved from: http://montanarenewables.org/policy/

154 MREA. "Net Metering Cost-Benefit Analysis Update." August 31, 2017. Retrieved from: http://montanarenewables.org/policy/

155 U.S. EIA. "Table 3.14. Utility Scale Facility Net Generation from Hydroelectric (Conventional) Power." Accessed May 2018. Retrieved from: https://www.eia.gov/electricity/annual/html/epa_03_14.html

156 IRENA 2012.

157 American Wind Energy Association. "Montana State Fact Sheet." 2017.Retrieved from: http://awea.files.cms-plus.com/FileDownloads/pdfs/Montana.pdf

158 Hurlbut, David, Joyce McLaren, and Rachel Gelman. "Beyond Renewable Portfolio Standards: An Assessment of Regional Supply and Demand Conditions Affecting the Future of Renewable Energy in the West." *National Renewable Energy Laboratory.* August 2013. Retrieved from: https://www.nrel.gov/docs/fy13osti/57830-1.pdf

159 The results were based on analyzing locations where an 80-meter-high wind turbine would operate, on average, at 30 percent of its maximum generation potential. Wind capacity is the percentage of power that a wind operation could produce if the wind blows constantly at the ideal speed for maximum power generation. Wind power generation is the amount of total energy generated from a wind operation.

current electricity needs using current wind technology.[160] Montana's peak wind energy output in winter months complements the spring peak of hydropower in the Pacific Northwest and California's solar peak in the summer.

A study conducted by Energy Strategies LLC, an independent energy consulting firm, assessed the relative costs of generating and supplying wind energy in Montana, Oregon and Washington into Puget Sound Energy's (PSE) system. Energy Strategies used comparative modeling tools by the National Renewable Energy Laboratory to compare various characteristics for nine potential wind project sites: five in Montana, two in Oregon, and two in Washington. The study found that Montana's wind resources are "generally more plentiful and of higher quality than those in Washington and Oregon. While the sites in all three states have roughly comparable summer capacity factors, the Montana wind sites have consistently and substantially higher winter capacity factors."[161]

PSE is a winter-peaking electric utility with highest demand during the same time of day that wind at the Montana sites is strongest and most consistent. The high capacity of Montana wind is enough to outweigh higher relative transmission costs of sending electricity longer distances to PSE in comparison to wind energy from Oregon and Washington. The addition of Montana wind to PSE's energy portfolio would increase the resilience and diversity of the system. Furthermore, the study's authors note that the retiring of Colstrip units will free up significant transmission capacity, in which Montana wind projects could utilize to more directly interconnect with PSE's transmission.[162]

"Montana's renewable energy potential is large enough to be effectively limitless,"[163] said Jeff Fox of Renewable Northwest. "It's a question of how much do we want to power our own economy through renewable energy resources and reap the benefits from renewable development?" According to Fox, the biggest barrier to greater renewable energy development in Montana right now is transmission constraints.

Outdated transmission lines controlled by the federal agency, Bonneville Power Administration (BPA), prevent Montana from expanding its out-of-state electricity transmission. A section of Montana's transmission line on BPA's network is currently subject to a double fee, making it economically less competitive in the Northwest clean energy electricity market.[164] The Sierra Club and MEIC, represented by Earthjustice, are asking BPA to eliminate the double charge. In doing so, BPA could release the nearly

160 Wind Energy Foundation. "Focus on Renewable Energy in Montana" Accessed August 2017. Retrieved from: http://windenergyfoundation.org/focus-areas/renewable-energy-in-montana/
161 Renewable Northwest, "Executive Summary of Energy Strategies LLC: Assessment of the Cost Competitiveness of Montana Wind Energy." September 2016.
162 *Ibid.*
163 Jeff Fox, Personal Interview. Missoula, Montana. September 2017.

200 MW of transmission capacity that is currently sitting idle for exported wind energy transmission.

The retail electricity price in Montana is below the national average. Most Montanans pay around 11.57 cents per kilowatt hour for electricity, vs. the national average of 12.86 cents per kilowatt hour.[165] Montana's rate is also lower than the Mountain region's average of 12.39 cents per kilowatt hour. However, the neighbor states of Idaho, Utah and Wyoming have lower rates with 10.04, 11.34, and 11.39 cents per kilowatt hour, respectively.[166] Even with comparatively reasonable electricity rates, the long-run economic, environmental and human health benefits of renewable energy—in addition to the declining economics of coal and oil—make renewable energy systems worth the investment.

The Weakened Economics of Coal

Jobs in the fossil fuel industries of coal, oil and natural gas are determined by highly volatile market forces. Employment in these industries is vulnerable to the boom and bust cycles of shifting market prices. The country is quickly shifting its sources of electricity generation to more sustainable forms of energy. While the country still fuels two-thirds of its electricity from coal and natural gas, the portion from coal is rapidly declining. In 2015, U.S. coal production dropped to below 900 million short tons—the lowest annual production levels since 1986.[167] Coal production declined that year in all three regions—the Western, Interior, and Appalachian.[168] Montana's coal production dropped 6.1 percent between 2014 and 2015.[169] Between 2006 and September 2016, electricity generation from coal declined 53 percent. Meanwhile, electricity generation from solar increased by more than 5,000 percent.[170]

Jobs in the coal industry have been plummeting since 2012, largely due to the competition of cheap natural gas and the rapid growth of renewable energy. Peaking in 2012, coal mining and extraction jobs in the U.S. were just under 90,000. By the second

---

164 Hedges, Anne. "A Federal Agency is Blocking Montana Renewable Energy Development." MEIC. December 23, 2016. Retrieved from: http://meic.org/2016/12/federal-agency-blocking-montana-renewable-energy-development/

165 The yearly average national electricity price for customers up until July 2017. Source: U.S. EIA. "Table 5.3. Average Price of Electricity to Ultimate Customers." July 2017. Accessed September 2017. Retrieved from: https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_3

166 Solar Resource Guide. "Residential Solar Power in Montana." 2017. Retrieved from: http://www.solarresourceguide.org/montana/

167 U.S. Energy Information Administration. "Annual Coal Report." November 2016.Retrieved from: https://www.eia.gov/coal/annual/pdf/acr.pdf

168 U.S. Energy Information Administration. "Annual Coal Report." November 2016.

169 *Ibid*, p.2.

170 U.S. DOE. "U.S. Energy and Employment Report." January 2017.

quarter of 2016, they had dropped to approximately 53,000.[171] The sector now employs about 0.03 percent of the national economy.[172] The decline in coal's popularity as an energy source is contributing to the closure of coal-fired power plants across the nation. Federal figures show that more than 45 coal-fired generating units at 25 electricity plants are scheduled to close over the next four years.[173] The Institute for Energy Economics and Financial Analysis (IEEFA) calculated that the closures will eliminate approximately 28.2 million tons of annual coal demand—equivalent to nearly $1.1 billion—by the end of 2018.[174]

In 2016, the number of coal mining jobs in Montana dropped from 1,320 to 1,196, according to the Mine Health and Safety Administration (MHSA).[175] Though supporters of coal often point to jobs as one of the primary reasons to keep coal-fired plants running, the numbers indicate otherwise. While coal mining is a high-paying profession (with an average wage of $27 per hour) in Montana, it isn't even in the top 20 job-producing industries in the state.[176] A study released in March 2017 on jobs in Montana's coal industry predicts losses between 800 to 4,300 industry jobs over the next 10 years.[177]

The upcoming closure of Colstrip plant generating Units 1 and 2 by 2022 signify the quickly waning economic benefits of coal in Montana. In addition to national market forces reducing the cost competitiveness of coal, growing consumer pressure has forced Oregon and Washington utilities to phase out coal-fired electricity from their electricity portfolios. A report by Headwaters Economics states that less than 3 percent of both total employment and personal income is connected to oil, gas and coal projects in Montana.[178]

---

171 *Ibid.*

172 *Ibid.*

173 Hill, Joshua."US Coal Plant Closures Likely to Eliminate 30 Million Tons of Annual Coal Demand." *Clean Technica*. April 24, 2017. Retrieved from: https://cleantechnica.com/2017/04/24/us-coal-plant-closures-likely-eliminate-30-million-tonnes-annual-coal-demand/

174 Feaster, Seth. "IEEFA Research Brief: Coal in Decline, Blow by Blow." *Institute for Energy Economics and Financial Analysis.* April 21, 2017. Retrieved from: http://ieefa.org/ieefa-research-brief-coal-decline-blow-blow/

175 Michels, Holly. "As coal production declines, Montana sees drop in coal jobs, plans for more." *The Missoulian*. June 11, 2017. Retrieved from: http://missoulian.com/news/state-and-regional/as-coal-production-declines-montana-sees-drop-in-coal-jobs/article_e4d8c572-bf48-578e-b1e7-0b020a83e589.html

176 U.S. Bureau of Labor Statistics. "May 2016 State Occupational Employment and Wage Estimates, Montana." Accessed September 2017. Retrieved from: https://www.bls.gov/oes/current/oes_mt.htm

177 Taimerica Management, Competitive Solutions, and the Trent Lott National Center. "The Changing Coal Industry: Regional Economic Impacts - Workforce Analysis - Transition Strategies." March 2017. Retrieved from: http://www.bigskyeconomicdevelopment.org/wp-content/uploads/Coal-Country-Coalition-Report-FINAL-3-17.pdf

178 Haggerty, Mark. "Planning for Montana's Energy Transition." *Headwaters Economics.* February 2016. Retrieved from: https://headwaterseconomics.org/wp-content/uploads/report-montanas-energy-transition.pdf

Economic incentives over the past century have heavily favored the coal, oil and gas industries. In Montana, a single tax break for oil and gas drilling, called the oil and gas tax holiday, has cost Montana's taxpayers approximately $265 million since 2008.[179] But as both Montana and neighboring-state consumers increasingly demand renewable sources of electricity generation, Montana will need to dramatically alter its energy profile to keep up with demand. While transitioning away from the use of fossil fuels is imperative to reverse current destructive trends of climate change, it also makes clear economic sense. Investing in Montana's wind and solar energy resources is a critical investment in the stability of Montana's economic future.

Part 3: Social Impacts of Colstrip Plant Closure and a Transition to Renewable Energy

Colstrip's Uncertain Future

The southeastern Montana town of Colstrip, located in Rosebud County, is home to approximately 2,300 people. With 13.6 percent of its jobs in mining or power generation, Rosebud is the fifth most dependent county in the nation on federal coal for employment.[180] About 360 people are employed at the Colstrip Power Plant, and over 700 Colstrip residents in total are employed by the Colstrip electrical plants or the nearby Rosebud coal mine—nearly 30 percent of the Colstrip population.[181] Coal from the Rosebud Mine is solely bought by the Colstrip Power Plant. Coal is the town's primary industry, as it has been since the power plant began operations in the 1970s. One of the leading attractors of coal jobs is that they are commonly financially lucrative—this is the case in Colstrip: the town's estimated median household income is $84,145, compared to $49,509 for all of Montana.[182]

Yet recent political decisions are expediting the power plant's closure, as well as the termination of jobs required for its operation. Legal settlements with the plant's largest owners suggest that Colstrip will cease all operations by 2027, if not sooner. The loss of hundreds of well paying jobs will be largely felt by the Colstrip community.

---

179 Montana Budget & Policy Center. "Oil and Gas Tax Holiday: It is time to end this free ride." February 3, 2017. Retrieved from: http://montanabudget.org/post/oil-and-gas-tax-free-ride

180Lutey, Tom. "Witnesses ask Puget Sound Energy to do right by Colstrip," The Billings Gazette. September 6, 2017. Retrieved from: "http://billingsgazette.com/news/government-and-politics/witnesses-ask-puget-sound-energy-to-do-right-by-colstrip/article_a126b5cd-5683-5761-a51e-b01128943e97.html

181 Harball, Elizabeth. "Inside a Western Town That Refuses to Quit Coal," *Scientific American.* April 12, 2016. Retrieved from: https://www.scientificamerican.com/article/inside-a-western-town-that-refuses-to-quit-coal/

182 Data USA Comparison Tool. Colstrip, MT Profile. Retrieved from: https://datausa.io/profile/geo/colstrip-mt/?compare=montana

Of equal importance to the question of an economic transition, is that of how environmental remediation will be addressed to clean up the toxic ash ponds and contaminated groundwater in Colstrip. Both of these can be addressed by prioritizing the development and training for renewable energy and remediation jobs. There is no better opportunity for the community to break its economic dependence on fossil fuels and transition into sustainable industries that will serve the community—and the state—for decades to come.

Timeline of Plant Closure

The bulk of coal-fired energy generated at Colstrip is sent over transmission lines to other states, but the demand for that energy is rapidly declining. Oregon is the first state to require its utilities to eliminate the use of coal-fired energy by law.[183] Mayors of 14 cities in Washington's King County have signed a Climate Action Plan that will phase out coal power by 2025.[184] More than 75 percent of Colstrip's ownership is with companies that serve areas that are rapidly reducing their dependence on the fossil fuel industry.[185]

In a 2016 settlement of an air pollution lawsuit, Puget Sound Energy and Talen Energy agreed to shut down Colstrip Units 1 and 2 by no later than July 2022.[186] Oregon's 2016 Clean Electricity and Coal Transition Bill requires PacifiCorp to end its supply of coal power to the state by 2030 and the same of Portland General Electric (PGE) by 2035, though PGE estimates the power plant's end life expectancy at 2030. Spokane-based Avista Corp has estimated that the usefulness of Units 3 and 4 will end by 2037.[187] In September 2017, Puget Sound Energy agreed to pay a minimum of $10 million for the economic transition of Colstrip and will pay down all debts to the plant by 2027—these legal settlements are preparing the plant's largest owner to close it down within a

183 In 2016, Oregon passed the Clean Electricity and Coal Transition Plan, which requires Pacific Power (PAC) and Portland General Electric (PGE) to eliminate coal from their portfolios by 2030 and source 50 percent of their power from renewables by 2040. This new RPS goal is one of the most ambitious in the nation, following the states of California and New York (50 percent by 2030), Vermont (75 percent by 2032) and Hawaii (100 percent by 2045).

184 Lutey, Tom. September 15, 2017. "Colstrip edges toward complete closure" *The Missoulian.* Retrieved from: http://missoulian.com/news/state-and-regional/colstrip-edges-toward-complete-closure/article_c39dd60c-4d8c-520b-ae69-f95fd9d315bf.html

185 Based in Bellvue, WA, Puget Sound Energy is Colstrip's largest shareholder. The company owns 50 percent of Units 1 and 2, and 25 percent of Units 3 and 4. The Portland, Oregon-based company, Portland General Electric, owns 20 percent of Units 3 and 4. Avista Corp is based in Spokane, WA, and owns 15 percent of Units 3 and 4. All three companies are feeling increasing pressure by state legislatures to swiftly transition their energy supply away from coal.

186 Lutey, Tom. "Colstrip edges toward complete closure."

187 Lutey, Tom. "Plan to close Colstrip power plant by 2027 approved, leaving $10M for community transition," *The Billings Gazette.* December 5, 2017. Retrieved from: http://billingsgazette.com/news/government-and-politics/plan-to-close-colstrip-power-plant-by-approved-leaving-m/article_0b0e8f15-eb3e-536d-8dc8-a3cf6db44a95.html

decade.[188] In March 2018, Avista Corp. also announced plans to financially prepare for closing Colstrip Units 3 and 4 by 2027.[189]

In September 2017, PSE announced an accelerated schedule for closure of Units 3 and 4 after filing a legal settlement with the Washington Utility and Transportation Commission. The settlement will prepare PSE to shutter the entire coal-burning facility by 2027, and include funds to help with a Colstrip community economic transition away from coal. In March 2018, Avista also agreed to financially prepare to close down Units 3 and 4 by 2027 as part of its plans to merge with Hydro One. While the final closure of Colstrip's Units 3 and 4 remains uncertain, all legal estimates indicate that it will cease operation by 2027 at the latest.

According to EarthJustice attorney, Jenny Harbine, the Colstrip owners have no incentive to give the public a heads up on plant closure. "The much more common scenario is that they announce the week that they're closing. To assume we're going to have a lot of notice...is really flawed," said Harbine.[190]

Without a legal requirement for Colstrip's owners to provide fair warning of the plant's closure, it befits the community to begin an economic transition away from a coal-based economy as soon as possible.

Economic Implications for the Colstrip Community

Ownership of the Colstrip power plants is divided among six utilities: Puget Sound Energy (PSE), Talen Energy, PG&E, Avista, PacificCorp, and NorthWestern Energy—of these, only NWE has an office in Montana, and none are headquartered in the state.[191] Units 1 and 2 are co-owned by PSE and Talen Energy. Ownership of Units 3 and 4 is divided among all six utilities.

Puget Sound Energy's 2017 legal settlement provides $10 million for Colstrip community planning purposes—$5 million is paid by PSE and $5 million comes from PSE shareholders. PSE will hold workshops to discuss the future of the transmission lines that currently transmit Colstrip's electrical load. In December 2017, Montana Governor Steve Bullock and Attorney General Tim Fox announced the designation of

---

188 *Ibid.*

189 Lutey, Tom. "Colstrip's coal-fired power plant may be casualty in partial owner's $5.3B merger" *The Billings Gazette.* March 20, 2018. Retrieved from: http://billingsgazette.com/news/state-and-regional/montana/colstrip-s-coal-fired-power-plant-may-be-casualty-in/article_50c9ad24-91dc-5b6a-a01f-a9e3969fddfe.html

190 Jenny Harbine, Personal Interview. Missoula, Montana. March 19, 2018.

191 The headquarters of the six owners of Colstrip are the following: PSE is based in Bellevue, WA; Talen Energy is based in Allentown, PA; PGE is based in Portland, OR; PacificCorp is based in Salt Lake City, UT; Avista Corp is based in Spokane, WA; and NorthWestern Energy is based in Sioux Falls, SD.

an advisory group that will help the Colstrip community allocate the $10 million. The Colstrip Community Impact Advisory Group is composed of Colstrip stakeholders including Colstrip mayor John Williams, Rosebud County commissioner Doug Martens, and State Senator Duane Ankney.[192]

On August 1, 2017, Montana Governor Steve Bullock announced that the state secured $4,646,248 million of federal funding that will aid in the transition of the Colstrip workforce. The funding comes from a POWER grant through the U.S. Department of Labor's Dislocated worker program, and is reported to assist in "workforce planning and worker training, and to ensure the successful transition of the region to a diversified economy."[193] The grant money will be used to retrain 1,700 workers in Colstrip and other eastern and south central Montana counties in new jobs for a more diversified economy.

In March 2018, Avista Corp. announced a proposed agreement with Washington state regulators to operate as a wholly-owned subsidiary of Canadian utility, Hydro One Ltd. The sale would keep Avista's headquarters in Spokane, WA, but bring Avista closer to a complete merger with Hydro One Ltd., scheduled to ensue in the second half of 2018.[194] The settlement must be approved by three-member Washington Utilities and Transportation Commission, which will hold public hearings through early May and make a decision this fall.[195]

Several conservation groups signed the proposed agreement, including the Natural Resources Defense Council, NW Energy Coalition and the Sierra Club, who say the settlement will protect Avista's customers and includes important commitments to renewable energy and energy-efficiency programs. It includes a $3 million pledge from Hydro One and Avista to help the town of Colstrip identify new energy projects for the transmission line that runs from Colstrip to Avista's customers in Washington.[196]

Coal Severance Tax Fund

---

192 The advisory group is co-chaired by Adam Schafer of the Governor's Office and Job Bennion of the Attorney General's Office.

193 State of Montana Newsroom. "Governor Bullock Secures Over $4.6 Million for the Community of Colstrip" *Montana.gov*. August 1, 2017. Retrieved from: http://news.mt.gov/governor-bullock-secures-over-46-million-for-the-community-of-colstrip

194 Kramer, Becky. "Washington regulators receive proposed terms for Avista's sale to Canadian utility," *The Spokesman-Review*. March 28, 2018. Retrieved from: http://www.spokesman.com/stories/2018/mar/27/washington-regulators-receive-proposed-terms-for-a/#/0

195 *Ibid.*

196 Kramer, Becky. "Avista's sale to Canadian utility could impact Colstrip power plant's future." KULR. March 28, 2018. Retrieved from: http://www.kulr8.com/story/37830845/avistas-sale-to-canadian-utility-could-impact-colstrip-power-plants-future

In 1975, Montana created the Coal Tax Trust Fund under Article IX, Section 5 of the state Constitution. The Trust receives 50% of the tax revenue generated from all coal severance collections and the state only uses money from the fund's interest; its principal value remains untouched. The legislature partitioned the Trust into five sub-trust funds, each of which are dedicated to a specific public interest project.[197]

Montana's trust fund is simultaneously used for public projects and budget relief, while still increasing in perpetuity. While the principal value of the fund remains untouched, some of the earned interest is withdrawn for various projects including renewable energy development and regional water systems.[198] Most of the interest revenue is transferred into the state's general fund for overall budget relief. As of 2017, the Trust holds nearly $1 billion, accumulating approximately $50-60 million in tax revenues each year.

There are many similar natural resource funds around the world, with the largest American fund being the Alaskan Permanent Fund—worth $ 64.7 billion as of February 28, 2018.[199] These funds can serve a variety of purposes, including government use to stabilize exchange rates or reduce economic volatility. Yet they are primarily used to generate wealth from a non-renewable resource for longer-term public benefit.

Colstrip as a Transition Town

The closure of Colstrip Units 1 and 2 are expected to create a $500 million loss in income during the first three years.[200] Property values of local homes and businesses are expected to decline, as will the taxes on which the Colstrip municipality and public schools rely on for funding. A viable and sustainable long-term economic transition plan for the Colstrip community remains amorphous.

In August 2016, the Obama Administration announced the Power+ Plan, which proposed "more than $9 billion of investment to support economic diversification in coal communities; employment and training services for workers displaced from the

---

197 The five sub-trust funds include the Coal Tax Bond Fund, the Treasure State Endowment Fund, the Treasure State Endowment Regional Water System Fund, the Big Sky Economic Development Fund, and the Permanent Fund. Details on each of Montana's sub-trust funds can be read here: http://leg.mt.gov/content/Publications/fiscal/leg_reference/Brochures/2015-Coal-Severance.pdf.

198 Smith, Brock. "How Should Montana manage the Coal Tax Trust Fund?" June 12, 2017. Retrieved from: http://ageconmt.com/montana-manage-coal-tax-trust-fund/

199 Alaska Permanent Fund Corporation. Accessed February 2018. Retrieved from: https://apfc.org/ and "Coal Severance Tax" in the *Legislative Fiscal Report 2019 Biennium: Volume 2 Revenue Estimates.* Retrieved from: http://leg.mt.gov/content/Publications/fiscal/Budget-Books/2019/Fiscal-Report/Volume-2/2-coal-severance-tax.pdf

200 Bureau of Business and Economic Research at the University of Montana. "The Economic Implications of Implementing the EPA Clean Power Plan in Montana." November 2015. Retrieved from: http://www.bber.umt.edu/pubs/Econ/EconImpactEPACPP2015.pdf

coal economy; the health and retirement security of coal miners and their families; the reclamation and redevelopment of abandoned mine lands; and the deployment of carbon capture and sequestration technology."[201]

Montana was one of 27 states that successfully sued the EPA to stop implementation of the Clean Power Plan (CPP). Following a hold by the Supreme Court, it then sent the case to the U.S. Court of Appeals where it remains until the Trump administration devises a replacement. A report produced for NorthWestern Energy on the economic impacts of implementing the Clean Power Plan in Montana estimates that compliance with the rule will result in the loss of 7,137 jobs by 2025—more than 4,000 of those jobs lost in eastern Montana.[202]

The EPA has proposed a change in the legal interpretation of a section of the Clean Air Act, on which the CPP was based. The change would allow hundreds of U.S. industrial facilities to dramatically increase their emissions of toxic air pollutants that were previously regulated by the Clean Air Act, including arsenic, lead and mercury.[203] Environmental groups are calling the move "among the most dangerous actions that the Trump EPA has taken yet against public health."[204] In April 2018, 14 states, Chicago and Washington D.C., filed a lawsuit that states that federal EPA head Scott Pruitt is violating the methane rule that established limits for methane emissions from existing sources in the oil and natural gas sector.[205]

There are communities throughout the state that are actively working towards a greener economy. EarthJustice attorney Jenny Harbine says that the Northern Cheyenne tribe could be a model for transition towns, such as the Colstrip community.

Rather than continuing coal development on the Northern Cheyenne Indian Reservation, the tribe launched an initiative to invest in the renewable resource of solar

---

201 The White House: Office of the Press Secretary. "Fact Sheet: Administration Announces New Economic and Workforce Development Resources for Coal Communities through POWER Initiative." August 24, 2016. Retrieved from: https://obamawhitehouse.archives.gov/the-press-office/2016/08/24/fact-sheet-administration-announces-new-economic-and-workforce

202 Bureau of Business and Economic Research at the University of Montana. November 2015. "The Economic Implications of Implementing the EPA Clean Power Plan in Montana," pp.4.

203 EPA. "Electric Utility Generating Units: Repealing the Clean Power Plan: Proposal," U.S. Environmental Protection Agency. Last updated February 27, 2018. Retrieved from: https://www.epa.gov/stationary-sources-air-pollution/electric-utility-generating-units-repealing-clean-power-plan-0

204 NRDC. "NRDC: EPA to Allow Greatest Rise of Hazardous Air Pollutants in the U.S. History." January 25, 2018. Retrieved from: https://www.nrdc.org/media/2018/180125-0

205 Flatt, Courtney. "Oregon, Washington Sue EPA Head Over Clean Air Act Violations." *EarthFix.* April 5, 2018. Retrieved from: https://kcts9.org/programs/earthfix/oregon-washington-sue-epa-head-over-alleged-clean-air-act-violations; The document of the filed lawsuit can be accessed at: http://agportal-s3bucket.s3.amazonaws.com/uploadedfiles/Another/News/Press_Releases/NY%20v%20Pruitt%20filed.pdf

energy. Working with SolarCity, a subsidiary company of Tesla, Inc., and students from Penn State, Cheyenne leaders devised an economic stimulus plan that creates jobs with the development of solar energy systems in their community.[206]

"The tribal government isn't clinging to the bygone era of dirty energy, they're aggressively pursuing a future of clean energy and a more sustainable income source for tribal members. If the Northern Cheyenne can do it, so too can the community of Colstrip," said Harbine.

Environmental Remediation in Colstrip

Montana generates approximately 1.8 million tons of coal ash each year.[207] The Colstrip Generating Station produces fine particle ash, which is a combination of soot, heavy metals, sulfur dioxide, and nitrogen oxides.[208] In 1977, the plant installed air pollution scrubbers to reduce its sulfur dioxide output, which have significantly reduced smokestack sulfur dioxide emissions. However, the scrubbers are unable to fully capture all noxious gases generated by the plant, and these pollutants are concentrated downwind.[209]

Fine ash, called fly ash, is mostly caught by air pollution scrubbers in Colstrip's smokestacks. Bottom ash, or waste ash, is the heavy ash particles captured from the incinerator once coal is burned. Waste ash contains several carcinogens and neurotoxins that are damaging to human health, including lead, arsenic, cadmium and boron. Toxic waste ash is often disposed of in open-air pits, where it frequently contaminates groundwater.

Coal ash is not subject to federal protections. The regulation of coal ash in Montana is particularly weak; coal ash is exempt from both the solid waste statutes and Montana's Major Facility Siting Act.[210] Colstrip's plant is the largest source of coal ash in the state. In 2009, the Environmental Protection Agency designated the plant's coal ash ponds as

---

206 Riley, David. "Partnership responds to solar energy opportunity in American Indian Community." *Penn State News.* September 6, 2017. Retrieved from: http://news.psu.edu/story/481080/2017/09/06/academics/partnership-responds-solar-energy-opportunity-american-indian

207 MEIC. "Coal Ash in Montana" Accessed February 2018. Retrieved from: http://meic.org/issues/montana-coal-facts/coal-ash-in-montana/

208 Lombardi, Kristen. "Coal Ash: The hidden story." *The Center for Public Integrity.* February 19, 2009. Retrieved from: https://www.publicintegrity.org/2009/02/19/2942/coal-ash-hidden-story

209 Cates-Carney, Corin. "Settlement Calls for Colstrip Units 1 & 2 To Close By 2022." *Montana Public Radio.* July 12, 2016. Retrieved from: http://mtpr.org/post/settlement-calls-colstrip-units-1-2-close-2022

210 Northern Plains Resource Council. "A Hidden Cost of Coal: Coal Ash in Montana" Accessed February 2018. Retrieved from: https://www.northernplains.org/wp-content/uploads/2013/06/NP-coal-ash-factsheet-FINAL10.19.10.pdf

among the 50 most hazardous in the U.S.[211] Colstrip has nine ash ponds, which have a long history of leaking and contaminating the groundwater with boron, sulfate, and dissolved solids.[212] In Colstrip, the coal ash waste is mixed with water creating a wet sludge, and dumped into 800-acres of coal ash pond waste impoundments—one of the ponds is known to have been leaking toxins into the surrounding groundwater since 1979.[213] An estimated 200 million gallons of ash-contaminated water are leaking into the groundwater of the Colstrip community each year.[214]

In 2003, 57 Colstrip residents sued the plant owners over decades of contaminated groundwater. Extensive monitoring of water wells in Colstrip showed boron levels 13 times above the safe limit.[215] In 2008, Colstrip's owners paid $25 million to settle this lawsuit but did not take steps to prevent the ash impoundments from further leakage.[216]

In 2012, the MEIC, the Sierra Club and the National Wildlife Federation filed a lawsuit against the DEQ and the plant owners for negligence in preventing ash pond contamination. The lawsuit required the plant's operators to pipe water from the Yellowstone river from roughly 30 miles away to the residents of Colstrip to provide safe drinking water.[217] In 2016, the conservation groups reached an agreement with Colstrip's owners, filing a legal settlement that required plant owners to dewater a portion of the waste from Units 3 and 4, converting the coal ash sludge to dry disposal. The conversion of wet to dry ash waste decreases its potential for contamination by 3 to 4 orders of magnitude, according to the EPA.[218] By July 1, 2022, all coal ash waste from the Units must be disposed of as dry waste.[219]

In February 2018, the environmental watchdog group EarthJustice warned Montana's Department of Environmental Quality about Talen Energy's submitted cleanup plans.

---

211 The listing cited the ash pond's common failure to prevent groundwater contamination and pollute the water of the residents living nearby with a toxic concentration of lead, arsenic, boron and other chemicals.
212 Keller, Sarah Jane. "EPA may finally look at coal ash regulation, much needed in Montana." *High Country News.* March 17, 2014. Retrieved from: https://www.hcn.org/blogs/goat/the-feds-will-finally-look-at-coal-ash-regulation-a-major-mess-in-montana-shows-why-its-needed
213 *Ibid.*
214 Brown, Matthew and Sarah Rankin. "Evidence of groundwater contamination found at U.S. coal-burning plants, data shows." The Billings Gazette. March 2, 2018. Retrieved from: http://billingsgazette.com/news/state-and-regional/evidence-of-groundwater-contamination-found-at-u-s-coal-burning/article_728fedc8-3bf8-5cd4-8f30-c38a78744faf.html
215 Bass, Rick. "Montanans fear coal's residues more than its role in disputing Earth's climate." *Sierra Club Magazine.* March/April 2010. Retrieved online at: http://vault.sierraclub.org/sierra/201003/coal.aspx
216 EarthJustice. "After Decades of Polluting Water, Colstrip Plant to Address Leaking Coal Ash Ponds." July 21, 2016. Retrieved from: https://earthjustice.org/news/press/2016/after-decades-of-polluting-water-colstrip-plant-to-address-leaking-coal-ash-ponds
217 Puckett, Karl. "Colstrip deal hailed as 'significant victory' for environment." *Great Falls Tribune.* July 21, 2016. Retrieved from: https://www.greatfallstribune.com/story/news/local/2016/07/21/settlement-reached-control-colstrip-coal-ash-pollution/87398118/
218 EarthJustice. "After Decades of Polluting Water, Colstrip Plant to Address Leaking Coal Ash Ponds."
219 *Ibid*.

Talen reduced the time and money allocated to the cleanup of ponds containing toxic coal ash. EarthJustice, the Montana Environmental Information Center, and the Sierra Club all contend that Talen's latest proposal will leave toxins in Colstrip's groundwater. The plan will allow contaminated pond water to drain into the ground before capping over the area and adding additional ash. These concerns come after previous lawsuits over groundwater contamination from Colstrip's ash ponds.

According to Anne Hedges, Deputy Director and Lead Lobbyist at the Montana Environmental Information Center (MEIC), the biggest obstacle to adequate remediation work is that the state doesn't have enough resources to keep up with Talen's shifting plans.[220]

In 2018, Talen will start dewatering the approximately 800 acres of ash ponds and then dry store the ash. Talen will de-water the bottom ash by the end of December 2018 and begin dry ash storage in 2019.[221] Capping the ponds is estimated to cost more than $113 million with an projected end date of 2049.[222]

In December 2017, the Westmoreland Coal Company applied for a permit to expand the Rosebud Mine by another 6,700 acres. Westmoreland is currently facing a financial crisis; the company lost 93 percent of its stock value last year.[223] In the 40 years of its operation, only 2.4 percent of the Rosebud coal mine has been reclaimed from environmental degradation.[224]

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), more commonly known as Superfund, provides funding for the EPA to clean up contaminated industrial sites that exist due to the dumping or improper disposal of hazardous materials. Goals of the Superfund program include protecting human health and the environment, making responsible parties pay for cleanup work, involving local communities in the Superfund process, and returning Superfund sites to

---

220 Anne Hedges, Personal Interview. Missoula, Montana. February 26, 2018.

221 Lutey, Tom. "Cleanup of toxic coal ash that contaminated Colstrip groundwater begins." *Billings Gazette.* January 11, 2018. Retrieved from: http://billingsgazette.com/news/government-and-politics/cleanup-of-toxic-coal-ash-that-contaminated-colstrip-groundwater-begins/article_b04a0671-0e10-5162-bb67-08e11bd994f0.html

222 Lutey, Tom. "Plan to clean up Colstrip ash ponds leaves several tasks undone, environmental group says." *Billings Gazette*. February 6, 2018. Retrieved from: http://billingsgazette.com/news/state-and-regional/montana/plan-to-clean-up-colstrip-ash-ponds-leaves-several-tasks/article_0bd4212d-df00-5bbc-896f-b03e4d3640b5.html#tracking-source=home-top-story

223 Whitney, Eric. "Interior's Misstatement on Montana Coal Mine Leads to Small 'Market Sensation.'" *Montana Public Radio.* January 3, 2018. Retrieved from: http://mtpr.org/post/interiors-misstatement-montana-coal-mine-leads-small-market-sensation

224 Institute for Energy Economics and Financial Analysis (IEEFA). "Westmoreland Coal, Teetering Near Bankruptcy, Wants Montana to Let it Build a Bigger Mine." March 2, 2018. Retrieved from: http://ieefa.org/westmoreland-coal-teetering-near-bankruptcy-wants-montana-let-build-bigger-mine/

productive use.[225] Montana currently has over 15 Superfund sites that have been determined to pose real threat to human and environmental health.[226] With its high production of toxic waste ash and a history of groundwater contamination, environmental groups deem it likely that Colstrip will become one of the state's future Superfund sites.

Montana's Post-Colstrip Closure Plan

Several third parties are calling for Montana legislators to establish an economic plan for transitioning Colstrip workers and community members in the closure of Colstrip. As there is no policy framework to guide the transition of coal-fired power plant closures, planning for a socially and environmentally-just transition is up to local and state leadership. One of the primary concerns of the transition is the cleanup of Colstrip's land and water from coal-related environmental contaminants.

Mike Scott, who works on energy issues for the Montana chapter of the Sierra Club, believes that responsibility for funding the transition should fall on utility companies. "These utilities have made a lot of money off of Colstrip. They owe that community something as they leave it,"[227] Scott said.

Scott notes the lack of legislation mandating the cleanup of environmental pollutants from the power plant. "How are we going to maintain a community that's essentially a Superfund site?"

Several conservation groups including NRDC, MEIC, Renewable Northwest, the Sierra Club, and NW Energy Coalition are advocating for the transition to include a strong emphasis on remediation and reclamation.

Montana's Department of Environmental Quality is overseeing cleanup of the plant. In August 2017, Talen Energy submitted to the DEQ an estimate that capping the Colstrip plant's toxic coal ash ponds will cost $138 million. The ash ponds are responsible for an estimated 200 million gallons of contaminated water that drains into Colstrip's groundwater supply each year. Capping the ash ponds is expected to be the cheapest step in a three-stage cleanup plan. Talen's plan does not include removal of the coal ash sludge—a byproduct that contains lead, arsenic, and boron among other toxins. As

---

225 U.S. EPA. "What is Superfund?" Accessed May 2018. Retrieved from: https://www.epa.gov/superfund/what-superfund
226 U.S. EPA. "Superfund Sites in Region 8: Montana." Retrieved from: https://www.epa.gov/region8/superfund-sites-region-8
227 Mike Scott, Personal Interview. Missoula, Montana. September 2017.

capping liners have leaked in the past in Colstrip, the plan leaves the risk of future groundwater contamination.[228]

The Montana Legislature passed the Coal-Fired Generating Unit Remediation Act in 2017 (SB 339), which requires the owner of a coal-fired generating unit to submit, review and approve a remediation plan and send to the DEQ within 90 days of plant retirement.[229] A May 2017 report titled the "Colstrip Economic Diversification Strategy" by the Southeastern Montana Development Corporation provides strategies for repurposing existing industrial infrastructure and diversifying Colstrip's economic opportunities.[230]

Anne Hedges of MEIC is not impressed with the composition of the Colstrip Community Impact Advisory Group, which will advise the allocation of the $10 million from PSE for Colstrip. The advisory group has only one member with a background in economic development. It has no members with an expertise in renewable energy development.

"They have a tough task because they don't have the knowledge they need in the room —that's a real lost opportunity," said Hedges.

EarthJustice attorney Jenny Harbine says that it remains possible that the DEQ requires vigorous cleanup on a reasonable timeframe. A more aggressive cleanup plan won't necessarily push the plant into earlier retirement and could bring unforeseen economic benefits to the Colstrip community.

"It could bring more jobs and income to the region as it faces a loss of income from a scaled back, and eventually retired, operations of the plant and mine," said Harbine.

Anne Hedges of MEIC also emphasizes the economic potential in environmental remediation efforts. "These are jobs that people that live out there now could be retrained to do—it's familiar work for them," said Hedges.

Social, Economic, and Environmental Impacts on Montana

---

228 Lutey, Tom. "Capping Colstrip ash ponds will cost $138M, Talen Energy estimates." *Billings Gazette.* August 15, 2017. Retrieved from: http://billingsgazette.com/news/government-and-politics/colstrip-ash-pond-cleanup-will-cost-m-talen-energy-estimates/article_a27ec367-0696-5c65-924b-ebc0b141b279.html
229 Haggerty, Mark. "The Context and Status of Colstrip's Coal-Fired Power Plant." *Headwaters Economics*. July 2017. Retrieved from: https://headwaterseconomics.org/energy/coal/colstrips-coal-fired-power-plant/
230 City of Colstrip and Southeastern Montana Development Corporation (SEMDC). "Colstrip Economic Diversification Strategy." May 2017. Retrieved from: http://semdc.org/wp-content/uploads/2016/12/Colstrip-Econ-Diversification-Report-Reduced-Size.pdf

While the social, economic, and environmental impacts of closing Colstrip will directly affect the Colstrip community, those impacts will reverberate throughout the entire state of Montana. The plant's closure will prevent future pollution caused by coal ash waste that has contaminated the air and groundwater of Colstrip's surrounding communities for decades—allowing both ecological and human populations a higher potential to heal. The plant's closure will mean the loss of hundreds of jobs for electrical and mining operations, however, this is an opportunity to implement large-scale worker retraining programs for long-term careers in the renewable energy industry.

The demand for coal-powered electricity from the Colstrip Power Plant is quickly plummeting, as Montana's neighboring states continue to ramp up investments in renewable energy. Powerful renewable energy legislation recently passed in both Oregon and Washington is requiring the owners of the Colstrip plant to comply with higher renewable energy-based portfolio standards. As the plant's largest customers shift their energy profiles towards renewable energy, the expected closure for all four units is 2027, if not sooner.

Montana is facing a monumental decision on the future of its social, environmental and economic welfare. It is time to move beyond the outdated, volatile, and high-polluting technology of coal-fired energy, and invest in the more economically and environmentally-stable systems of renewable energy. This transition will provide immediate social and economic benefits for the town of Colstrip, as well as a cleaner, safer and more economically-robust future for generations of Montanans to come.

Part 4: Literature Review on the Economic and Social Benefits of Renewable Energy

This is a brief overview of the academic literature on global and domestic economic market trends and the social benefits of transitioning communities to renewable energy, focused on wind and solar energy technologies. As this paper intends to present the most compelling evidence on the benefits of investing in renewable energy, it draws primarily from energy industry and policy expert-driven data. Thus, this section is a non-exhaustive review of the academic literature on the economics of renewable energy and contains some overlap of non-academic sources. Due to the rapidly changing nature of global energy markets, this section only discusses literature from 2010 on; the most relevant information is that produced most recent to the publication of this paper. For more current data on the economics of renewable energy in the U.S., refer to section 2 of this report.

Global Energy Market Trends

Around the world, renewable energy (RE) is proving to be a technologically viable, economically beneficial replacement for fossil-fuel based electricity generation. As the global population climbs towards the projected 9.8 billion by 2050,[231] and devastating effects of climate change continue to escalate, a quick transition to a net zero-emission economy becomes increasingly urgent. World primary energy demand is projected to reach 16.5 billion tons of oil equivalents (toe) in 2030.[232] Fortunately, these demands can already be met with the existing RE technology and generation capacity.[233] Energy experts estimate that solar energy can fulfill roughly 1000 times the global energy requirement, yet less than 0.05 percent of this energy is currently employed.[234]

As energy demand increases at a rate directly proportional to economic growth, developing countries must especially prepare for installed generation capacity to meet exponentially growing energy needs.[235] The advancement of RE technologies is making large-scale deployment of clean energy increasingly possible within centralized energy networks. In 2016, RE accounted for nearly two-thirds of global net new power capacity, with the addition of 165 GW.[236] Solar PV accounted for about 47 percent of that total, wind power at 34 percent, and hydropower at 15.5 percent.[237]

As a cheap and abundant source of energy with minimal environmental and ecological hazards associated with its production, solar energy is one of the fastest growing energy sources worldwide.[238] The amount of solar energy technical potential far exceeds total global energy demand.[239] Several economic factors are contributing to the growing

---

231 United Nations. 2017. "World Population Prospects 2017" Retrieved from: https://esa.un.org/unpd/wpp/

232 Solangi, K.H., Islam, M.R., Saidur, R., Rahim, N.A., and H. Fayaz. 2011. "A review on global solar energy policy" *Renewable and Sustainable Energy Reviews* 15: 2149-2163. Retrieved from: https://ac.els-cdn.com/S1364032111000220/1-s2.0-S1364032111000220-main.pdf?_tid=a4d6d332-1994-11e8-9557-00000aab0f6b&acdnat=1519498865_e0c6f28bbfc3356477e9a03fc2cb56d7

233 Edenhofer, O. et al. 2011. "Renewable Energy Sources and Climate Change Mitigation: Summary for Policymakers and Technical Summary" IPCC. Retrieved from: https://www.ipcc.ch/pdf/special-reports/srren/SRREN_FD_SPM_final.pdf

234 Xia, X. and J. Xia. 2010. "Evaluation of potential for developing renewable sources of energy to facilitate development in developing countries." In Proceedings of the Asia-Pacific power and energy engineering conference. Chengdu, China, p.1-3.

235 Devabhaktuni, V. et al. 2013. "Solar energy: Trends and enabling technologies." *Renewable and Sustainable Energy Reviews.* 19: 555-564. Retrieved from: https://www.sciencedirect.com/science/article/pii/S1364032112006363

236 International Energy Agency. "Renewables 2017." Accessed March 2017. Retrieved from: https://www.iea.org/publications/renewables2017/

237 Renewable Energy Policy Network (REN21). "Renewables 2017 Global Status Report" Retrieved from: http://www.ren21.net/wp-content/uploads/2017/06/17-8399_GSR_2017_Full_Report_0621_Opt.pdf

238 *Ibid.*

239 Timilsina, G.R., Kurdgelashvili, L. and Patrick A. Narbel. 2012. "Solar energy: Markets, economics and policies." *Renewable and Sustainable Energy Reviews*, 16(1): 449-465. Retrieved from:

popularity of solar energy deployment, including more favorable renewable energy policies, quickly diminishing RE technology costs, and the increased volatility of fossil fuel prices. Additionally, solar energy is a highly viable resource for many developing countries, as they are often located in regions with above average solar radiation.[240]

Advances in technology and economies of scale for manufacturing of solar components are contributing to steady declines in the cost of implementing solar energy systems. Early solar technology consisted of small-scale photovoltaic (PV) cells, but current technologies include solar concentrated power (CSP) and large-scale PV systems that feed into electricity grids.[241] Small-scale solar systems are part of distributed energy resources (DER) systems, which allow customers greater control of their electricity usage and to meet energy needs while living off the centralized grid.[242] DER technologies also include wind turbines, fuel cells, microturbines and energy storage systems, and generally produce less than 10 MW of power.[243] Large-scale PV and CSP technologies, however, can compete with conventional energy resources that do serve the centralized grid, including natural gas, oil, and coal.

Wind energy ranks second only to hydroelectric power for renewable energy sources in terms of installed capacity worldwide. Wind power is especially important in developing countries, as it can be installed and transmitted rapidly—even in remote and hilly areas.[244] The global potential for wind energy is estimated to be 26,000 TWh/yr.[245]

In March 2017, the U.S. hit a RE milestone with 10 percent of the total monthly electricity in the nation generated from wind and solar energy.[246] In 2016, the U.S. was the second highest producer of wind power globally (behind China), and has the fourth

---

https://ac.els-cdn.com/S1364032111004199/1-s2.0-S1364032111004199-main.pdf?_tid=319bbf50-0dea-4e97-915e-6d6dfc83e24c&acdnat=1521823776_eb8cae12c2fd34aad279a0b040feb577

240 For example, the highest annual average solar resource is found in the Red Sea area of the globe with 300 W/m², compared to the average U.S. solar resource of 185 W/m². Source: World Energy Council. "World Energy Resources: Solar." 2013. Retrieved from: https://www.worldenergy.org/wp-content/uploads/2013/10/WER_2013_8_Solar_revised.pdf

241 Panwar, N.L., Kaushik, S.C., and Surendra Kothari. 2011. "Role of renewable energy sources in environmental protection: A review" *Renewable and Sustainable Energy Reviews* 15: 1513-1524. Retrieved from: https://ac.els-cdn.com/S1364032110004065/1-s2.0-S1364032110004065-main.pdf?_tid=5f63c401-c22a-4352-b205-40da3c7149e7&acdnat=1521739746_b7207988845b7ccaf6a686d2e59fecdb

242 NREL. 2002. "Using Distributed Energy Resources: A How-To Guide for Federal Facility Managers." U.S. Department of Energy. Retrieved from: https://www.nrel.gov/docs/fy02osti/31570.pdf

243 Timilsina et al. 2012. "Solar energy: Markets, economics and policies."

244 Panwar et al. 2011. "Role of renewable energy sources in environmental protection: A review."

245 *Ibid.*

246 Renewable Energy Policy Network (REN21). "Renewables 2017 Global Status Report"

greatest total PV installed capacity.[247] While it currently holds second-largest growth market for RE, the U.S. has still only tapped a fraction of its RE potential.[248]

The increasingly favorable economics of RE technology coupled with a growing effort to reduce fossil fuel emissions is prompting greater global investment in renewable energy. Not only is RE more cost effective than fossil fuels in the long-term economy, both solar and wind are major job-generating industries. Economists assert that global investment in energy security, environmental protection and remediation could generate more jobs than stimuli to consumer spending.[249]

Global energy policy is based on several factors, including legislation, international treaties, and economic incentives to invest. The full economic potential of RE has yet to be determined, as it is a complex function of public policy objectives, including a multitude of social and environmental costs, benefits, co-benefits[250] and externalities.[251] Economic analyses that compare renewable energy technologies with conventional systems are inconsistent from year-to-year, as fuel costs are highly volatile and the capital costs of renewable technologies continue to drop.[252]

In economic terms, the economic potential of a given technology is known as the welfare-optimal deployment level. Calculating the welfare-optimal benchmark requires an investigation of externalities, market failures and policy instruments using numerical integrated assessment models (IAMs). Yet globally, policymakers lack a consistent framework for assessing an optimal RE policy in terms of the social and ecological costs and benefits.[253] While the world remains without a comprehensive valuation method for RE, numerous studies demonstrate a positive correlation between RE investment and economic growth.[254] One evaluation revealed both long and short-term bidirectional

---

247 In 2016, China had the greatest total solar PV installed capacity with , followed by Japan and Germany.

248 International Energy Agency. “Renewables 2017.”

249 Jackson, Tim. 2011. “Prosperity Without Growth: Economics for a Finite Planet,” *Energy & Environment*, 22(7): 1013-1016. Retrieved from: http://journals.sagepub.com/doi/pdf/10.1260/0958-305X.22.7.1013

250 The concept of ‘co-benefits’ has become increasingly popular in both academic and policy-oriented scientific writing that addresses both environmental and development goals. Co-benefits are defined by the IPCC as “the positive effects that a policy or measure aimed at one objective might have on other objectives, irrespective of the net effect on on overall social welfare.” Source: IPCC. 2014. “Climate Change 2014: Mitigation of Climate Change.” *Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Retrieved from: http://www.ipcc.ch/report/ar5/wg3/

251 Edenhofer, O. et al. 2013. “On the economics of renewable energy sources.” Energy Economics, 40(1): S12-S23. Retrieved from: https://www.sciencedirect.com/science/article/pii/S0140988313002107#bb0165

252 Timilsina et al. 2012. “Solar energy: Markets, economics and policies.”

253 Edenhofer, O. et al. 2013. “On the economics of renewable energy sources.”

254 Apergis, Nicholas and James E. Payne. 2010. “Renewable energy consumption and economic growth: Evidence from a panel of OECD countries.” Energy Policy, 38(1): 656-660. Retrieved from:

causality between renewable energy consumption and economic growth for 20 OECD countries from 1985 to 2005.[255]

U.S. Energy Market Trends

The influence and impacts of Western-style consumerism, in conjunction with a stalled transition from fossil fuel-sourced electricity to a RE-generated electrical grid, continues to plague the U.S. In 2017, the U.S. was the second-largest GHG emitter in the world (behind China), contributing 14.36 percent of global emissions. By far the greatest proportion of U.S. emissions comes from the energy sector, with 12.56 percent of global emissions.[256]

Shifting federal government priorities over the last three decades have created inconsistent trends in U.S. energy conservation and efficiency policies, including those on energy security and the need to reduce energy imports, environmental protection and remediation, and RE productivity and job creation.[257] Yet a major distinction of the U.S. energy market separates its operationalization from that of other nations: it is primarily regulated at the state level rather than at a fully national scale. Thus each state creates its own distinct RE market, making state-to-state or even state-to-country RE development analysis generally more useful than assessing federal U.S. RE policy on its own.[258]

However, one consistent national RE trend is the increase in "Sustainable, Responsible and Impact Investing" (SRI) over the past decade. SRI is an investment practice that meets certain environmental, social and corporate governance (ESG) criteria for both long-term financial returns and positive societal impact.[259] Examples of such criteria includes water use and conservation, positive labor relations, and corporate board diversity and independence.[260] SRI practitioners include individuals who invest in mutual funds, credit unions and community development banks, foundations, religious institutions, venture capitalists, pension funds, nonprofit organizations and universities.

---

https://www.sciencedirect.com/science/article/pii/S0301421509006752

255 Apergis, Nicholas and James E. Payne. 2010. "Renewable energy consumption and economic growth: Evidence from a panel of OECD countries."

256 Friedrich, J., Ge, M. and Andrew Pickens. "This Interactive Chart Explains World's Top 10 Emitters, and How They've Changed." *World Resources Institute.* April 11, 2017. Retrieved from: http://www.wri.org/blog/2017/04/interactive-chart-explains-worlds-top-10-emitters-and-how-theyve-changed

257 Dixon, R.K., McGowan, E., Onysko, G., and Richard M. Scheer. 2010. "US energy conservation and efficiency policies: Challenges and opportunities." *Energy Policy*, 38(11): 6398-6408.

258 Burns, John Edward and Jin-Su Kang. 2012. "Comparative economic analysis of supporting policies for residential solar PV in the United States: Solar Renewable ENergy Credit (SREC) potential." *Energy Policy*, 44: 217-225. Retrieved from: https://www.sciencedirect.com/science/article/pii/S0301421512000717

259 U.S. SIF. "SRI Basics" Accessed April 2018. Retrieved from: https://www.ussif.org/sribasics

260 *Ibid.*

In 2016, U.S. SRI reached a record $8.72 trillion, increasing at a growth rate of more than 33 percent since 2014, when SRI was $6.57 trillion.[261] Private investments are now the largest source of capital for renewable energy projects.[262]

Economic Tools and Strategies to Promote RE

The U.S. energy marketplace remains tipped in the favor of fossil fuel industries. According to Oil Change International, the U.S. spends $20.5 billion per year on fossil fuel exploration and production subsidies.[263] A report by the Environmental Law Institute stated that between 2002 and 2008, federal subsidies for fossil fuels reached approximately $72 billion, whereas subsidies for RE totaled $29 billion over the same period.[264] U.S. taxpayers are also funding fossil fuel research and development, mining, drilling, and electricity generation. However, certain economic mechanisms are currently working to improve the cost effectiveness of RE. By expanding these economic tools and policies that benefit RE development, the U.S. could become the leading country in the global green economy.

Renewable portfolio standard (RPS): The RPS is one of the most common state-level policy instruments for ensuring that a minimum amount of renewable energy is included in the portfolio of electricity-generating energy sources serving the state. RPS policies generally require that amount to increase over time, with the aim to increase reliability, diversity, and the social and environmental benefits of the overall energy mix.[265] Utilities in 38 states and Washington D.C. are currently under a RPS, typically requiring that at least 20 percent of their energy is generated from renewable sources.[266] While sharing several fundamental components, RPS policies vary significantly across states, making econometric analyses of their effectiveness difficult to measure.[267] For example, some states have included partial exemptions in meeting RPS requirements

261 *Ibid.*

262 Wüstenhagen, Rolf and Emanuela Menichetti. 2012. "Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research." *Energy Policy*, 40:1-10. Retrieved from: https://www.sciencedirect.com/science/article/pii/S0301421511005064

263 Oil Change International. 2018. "Fossil Fuel Subsidies: Overview." Retrieved from: http://priceofoil.org/fossil-fuel-subsidies/

264 Adeyeye, A., Barrett, J., Diamond, J., Goldman, L., Pendergrass, J. and Daniel Schramm. September 2009. "Estimating U.S. Government Subsidies to Energy Sources: 2002-2008." Retrieved from: https://www.eli.org/research-report/estimating-us-government-subsidies-energy-sources-2002-2008

265 Yin, Haitao and Nicholas Powers. 2010. "Do state renewable portfolio standards promote in-state renewable generation?" *Energy Policy*, 38(2): 1140-1149. Retrieved from: https://www.sciencedirect.com/science/article/pii/S0301421509008283

266 SEIA. "Renewable Energy Standards." Accessed April 2018. Retrieved from: https://www.seia.org/initiatives/renewable-energy-standards

267 Hongtao, Y. and Richard C. Feiock. 2012. "Policy Tool Interactions and the Adoption of State Renewable Portfolio Standards." Review of Policy Research, 29(2): 193-206. Retrieved from: https://www.researchgate.net/profile/Hongtao_Yi/publication/254394510_Policy_Tool_Interactions_and_the_Adoption_of_State_Renewable_Portfolio_Standards/links/59b176f5458515a5b4893566/Policy-Tool-Interactions-and-the-Adoption-of-State-Renewable-Portfolio-Standards.pdf

for individual or certain classes of utilities.[268] Additionally, some states only count electrical generation from new assets, while others allow generation from all existing units to count towards the RPS policy. As discrepancies between state-to-state RPS policies present a challenge for assessing overall effectiveness of the mechanism in incentivizing a shift from fossil fuels to RE-generated electricity, studies indicate that, on average, they do have a significant and positive effect for RE development.[269]

Production tax credits: In 1978, the first investment tax credits (ITC) were established for renewable energy technologies in the U.S. The 1978 Energy Tax Act provided residential tax credits for 30 percent of the initial $2000 invested in wind or solar systems, with additional 20 percent for the next $8000.[270] It was also the first policy to provide business tax credits for RE investment. Shifting federal priorities on energy development have altered the distribution of tax credits over the past three decades. Currently, a personal income tax credit is given at the federal level, while state and local governments provide various RE-targeted tax incentives including tax exemptions, deductions and credits.[271] The Residential Renewable Energy Tax Credit is the federal, non-refundable personal tax credit which only applies to residential RE systems. Different states have adopted Solar Renewable Energy Credits (SRECs) to assign monetary values for every megawatt-hour of solar energy produced in a given energy year.[272] The SREC value is determined by market supply and demand constraints and in general declines each year as more solar power is installed within the state. As of 2018, six states and Washington D.C. have active SRECs.

PURPA: The Public Utility Regulatory Policies Act adopted in 1978. PURPA required utilities to purchase renewable electricity from qualified independent generators over long-term contracts. PURPA payments were based on the avoided cost of generating electricity from conventional sources; from 1981 to 1990 approximately 12,000 MW of renewable energy was installed under this policy.[273] The substantial drop in the price in oil and natural gas in the 1990s made that avoided cost too low for renewable energy to

---

268 In Montana, the RPS is only required for investor-owned utilities, which only generate 45 percent of in-state electricity. Source: Yin, Haitao and Nicholas Powers. 2010. “Do state renewable portfolio standards promote in-state renewable generation?”

269 National Renewable Energy Laboratory. “Renewable Portfolio Standards: Understanding Costs and Benefits.” Accessed April 2018. Retrieved from: https://www.nrel.gov/analysis/rps.html

270 Solangi, K.H., Islam, M.R., Saidur, R., Rahim, N.A., and H. Fayaz. 2011. “A review on global solar energy policy.” *Renewable and Sustainable Energy Reviews*, 15: 2149-2163. Retrieved from: http://wgbis.ces.iisc.ernet.in/biodiversity/sahyadri_enews/newsletter/issue45/bibliography/A%20review%20on%20global%20solar%20energy%20policy.pdf

271 Burns, John Edward and Jin-Su Kang. 2012. “Comparative economic analysis of supporting policies for residential solar PV in the United States: Solar Renewable ENergy Credit (SREC) potential.”

272 *Ibid.*

273 Solangi, K.H., Islam, M.R., Saidur, R., Rahim, N.A., and H. Fayaz. 2011. “A review on global solar energy policy.”

compete; the limitations of PURPA resulted in further development of renewable energy policy incentives.

Feed-in tariff (FIT): FITs are considered one of the most effective government incentive programs for stimulating the rapid development of renewable technology.[274] The basis of these policies are guaranteed prices for fixed periods of time for RE-generated electricity, which can be differentiated for a variety of factors such as type of technology, the size of installation, the quality of the resource, and project location. The most successful FIT programs are those which determine payment levels that are most closely correlated to specific generation costs, and enable efficiently operated RE systems to be developed cost-effectively.[275] FITS are more prevalent in European energy markets, as states in the U.S. typically pass other forms of economic policies to incentivize residential RE growth.[276]

Numerous studies indicate that on the residential consumer level, energy tax deductions and subsidies are among the most effective incentives to adopt renewable energy sources.[277] Following those, the third greatest incentive is a price doubling of conventional energy sources.[278] Household economic profiles and perceived maintenance cost of RE are also statistically significant factors that positively affect consumer willingness to adopt RE.[279]

Economic Challenges for RE Expansion in the U.S.

While shifting conventional fossil fuel-based systems to RE-generated electricity is a long-term energy efficient and cost-effective decision for local communities, certain

---

274 Solangi et al. 2011, p.2153; Couture, Toby and Yves Gagnon. 2010. "An analysis of feed-in tariff remuneration models: Implications for renewable energy investment." *Energy Policy*, 38: 955-965. Retrieved from: http://www.mresearch.com/pdfs/docket4185/NG11/doc15.pdf

275 Couture, Toby and Yves Gagnon. 2010. "An analysis of feed-in tariff remuneration models: Implications for renewable energy investment."; Klein, A. Held, A., Ragwitz, M. and Faber, T. 2008. "Evaluation of Different Feed-In Tariff Design Options: Best Practice Paper for the International Feed-In Cooperation." *Energy Economics Group & Fraunhofer Institute Systems and Innovation Research*

276 Burns, John Edward and Jin-Su Kang. 2012. "Comparative economic analysis of supporting policies for residential solar PV in the United States: Solar Renewable ENergy Credit (SREC) potential."

277 Roe, B., Teisl, M.F., Levy, A., and Matthew Russell. 2001. "US consumers' willingness to pay for green electricity." *Energy Policy*, 29(11):917-925. Retrieved from: https://www.sciencedirect.com/science/article/pii/S0301421501000064; Sardianou, E. and P. Genoudi. 2013. "Which factors affect the willingness of consumers to adopt renewable energies?" *Renewable Energy*, 57: 1-4. Retrieved from: https://www.sciencedirect.com/science/article/pii/S0960148113000694; Schelly, Chelsea. 2014. "Residential solar electricity adoption: What motivates, and what matters? A case study of early adopters." Energy Research & Social Science, 2: 183-191. Retrieved from: https://www.sciencedirect.com/science/article/pii/S2214629614000024;

278 Sardianou, E. and P. Genoudi. 2013. "Which factors affect the willingness of consumers to adopt renewable energies?"

279 *Ibid.*

economic obstacles remain. Some challenges are inherent with new technologies, while others are due to a highly skewed regulatory framework and marketplace.[280]

The upfront expenses, or capital costs, of building and installing solar and wind are the most commonly-cited barrier to greater RE investment. Higher construction costs can contribute to financial institutions lending money at higher rates, making it harder for utilities to justify initial investments. Additionally, wind and solar often operate on a decentralized energy model—in which smaller generating sources working together to provide power are spread throughout a larger area. While decentralization of energy sources increases grid resiliency, it presents cost barriers related to siting and transmission. Siting costs can include negotiations, contracts, permits and the organizing of community discussion. As the majority of existing power lines were built to transmit fossil fuel-based electricity to its consumers, updates to transmission infrastructure are required to take advantage of RE-generated electricity.

Yet, when the costs of energy projects are considered over their entire lifespan, wind and utility-scale solar are among the least expensive energy generating sources.[281]Renewable energy is competing with well-established, wealthy, and politically-powerful fossil fuel industries that have existing infrastructure and policy on their side. New energy technologies must prove their worth by demonstrating the ability to scale, as most investors are looking for large, reliable sources of energy. The inherent intermittency of wind and solar resources are one challenge in convincing utilities to shift their energy sourcing to renewables, yet energy experts contend that solar and wind resource availability is in fact highly predictable.[282] Thus, greater government intervention in RE policy is likely necessary to convince utilities to make the shift from conventional fuel sources to RE. Increased government investment in subsidies, loan assistance, and energy storage development would certainly help to even the energy industry playing field.

Transition Towns: The Social and Economic Benefits

Started in Totnes, England in 2005, the Transition Town Network (TTN) is arguably the strongest social movement of the 21st century for community-controlled renewable energy systems. The movement is self-described as a "community-led response to the

---

280 Negro, S., Alkemade, F., and Marko Hekkert. 2012. "Why does renewable energy diffuse so slowly? A review of innovation system problems," *Renewable and Sustainable Energy Reviews,* 16(6):3836-3846. Retrieved from: https://www.sciencedirect.com/science/article/pii/S1364032112002262

281 IRENA. "Renewable Power Generation Costs in 2017." 2017. Retrieved from: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_2017_Power_Costs_2018.pdf

282 Krakauer, Nir Y. and Daniel S. Cohan. 2017. "Interannual Variability and Seasonal Predictability of Wind and Solar Resources," Resources, 6(3): 29-43. Retrieved from: http://www.mdpi.com/2079-9276/6/3/29

pressures of climate change," and seeks out innovative energy solutions to liberate communities from their dependence on fossil fuels.[283] The Transition Handbook is a manual that provides a program framework to help communities organize initial efforts for a transition.

Though urban cities have also joined the movement, TTN first emerged as a response of rural and semi-rural communities to the concept of Peak Oil and the growing devastation of climate change on small, agricultural regions.[284] Rooted in the principles of permaculture, TTN approaches community-devised energy transitions with a strong consideration of socio-ecological systems.[285] Drawing from permaculture design ethics, TTN communities work to deliberately devise an energy system that accommodates the surrounding natural environment, based on various bioregional factors. While objectives such as reducing carbon emissions and increasing energy security are integral to TTN initiatives, they are not the end goal. Rather, TTN is primarily concerned with enhancing 'community resilience'—taking a collective, rather than individual, approach to living more closely and connected to geographical and ecological place.[286]

Transition culture interacts as a hybrid of social, economic and environmental movements, seeking to establish community-based energy systems that ensure the long-term prosperity of both humans and environment. The TTN provides a basic framework for rural communities to transition from energy dependence on centralized, fossil fuel-based energy systems to localized, community-planned RE systems. As the concept 'community' is strongly emphasized in the TTN and also connected to location, it is up to the residents of a place to initiate a community-based transition that best serves their specific social, economic and ecological needs.

Another public-led renewable energy project development concept is known as community renewable energy (CRE). Similar to the TTN, CRE systems are created with intentions to produce local and collective social and economic benefits.[287] Whereas traditional energy systems are dominated by centralized generation and one-way

---

283 Aiken, Gerald. 2012. "Community Transitions to Low Carbon Futures in the Transition Towns Network (TTN)." *Geography Compass*, 6(2): 89-99. Retrieved from: https://orbilu.uni.lu/bitstream/10993/17297/1/Aiken%20(2012).pdf

284 Neal, Sarah. 2013. "Transition culture: Politics, localities and ruralities" *Journal of Rural Studies*, 32: 60-69. Retrieved from: https://ac.els-cdn.com/S0743016713000272/1-s2.0-S0743016713000272-main.pdf?_tid=bcb13c42-1332-444d-aef6-f415fb8fab58&acdnat=1522526430_23f25a851ff9a836a3ee42bc7f3db259

285 Aiken, Gerald. 2012. "Community Transitions to Low Carbon Futures in the Transition Towns Network (TTN)."

286 *Ibid*, p.93.

287 Rogers, J.C., Simmons, E.A., Convery, I., and Andrew Weatherall. 2012. "Social impacts of community renewable energy projects: findings from a woodfuel case study." *Energy Policy*, 42: 239-247. Retrieved from: https://ac.els-cdn.com/S0301421511009797/1-s2.0-S0301421511009797-main.pdf?_tid=4e866251-dfc8-4331-a1f1-948df64ba659&acdnat=1521825362_a187e1dbaa9b143cb0a04751f721ccef

supply, CRE projects offer opportunities for the public to directly interact with and invest in energy production systems. Rather than taking a passive role to energy generation, CRE allows citizens to take part in each step of building a renewable energy system--such as the organizing, financing and installation of system equipment.

Due to the relative newness of CRE opportunities, research on the social benefits remains limited. However, several case studies suggest positive correlations between interaction with RE technologies and other environmentally sustainable behaviors, as well a greater understanding of energy efficiency and increased energy awareness.[288]

Part 5: Suggestions for 350 Montana, Options for the Future

350 Montana is among the leading organizations in the powerful and diverse global grassroots movement to reverse climate change. As tireless advocates for the transition from the current destructive energy system to one based entirely on clean, renewable resources, it is impossible to measure the value of their work for the benefit of humanity and the planet. 350 Montana has engaged the public in numerous campaigns to put an end to the production of GHG emitting, coal-fired energy, and continues to collaborate with several other environmental organizations, energy policy experts, renewable energy stakeholders, and local residents. Yet this hyper-polarized political time calls for even greater collaboration across ideological and community lines.

We cannot achieve a future of climate stability and resilience under the current level of political support. It is up to leaders of the climate justice movement to find more effective ways of communicating with opposing voices and find a values-based common ground on which to build a more climate-resilient and community-oriented energy system.

A March 2018 Gallup poll revealed that while a record percentage of people said climate change will pose a serious threat in their lifetime—45 percent of those surveyed—the issue is more politically polarized than ever.[289] Seven in ten Republicans think that the severity of climate change is exaggerated by the media, and the Republicans who acknowledge a scientific consensus of global warming has dropped 11 percentage points since 2017.[290]

Climate activists and their supporters can refer to scientific data and studies all day (and night) long in their attempt to persuade skeptics, but so far it doesn't seem to be

288 Rogers et al. 2012. "Social impacts of community renewable energy projects: findings from a woodfuel case study."
289 Brenan, Megan and Lydia Saad. "Global Warming Concern Steady Despite Some Partisan Shifts." Gallup. March 28, 2018. Retrieved from: http://news.gallup.com/poll/231530/global-warming-concern-steady-despite-partisan-shifts.aspx
290 *Ibid.*

working.[291] This critical time calls for a more empathetic approach to bridging the political and ideological gaps on climate change. We need solutions that emphasize the economic and social opportunities for those most affected by the transition to a low-carbon economy.

This report is intended to be a resource for 350 Montana in their ongoing efforts for a socially- and environmentally-just energy transition in Montana. The data and expert testimonies can be cited as reasoning for legislation that supports greater renewable energy production and consumption. Below is a list of suggested actions that 350 Montana can utilize or continue to advance in their quest for a statewide transition to renewable energy.

Option 1: Incorporating more economic data into the conversation on energy

As this report demonstrates, the economic argument for investing in clean energy in Montana is solid. Not only is the demand for coal plummeting domestically and globally, but Colstrip's largest customers are quickly shifting their investments over to renewables. While the environmental and human health benefits of this shift are undeniable, 350 Montana could utilize the economic data on jobs and cost-effectiveness to underscore how a transition to renewable energy also makes sense for Montana's workforce and long-term economy.

Option 2: Continue to push legislators for stronger renewable energy policy

Though recent polls have demonstrated that the majority of Montanans are in favor of greater investments in renewable energy, state policy inhibits its development. 350 Montana is among the more knowledgeable and active organizations that advocate for renewable energy policy. Efforts should continue to lobby local, regional and state politicians, educating them about the changing popular perspective and encourage them to support policies that advance the capacity and economic viability of small, medium and large-scale renewable energy systems.

Option 3: Increase communication and collaboration with energy stakeholders in Montana

As one of the leading organizations on climate action, 350 Montana knows how to build and sustain successful partnerships for moving their agenda forward. The debate on fossil fuels is often politically divisive and volatile, yet 350 Montana can find common ground with stakeholders across political lines by focusing on shared values, such as

291 In the March 2018 Gallop poll, fewer Americans believe that there is a scientific consensus on climate change (down 11 points since 2017), and that global warming is caused by human activity (down 5 points since 2017).

the long-term environmental, human health, and economic sustainability of Montana's communities.

As every organization is bound to its "sphere of influence," 350 Montana is limited in its capacity to reach out on its own. And while increasing collaboration with similar organizations is critical for political momentum and support, the sphere of influence can be expanded through greater communication and engagement with a more diverse range of stakeholders. Collaborating with more of Montana's energy stakeholders—such as the electrical workers union IBW, Montana AFL-CIO, and Colstrip community groups such as Colstrip United—will enhance 350's ability to advance renewable energy solutions that benefit all parties.

Option 4: Continue to explore the health impacts of coal-fired electricity generation on Colstrip residents and others

Although it was beyond the scope of this report, 350 Montana may consider exploring further and documenting the health impacts of coal-based power generation for Colstrip residents, as well as others. The impacts on human health may reveal themselves immediately, such as asthma and respiratory disease, or years down the road. However, given the known impacts of exposure to coal-related toxins, and the rising costs of health care in this country, linking the consequences of coal to human health for residents of Colstrip, may be a powerful addition to the debate.

Acknowledgements

This report would not have been possible without the gracious support of 350 Montana; my committee of Josh Slotnick, Len Broberg and Lisa Swallow; the advice and encouragement from other EVST and Journalism School faculty; and my wonderful friends and family who reside near and far.

I am so grateful for the opportunity to work as a research fellow for 350 Montana using the financial support of the Brainerd Fellowship. Attending 350 Montana's strategic action meetings, public hearings, events, and public forums heightened my appreciation and understanding for the immensity of energy that these environmental activists put forth in their efforts to create a more environmentally-just and sustainable Montana. Thank you to Jeff Smith, Marta Meengs, and Jerome Walker for your support, critical oversight and ongoing inspiration throughout this process.

Thank you to Josh Slotnick for your bottomless well of encouragement, creativity and optimism throughout this project and my entire grad school experience. I could not have asked for a better advisor and chair. Thank you to Len Broberg and Lisa Swallow for your expertise in the highly-technical aspects of sustainable energy, constructive feedback and keen insights that strengthened this report immeasurably.

To all of the other UM faculty, my fellow grad students, friends and family—I could not have completed this chapter without you. Thank you to my grad school pals who accompanied me on many hikes, road trips, hot spring dips, dog walks, and snow adventures to keep the cabin fever at bay. Thank you to my non-grad school friends who reminded me of the dynamic life on the outside, and how this enriching, though challenging, experience was in fact, temporary. And to my mom, Connie, who with her boundless energy, adventurous spirit, and intellectual prowess serves as my greatest role model, I love you and I can never thank you enough.