Montana Solar Market Assessment

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Prepared for

Montana Department of Environmental Quality

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Executive Summary

As part of the U.S. Department of Energy's SunShot Initiative, the Montana Energy Office (MEO) of the Montana Department of Environmental Quality (DEQ), received a partnership award to assess options for solar generated energy in the state. The first phase of the project is to create a "Menu of Options" report that will provide a blueprint for how Montana communities can expand their access to community-scale solar energy developments.

This report, prepared by Clean power Research (CPR) and Synapse Energy Economics, Inc., supports the effort by providing an assessment of Montana's current solar market activities and the resources available in the state. This Assessment Report provides a snapshot of the state's current solar energy market and trends for solar development in the state. It compares Montana with other states in the adoption of and access to solar energy technology. It reviews community-scale solar policies across several states. Finally, it describes Montana's experience with community-scale solar to date.

Montana Solar Energy Market Penetration

Montanta currently has a cumulative installed capacity of 11 MW of behind-the-meter (BTM) capacity, expected to grow to about 38 MW by 2027. In addition, there are six qualifying facilities (QFs), each 2-3 MW in size, totaling 17 MW. Recent changes in compensation terms make development of additional QF solar in the state unlikely.

Compared to Idaho, Montana has significantly lower solar penetration (0.5% of Montana customers have solar compared to 5.4% of Idahoans. However, Montana has higher solar penetration than Wyoming, North Dakota, and South Dakota. Leading U.S. solar states have significantly higher solar penetration. California has the highest percentage of electricity generated from solar (13%), a rate 300 times that of Montana at 0.04%.

Solar productivity is dependent upon two primary factors: available solar radiation and ambient temperature.[1] As shown in Figure 1, Montana cities are fairly typical of productive output relative to other U.S. cities, capable of delivering over 1500 kWh per year for each kW of rated system capacity. While productivity varies somewhat within the state—solar resources in Billings and Miles City each produce about seven percent more energy per year than resources in Missoula—the year to year variability in each city is small.

[1] Solar modules operate more efficiently in cooler ambient temperatures as compared to warmer.

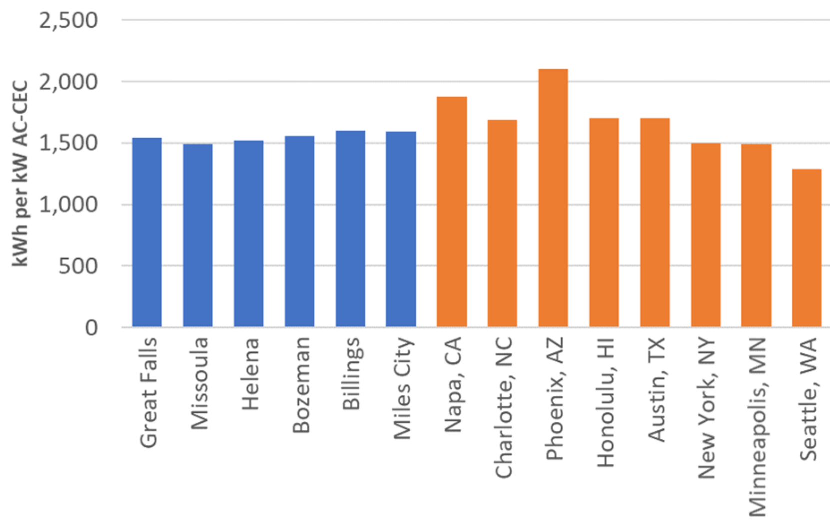

Figure 1. Ten-year average solar production in selected U.S. cities

Minute by minute variability of the total Montana solar fleet is estimated to be roughly 550 kW on the worst day of the year. As patchy clouds pass through the state, the production increases and decreases significantly for a single resource, but with many resources over a large geographical area, the fluctuations cancel each other out, similar to the smoothing effect of aggregated customer load. While more research would be necessary to quantify the variability using actual resource locations, the generation capacity necessary to handle these fluctuations appears, based on this initial estimate, to be minimal, with no foreseeable issues over a 10-year growth scenario.

Solar fleet generation matches reasonably well with 2015 hourly loads in the NorthWestern Energy (NorthWestern) service territory, but not well in the Montana-Dakota territory. In both territories, the 20 peak load hours of 2015 were all found during the summer. During these 20 hours, average residential solar production was about 58% of rated power output in NorthWestern and about 33% of rated output in Montana-Dakota, where afternoon clouds reduced solar output during a 6-hour window on the 2015 peak day. A more detailed analysis is warranted for Montana-Dakota, where only a single location was represented. Six locations were used for NorthWestern.

Customer econmic viability was evaluated in seven scenarios, and the most attractive result is for non-residential customers without a demand charge at NorthWestern. These customers would expect to see a payback on their investment in solar PV in under 10 years. Residential system payback is 12-13 years at the two IOUs. The worst case scenario was residential systems at Flathead Electric Cooperative where payback is about 23 years. Viability for community solar will depend upon ownership (IOUs do not receive a key federal investment tax credit that residential and commercial customers receive) and will depend upon other terms.

Solar PV throughout the US meets industry standards for power quality and reliability. These standards are evolving based upon impacts in high penetration states such as California and Hawaii, where inverters will be used to support the grid. These standards provide for wider operating ranges in frequency and voltage, and active control of voltage and power factor. Montana has not seen commensurate penetration levels, but could benefit from the “smart” inverters as they come to market.

Community-Scale Solar Policies

Solar policies vary across states. In several states, solar policies reflect the need to meet aggressive renewable portfolio standard (RPS) requirements in future years. Some states such as Minnesota have created a value of solar framework to quantify the solar benefits. Other states have created set asides for community scale solar projects. These are all options for Montanans to consider whether they are appropriate for the state. Relative to other states, Montana has very low solar penetration. This means that Montana has an opportunity to learn from policy choices made in other states.

Montana Community-Scale Solar Developments

Four Montana cooperatives have successfully developed community solar projects based on input from their respective members. Economically, the largest barrier to community solar in Montana may be the long payback period of investments in solar energy. Although the solar resource is abundant in Montana and the costs of solar panels are declining nationwide, Montana’s low electricity rates mean that ownership of a share of a community solar project in Montana will generate less savings on customer utility bills than in states with equivalent solar resources but higher electricity rates. The four community solar projects demonstrate that there is sufficient interest in community solar. The key goal for policymakers is to maintain and expand interest for additional community scale solar projects within state.

Figure 2. Flathead Electric Cooperative Solar Array

Background

As part of the U.S. Department of Energy's SunShot Initiative, the Montana Energy Office (MEO) of the Montana Department of Environmental Quality (DEQ), received a partnership award to assess options for solar generated energy in the State. The first phase of the project is to create a "Menu of Options" report that will provide a blueprint for how Montana communities can expand their access to community-scale solar energy developments.

The project will determine how best to provide increased access to solar energy options to Montanans that previously had few or none. By addressing issues of solar energy access and affordability and securing cooperative buy-in from key stakeholder groups, the project will help increase the number of Montanans who have potential access to the benefits of solar energy generation. Additionally, by working with the state's electric utilities and cooperatives, the project and communities can help ensure that the state's solar energy development works in conjunction with the needs and limitations of the state's electric distribution system.

This report, prepared by Clean power Research (CPR) and Synapse Energy Economics, Inc., is an assessment of Montana's current solar market activities and the resources available in the state. The Assessment report provides a snapshot of the state's current solar energy market and trends for solar development in the state. It compares Montana with other states in the adoption of and access to solar energy technology.

This work draws upon data and information provided by partner utilities and organizations including Ravalli Electric Cooperative, Flathead Electric Cooperative, Fergus Electric Cooperative, Missoula Electric Cooperative and Montana-Dakota Utilities (Montana-Dakota) Co. It also draws upon load data from Montana-Dakota and the Federal Energy Regulatory Commission (FERC), and CPR's software tools. These tools include SolarAnywhere FleetView, comprising satellite-derived solar irradiance data and modeling tools, and PowerBill, comprising electric rates and bill calculations.

The Solar Market Assessment includes the following topics:

- Montana Solar Energy Market Penetration
- Community-Scale Solar Policies
- Montana Community-Scale Solar Developments

Montana Solar Energy Market Penetration

Solar Capacity and Growth Trends

According to the Montana Renewable Energy Association (MREA),[2] Montana had about 6.6 MW of installed net metered solar capacity statewide as of the end of 2014. Future growth is assumed to follow the same trend as the growth rates reported by MREA for NorthWestern Energy.[3]

Using historical trends of new annual capacity of NorthWestern systems, scaled to match MREA-reported state-wide capacity, CPR projected future solar capacity additions, shown in Figure 3. Using this model, CPR estimates that Montana currently (2017) has a cumulative installed capacity of 11 MW of behind-the-meter (BTM) capacity. Continuing this growth rate would result in 38 MW of cumulative installed solar BTM capacity in Montana in 2027.

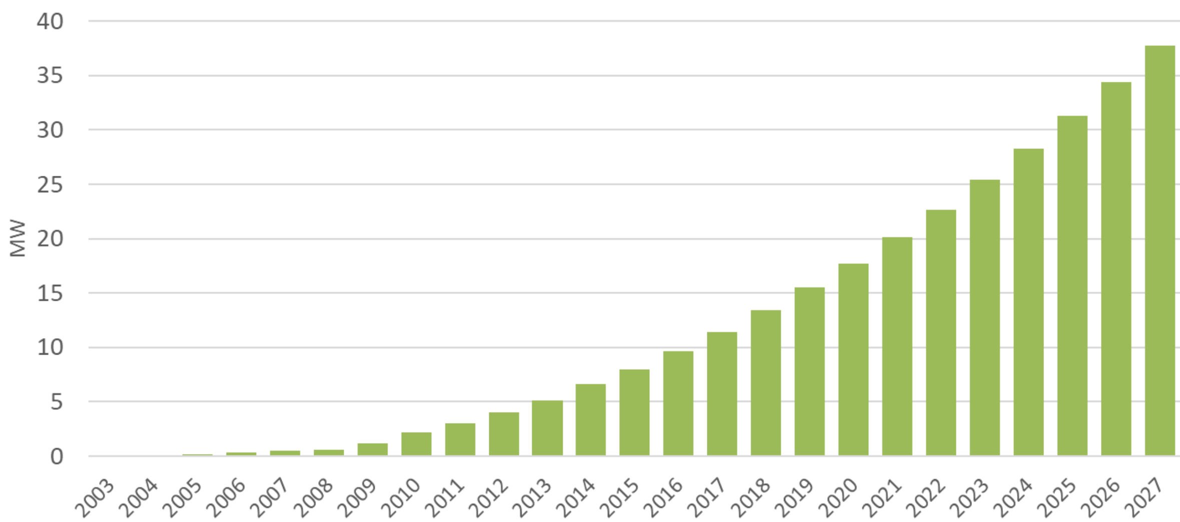

Figure 3. Montana BTM solar capacity growth outlook

Montana also has six qualifying facility (QF) resources, 2 to 3 MW each and totaling 17 MW, which came online during the end of 2016 and the beginning of 2017. These are not included in the projections above and new QF capacity is not anticipated to be a significant in the foreseeable future due to recent policy changes and avoided cost rates.[4] Including both BTM and QF contributions, we estimate a current installed capacity of about 28 MW.

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[2] http://montanarenewables.org/maps-data/net-metering/

[3] http://montanarenewables.org/maps-data/net-metering/nwe/#symple-tab-solar-capacity

[4] As of June 2017, QF contract length will be a maximum term of 10 years, with rates to be recalculated at the five-year mark. Rates will range from $23.32 to $31.54 per MWh, with an additional capacity rate of $9.10 per MWh

Comparison of Penetration with Neighboring and Top PV States

CPR used state SEIA data and EIA energy data to compare solar penetration in Montana, Idaho, Wyoming, North Dakota, South Dakota, California, North Carolina, Arizona, and Hawaii. Comparisons include the percentage of electricity produced by solar and the capacity of solar generators compared to peak demand.

Idaho, which experienced a growth surge, with 62% of its 359 MW of solar capacity installed in 2016, is far ahead of Montana in solar penetration. This is true not only in absolute capcity, but also in the percentage of annual energy from solar (Figure 4),and solar capacity as a percentage of peak demand (Figure 5). Compared to its other three neighboring states, however, penetration is relatively high on all counts. The underlying data is shown in Table 1.

during December, January, February, July and August. These terms would not be expected to attract additional investment. See http://www.missoulacurrent.com/outdoors/2017/06/montana-power-electric-rates-northwestern-energy/.

Table 1. Solar penetration summary

	Montana	Idaho	Wyoming	North Dakota	South Dakota	California	North Carolina	Arizona	Hawaii
Number of Customers (2015)[5]	605,057	835,429	336,471	450,869	461,994	14,832,166	5,012,181	3,011,728	489,694
2016 Peak Demand (MW)[6]	4,348	3,935	1,256	8,032	3,558	66,775	42,637	19,560	1,659
Solar Capacity (MW)[7]	28	359.3	3	0.3	0.4	18,920	3,288	3,151	748
Solar Capacity as % of Peak Demand	0.64%	9.13%	0.24%	0.00%	0.01%	28.33%	7.71%	16.11%	45.12%
2015 Retail Electric Sales (MWh) [8]	11,485,015	23,058,814	16,924,762	18,128,948	12,101,979	181,586,115	133,847,523	77,295,498	9,503,226
% Electricity from Solar[7]	0.04%	0.61%	0.01%	0.00%	0.00%	13.39%	3.25%	5.11%	7.01%

[5] https://www.eia.gov

[6] https://www.eia.gov/electricity/data/eia861/zip/f8612015.zip (Operational_Data_2015.xlsx)

[7] Montana data includes MREA sources as described. Other state data from http://www.seia.org

[8] https://www.eia.gov

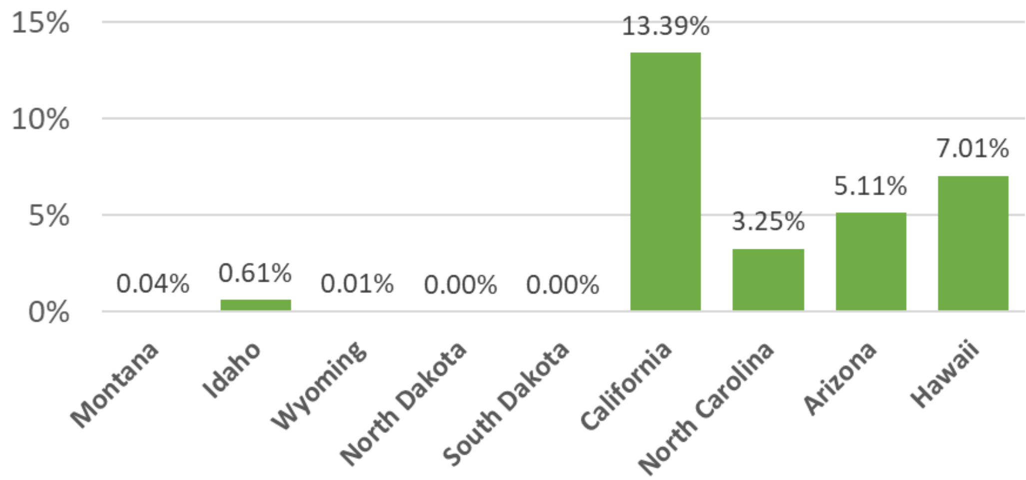

Figure 4. Percentage of electricity from solar in 2016

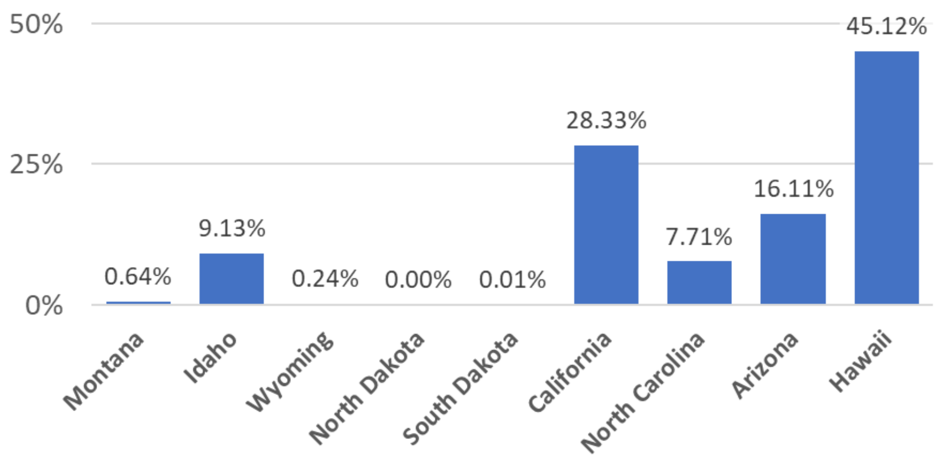

Figure 5. Solar capacity as a percentage of state peak demand

Impact of Montana's Weather Patterns

CPR modeled solar resources for comparative purposes using its SolarAnywhere Fleetview tool for six cities in Montana and eight other cities around the U.S. The simulation[9] was carried out for all cities using data from 2007 through 2016.

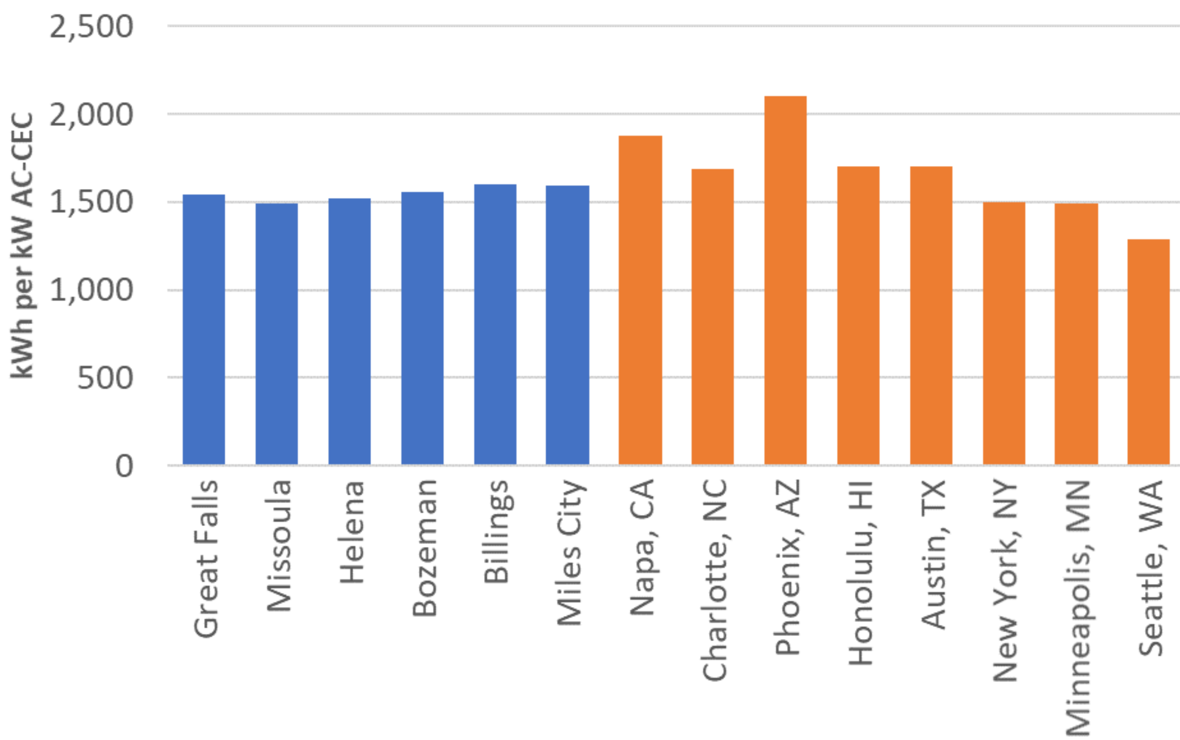

Figure 6: Variation in 10-year average production among selected U.S. cities

Annual energy production (10-year average) across all of the cities varied between 1,286 kWh to 2,104 kWh per kW. The median production was 1,575 kWh per kW, [10] and this is very close to the median production for the Montana cities of 1,551 kWh.

Solar energy production is influenced by a variety of locational factors, such as latitude, cloud conditions, and temperature. Latitude affects the solar elevation in the sky (and consequently the intensity of the remaining radiant energy after passing through the atmosphere) and the number of

[9] Systems used a south-facing, 30-degree tilt angle design and included typical loss factors. All systems were identical except for input weather data.

[10] The AC-CEC rating convention (CEC refers to California Energy Commission) is used consistently throughout this report. AC-CEC ratings incorporate module PVUSA test conditions and inverter efficiencies. Due to these factors, AC-CEC ratings are typically about 80% of DC ratings (DC-STC). Rating conventions are arbitrary but results expressed relative to ratings (such as annual energy per kW or effective capacity per kW) are dependent upon the selection of rating convention.

daylight hours. Cloud conditions can significantly modulate the amount of direct beam radiation on the panels. Temperature affects panel efficiency (higher efficiency at cooler temperatures). For this reason, average annual energy production is useful as a comparative metric. It accounts for all of these factors, and comparing annual values accounts for variations in seasonal results.

Figure 7 shows that the annual variation in Montana is not particularly significant. This means that producers (whether utility scale or customers) would not see significant variations in revenues from year to year if pricing did not vary on an hourly basis.

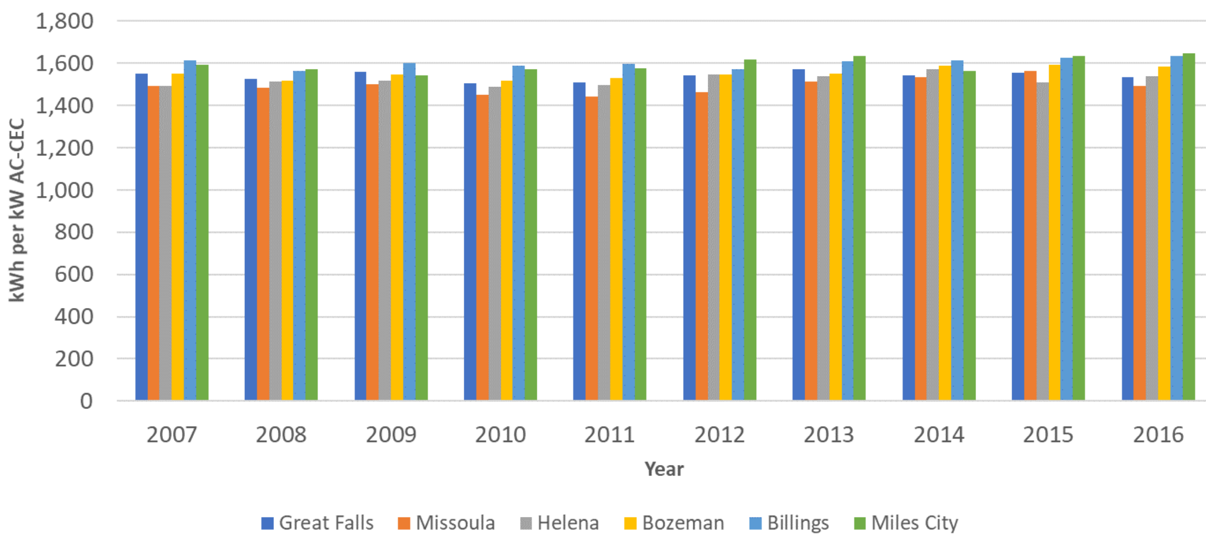

Figure 7. Variation in energy production due to location and annual weather patterns

Solar Variability

One of the potential challenges of accepting high levels of solar energy onto the state power grids is the variability of PV caused by cloud transients. Depending upon the magnitude and speed of these power output changes, load-following resources may be needed to accommodate solar over those needed to handle fluctuations of load alone.

An estimate of solar variability is provided in Appendix A. The estimate is based on a worst-case variability hour to be comparable as that measured by CPR in Napa, California (although more hours may reach that worst-case condition in Montana as compared to California).

Using the current estimate of installed capacity in Montana, including 11 MW of BTM capacity and 17 MW of QF capacity, CPR estimates a total worst case variability of about 546 kW per minute. This means that the minute-by-minute change in aggregate power output is about 546 kW during the highest variability hours of the year. Therefore, the amount of additional capacity needed to absorb these fluctuations would be about 546 kW over and above the amounts needed to handle variability in load alone.

This estimate assumes that each of the resources are dispersed far enough away from each other as to be uncorrelated. An estimate to include correlated output, such as that found with geographically clustered resources, could be done for Montana, provided the locations and ratings of each system were known.

A similar calculation was performed for the future set of resources corresponding to the 55 MW of solar capacity estimated for 2027 (38 MW BTM plus 17 MW QF). In this case, the statewide variability is 548 kW, or 1.0% of the 55 MW solar fleet rating. Thus, the additional dispersed solar resources over 10 years, without additional large QF projects, would not be expected to materially affect total variability, and no additional regulation reserves would be required over the current amount.

Alignment of Solar with Electricity Demand Profiles

To analyze how solar energy generation aligns with electricity demand, CPR used FleetView to model power output for 630 hypothetical PV systems at eight locations across Montana and correlated production with utility load data.

PV System Orientations

Since detailed information about PV system installations was not available for Montana, CPR derived certain system characteristics of the systems, such as tilt and azimuth, from the actual specifications of 545 residential and 574 non-residential PV systems in Rocky Mountain Power's (RMP's) service territory in Utah. We used that data to estimate the distribution of capacity among design orientations as shown in Figure 8 and Figure 9. RMP data was the nearest high-quality data available for this purpose.

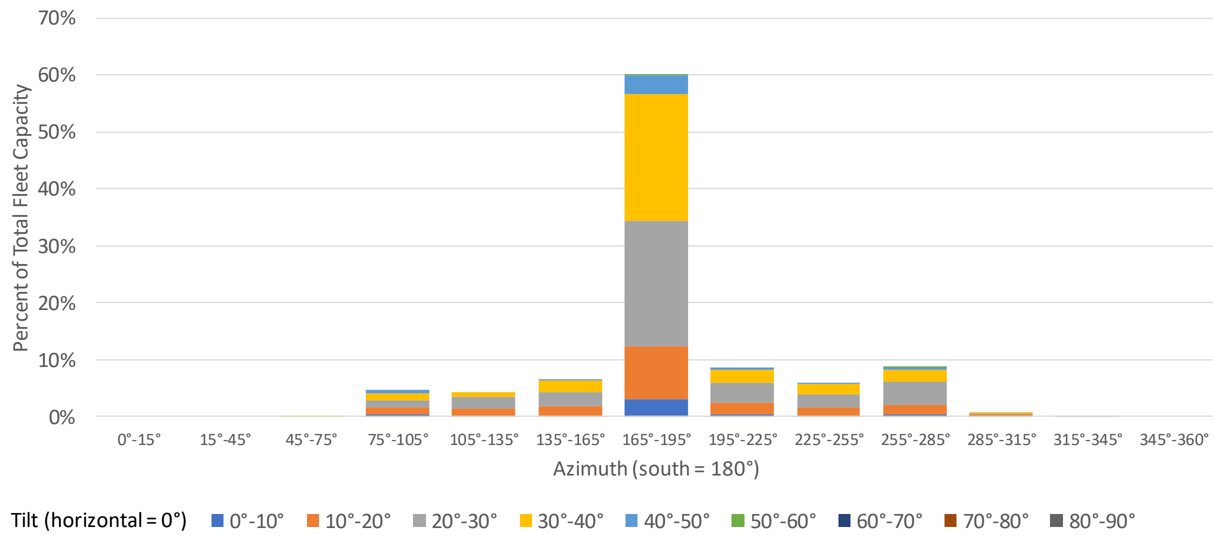

Figure 8. Residential distribution of capacity by orientation

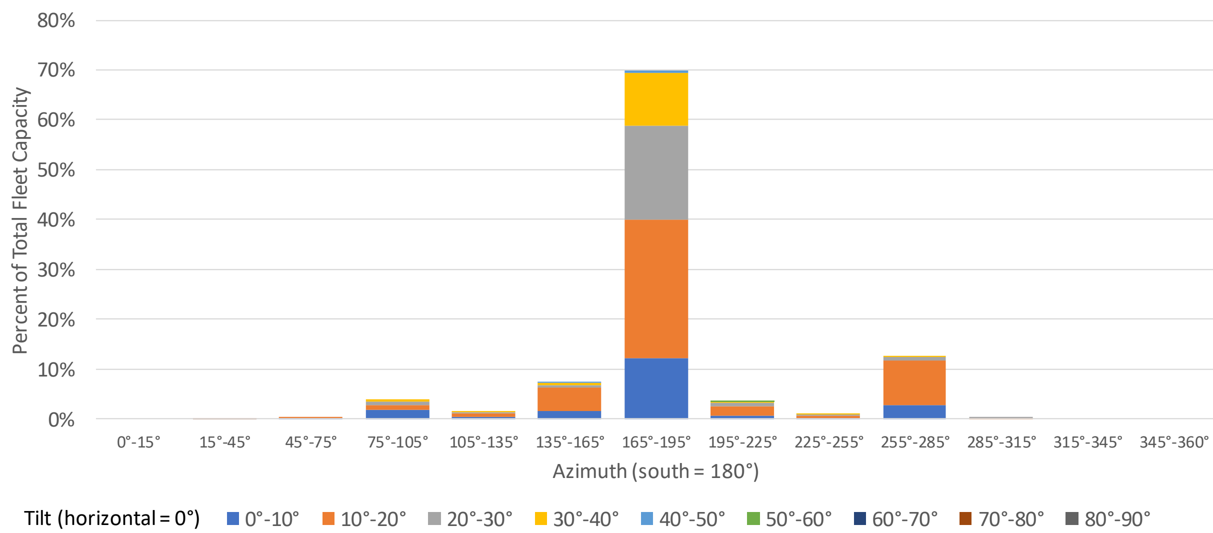

Figure 9. Non-residential distribution of capacity by orientation

PV System Locations

The population of cities in each utility's service territory provided the basis for selecting system locations. For NorthWestern, we selected the six cities with a population greater than 10,000 and we assigned capacity based on the relative population of each city. For Montana-Dakota, we chose Miles City as our one location, while Kalispell was selected as the location for Flathead Electric Cooperative. Figure 10 shows a map of the selected PV system locations.

Using the orientations and locations discussed above, CPR created seven hypothetical fleets, summarized in Table 2.

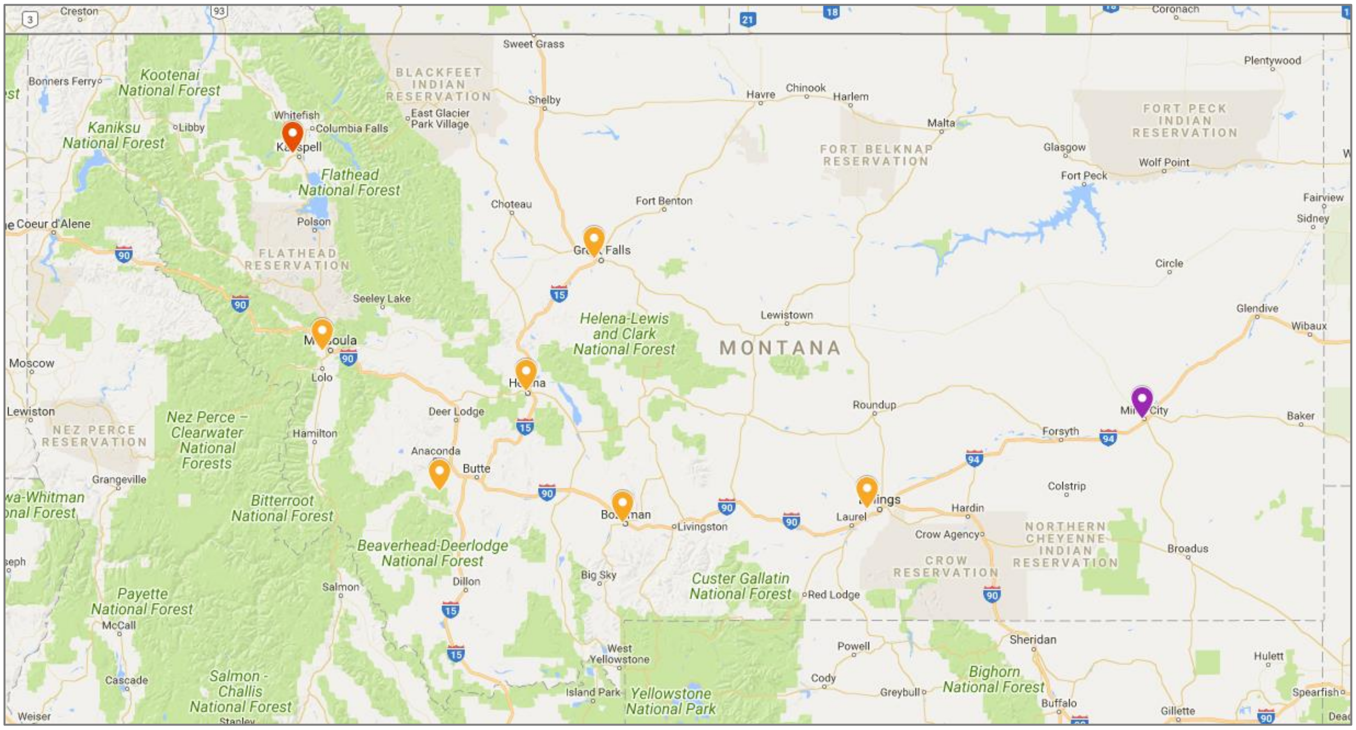

Figure 10. Eight locations modelled

Table 2. PV fleet summary

	Residential	Non-Residential	Utility Scale
Flathead Electric Cooperative	40 systems, 1 location	37 systems, 1 location	
Montana-Dakota Utilities	40 systems, 1 location	37 systems, 1 location	
NorthWestern Energy	241 systems, 6 locations	223 systems, 6 locations	12 systems, 6 locations

Solar Generation Impact

CPR used the modeled solar fleets described above to determine the match between solar production and utility loads. This match is quantified as the “effective capacity” provided by the fleets. There are several defined methods for calculating effective capacity across U.S. jurisdictions,[11] and for simplicity CPR selected the average fleet output during the top 20 load hours.[12]

To conduct this analysis, CPR obtained 2015 hourly utility load data for NorthWestern from FERC (2015 was the most recent year available). We used this data as a proxy for load in Flathead Electric Cooperative as well. Montana-Dakota provided us with its 2015 load data.

In 2015, peak load for both NorthWestern and Montana-Dakota occurred in the summer. For Montana-Dakota, the peak load day was August 12 and 30% of the top 20 load hours occurred on that day. For NorthWestern, the peak load day was June 29 and 35% of the top 20 load hours occurred on that day. All of the Montana-Dakota and NorthWestern top 20 load hours for 2015 occurred in the summer months.

Using the modeled fleet output, time-synchronized with hourly loads, CPR calculated the 2015 effective capcity, and the results are shown in Table 3. The metric is calculated as the average fleet output during the top 20 hours of load during 2015, divided by the CEC-AC rating of the fleet.[13]

Table 3. Effective capacity in 2015

	Effective Capacity (Percent of AC-CEC Rating)
NorthWestern Residential Fleet	58%
NorthWestern Non-Residential Fleet	59%
NorthWestern Utility-Scale Fleet	65%
Montana-Dakota Residential Fleet	33%
Montana-Dakota Non-Residential Fleet	33%
Flathead Residential Fleet	48%
Flathead Non-Residential Fleet	48%

[11] For example, effective capacity may be defined by the effective load carry capability, or ELCC, which may be measured as the rating of a baseload resource having the same loss of load probability as the solar resource on an annual basis.

[12] The method used here is a variant of the method approvied by the PSC in D2016.5.39. The PSC decision defines the peak hours to be the hours of 7 am to 10 pm during January, February, July, August, and December (thus, the "peak" is made up of 2432 pre-defined hours). The effective capacity is then the output exceeded during 85% of these hours. The method we used does not define pre-define peak hours but rather uses the actual 20 peak load hours during the year.

[13] Note that numeric results would be lower if DC ratings were used. For example, the NorthWestern Residential Fleet would have an ELCC of about 58% x 0.9 (DC-to-PTC) x 0.95 (Inverter effeiciency) = 50%.

Note that Montana-Dakota's effective capcity is significantly lower that NorthWestern's or Flathead's due to the use of a single location for the fleet, which experienced cloudy weather on the afternoon of their peak load day, as shown in Figure 11.

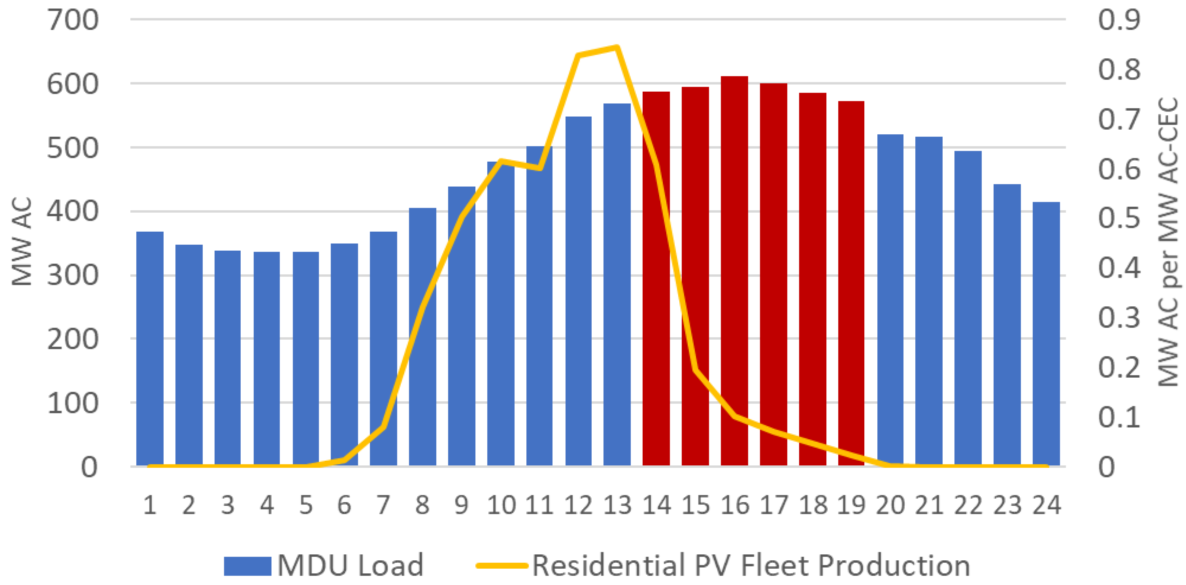

Figure 11. Montana-Dakota load and residential fleet production, August 12, 2015

To illustrate the impact of solar production on utility loads, Figure 12 shows the gross NorthWestern load on the peak load day of June 29, 2015, the current net load (with 2017 behind-the-meter solar capacity of 11 MW) and the 10-year projected net load (with 2027 behind-the-meter solar capacity of 38 MW). These curves were created with hourly output from a composite set of fleets (NorthWestern residential, non-residential, and utility-scale).

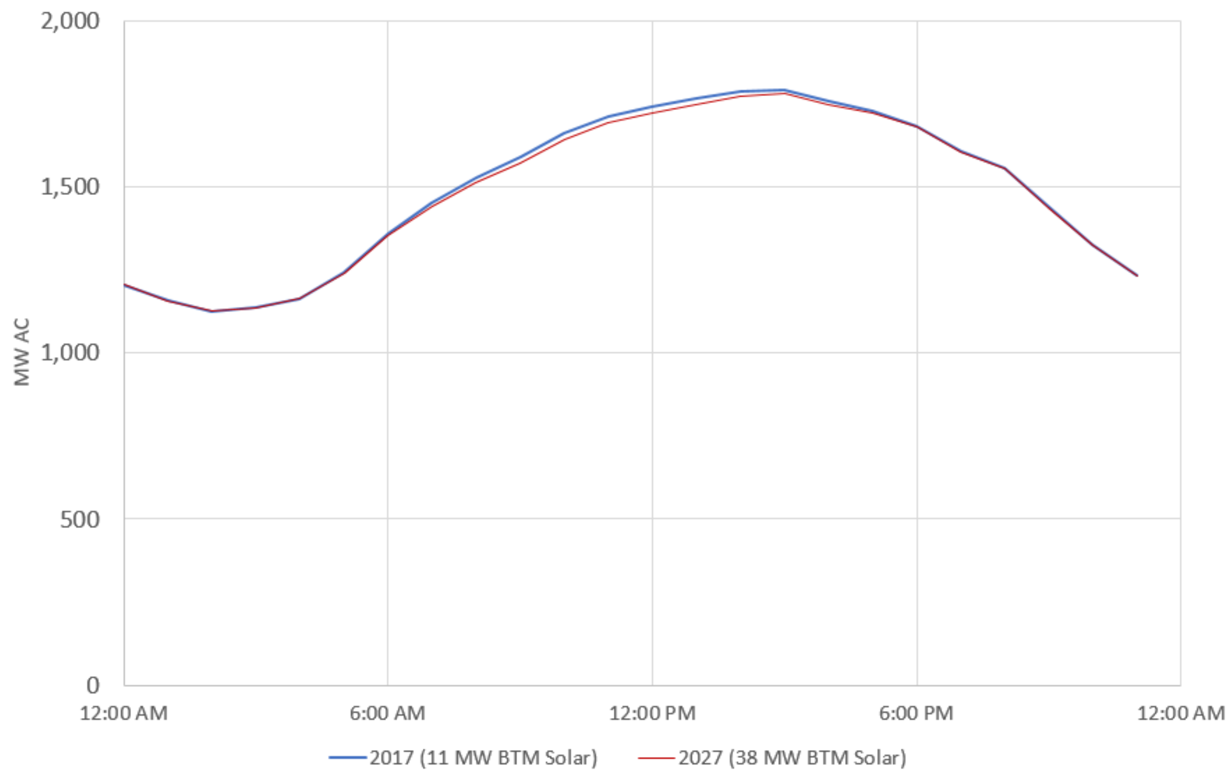

Figure 12. NorthWestern gross and net load on peak load day

This shape suggests that over the 10-year forecast horizon, the peak load will still be within the solar hours. In other words, solar resources will continue to provide generation capacity support beyond the 10-year horizon of this analysis. There will also be no significant change in generation ramp rates, an issue facing California and other high penetration states.

Cost and Payback Period (Customer Perspective)

The economic viability of Montana customer-owned, rooftop PV is a function of net system cost, usage, and rate schedule. Scenarios were evaluated for three Montana utilities for residential and non-residential types. For NorthWestern, both demand and non-demand commercial scenarios were included.

CPR performed the analysis using its PowerBill savings estimation tool. This tool calculates billing determininants (e.g., monthly energy and maximum demand) and applies the pricing corresponding to the assumed rate schedule. Details are shown in Appendix B.

The results are shown in Figure 13. Among the scenarios selected, Flathead Electric residential customers have the longest payback at 22.9 years (i.e., the least likely to adopt solar), while Northwestern non-residential customers (without demand) have the shortest payback period.

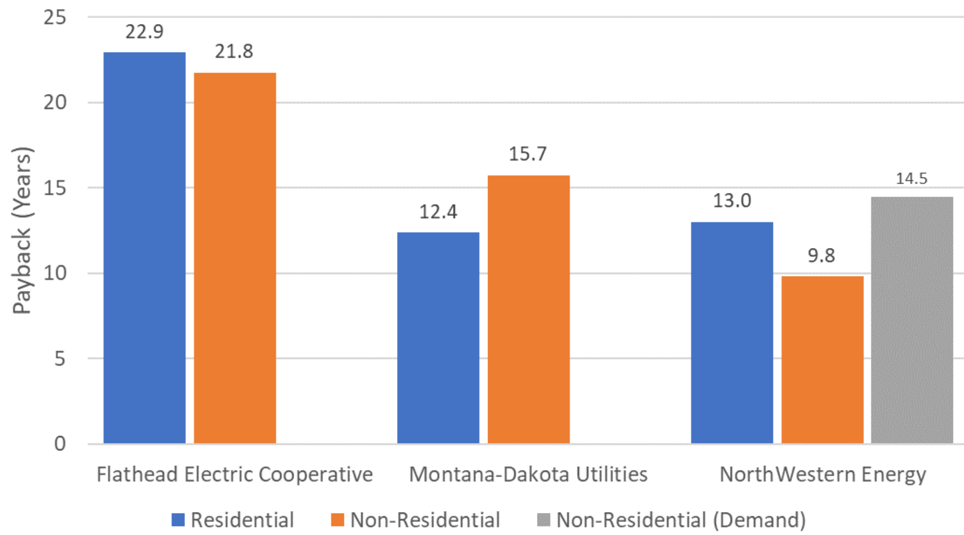

Figure 13. Customer payback periods.

These results do not necessarily reflect community solar, where the cost effectiveness will depend upon other factors. For example, the cost of installing solar for homeowners and businesses may be higher than community solar due to building-specific design requirements and economies of scale, yet these customers are eligible for the federal tax credit, unlike a IOU-owned community solar installation (cooperative community solar projects are individually owned, so they do qualify for the tax credit).

Power Quality and Inverter Technology Development

Solar inverters convert the direct-current power generated by PV modules and strings into usable alternating-current power that is compatible with the grid frequency, voltage and phase. To ensure safety and reliability, inverters must meet established technical standards such as IEEE 1547, which specify the allowable operating range of frequency and voltage, outside of which the inverter is required to de-energize. Other standards specify maximum allowable harmonic content for voltage and current.

Interconnection requirements for systems under 50 kW at NorthWestern, for example, require static inverters that comply with IEEE standard 929, UL 1741, and relevant codes and standards of the NEC, IEEE, and UL (from MCA 69-8-604).

Concern about the potential for overvoltage on distribution systems has led some states to evaluate changes to interconnection rules that would enable inverters to actively control voltage in response to the needs of the grid. These inverters are designed with the same hardware capabilities as traditional inverters but incorporate advanced control software. The California Public Utilities Commission (CPUC), for example, is in the process of changing its Rule 21 to reflect changes in IEEE 1547 which allow for additional "smart inverters."

The trend toward advanced inverters, described in a 2015 NREL report,[14] enables higher amounts of PV to be accommodated on grids where customer adoption is high. Advanced functionality includes wider operating ranges in frequency and voltage, and active control of voltage and power factor.

To date, Montana has not allowed or required interconnection of advanced inverters. Montana has not seen penetration levels commensurate with high penetration states like California and Hawaii, but will be able to benefit from smart inverters as they come onto the market.

[14] Reiter, et. al., "Industry Perspectives on Advanced Inverters for U.S. Solar Photovoltaic Systems: Grid Benefits, Deployment Challenges, and Emerging Solutions," NREL, NREL/TP-7A40-65063, September 2015.

Community-Scale Solar Policies

Despite its geographic location in the north of the country, Montana should be an attractive state for potential solar customers or developers. It holds substantial potential for solar power. As Flathead Electric Cooperative points out, Montana receives an amount of sunshine similar to Germany, the world's leader in solar power.[15] This observation is consistent with the findings of the National Renewable Energy Laboratories' (NREL) 2012 GIS-based study of renewable potential by state, which found that Montana has the potential to develop over 4,000 gigawatts of rural utility-scale solar, thanks to its large land area, low population density, and solar irradiation.[16] This 4,000 gigawatts of solar potential could translate into over 8,000 terawatt-hours of solar generation potential per year. As a point of reference, 2015 electricity sales in Montana reached 14 terawatt-hours.[17] A large technical potential for substantial amounts of solar exists in Montana; capturing this potential is a matter of economics and policy support.

Currently, Montana does not have any policies that directly promote community solar, but does have a few policies that help promote solar in general. Montana does, for example, require NorthWestern to offer a renewable energy option on their electric bills.[18] As discussed in detail, the Missoula Parking Garage and Darby library both benefited from NorthWestern Energy Grants. The NorthWestern Energy E+ Renewable Energy Program provides custom incentives for projects benefitting organizations and communities with nonprofit or government facilities.[19] Through the E+ Green program, customers are allowed to purchase renewable energy environmental benefits in 100 kWh blocks at $0.02/kWh. This money is used to fund new renewable energy projects.[20]

Montana's investor-owned utilities (IOUs) are required by law to offer net metering for renewable installations up to 50 kilowatts and the state's electric cooperatives (co-ops) adopted voluntary net metering policies that vary in their specifics from one co-op to the next.[21] Montana's net metering regulations place no limit on statewide capacity included in the program, creating a revenue stream for

[15] Taken from http://www.dailyinterlake.com/archive/article-9d6f586c-3f0d-11e5-8ad7-93ca53309b06.html, retrieved 7/13/17

[16] Lopez, A., et al., "U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis," National Renewable Energy Laboratory, July 2012.

[17] EIA 861 data from 2015.

[18] MCA 69-8-210, enacted: 2003. Available at: http://programs.dsireusa.org/system/program/detail/26

[19] https://www.nrel.gov/solar/rps/mt.html

[20] http://www.northwesternenergy.com/save-energy-money/business-services/business-services-montana/renewable-energy

[21] Taken from: http://deq.mt.gov/Energy/EnergizeMT/Renewable/netmeterrenew. Accessed, 6/29/17.

all new residential and on-site commercial solar. Importantly, it appears that Montana's net metering policy does not explicitly allow for virtual net metering, which may limit NorthWestern's ability to implement community solar projects. Because Montana-Dakota never deregulated, the net metering rules that apply to the utility allow for it to implement community solar projects. Conversely, there are specific Montana laws regarding net metering that apply to NorthWestern, as a result of its re-regulation a decade ago, that specifically rule out the most common community solar project structures, limiting the utility's ability to implement these types of projects.

Montana also has a property tax exemption for non-fossil forms of energy generation.[22] The policy allows single-family residential buildings to avoid paying taxes on up to $20,000 of the value from an on-site solar installation for ten years. Multi-family or non-residential structures can exempt property taxes on up to $100,000 of the value from a solar installation for ten years.[23] In both cases, however, the property tax exemption is only allowed for property classified as "class 4 property." This classification includes residential, commercial, and industrial (land and improvements) property, but does not include electric generation property of electric utilities (class 13) or renewable energy production facilities (class 14). This suggests that community solar installations would not be exempt from property taxes on the value of the system.[24] The cooperatives have cited this exclusion as an economic barrier to developing community solar projects.

At this time, four of the state's electric co-ops have offered community solar projects based on interest of their members. State-mandated net metering laws prevent customers of the large IOUs—NorthWestern and Montana-Dakota—from participating in community solar projects. That said, Montana-Dakota is evaluating other community solar models to offer its customers, and NorthWestern has completed a community-scale solar pilot project in Bozeman.

Various policies introduced in Montana this year could have had competing impacts on community solar. Senate Bill 277 would have prohibited the use of the Alternative Energy Revolving Loan Program for virtual net metering and thus removed the opportunity for one of the key policies necessary to promote community solar growth.[25] However, it failed to make it out of committee. Conversely, House Bill 504 would have established a "neighborhood net metering" policy, allowing for shared renewables in-state and raising the cap for net metering to 1 megawatt for all customers.[26] HB 504 also failed to make it out of committee.

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[22] http://leg.mt.gov/bills/mca/title_0150/chapter_0060/part_0020/section_0240/0150-0060-0020-0240.html

[23] http://programs.dsireusa.org/system/program/detail/154

[24] https://revenue.mt.gov/property-types#Classifications

[25] https://legiscan.com/MT/text/SB277/id/1518753/Montana-2017-SB277-Introduced.pdf

[26] http://leg.mt.gov/bills/2017/BillPdf/HB0504.pdf

Other recent changes to Montana's net metering legislation is HB 219 that created a framework for reviewing NorthWestern's rate structure to determine whether future net metering customers should be in a separate electric rate to address concerns of cost shifts being imposed by current net metering customers.[27] In addition, SB 12 requires the PSC to conduct a biennial review of interconnection standards to make sure that Montana legislation remains current.[28]

Community-Scale Policies in the West

Solar penetration will vary due to economics and policies in place across the country. This section details some solar policies across selected states. The following figure shows cumulative solar penetration across selected states across the United States.

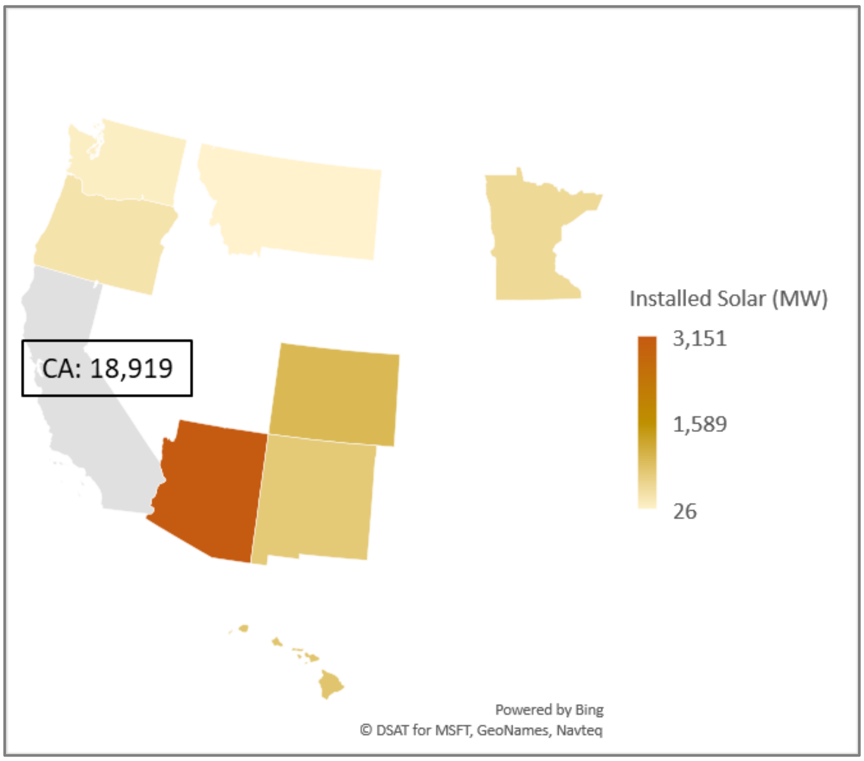

Figure 14. Summary of Installed Solar Capacity in Selected States[29]

[27] http://leg.mt.gov/bills/2017/sesslaws/ch0248.pdf

[28] http://leg.mt.gov/bills/2017/BillPdf/SB0012.pdf

[29] Data for 2016 from EIA Electric Power Monthly. Due to the size of the California market, we have not included the values within the scale of the figure.

All the selected states have much more solar penetration than Montana, and consequently may provide Montana with opportunities to understand policies that have worked or not worked to promote solar installations. A more detailed table of the selected states and Montana is provided below.

Table 4. Solar Penetration Statistics from Selected States

	Installed Solar (MW)	Homes with Solar	Solar Generation (000's MWh)	State Generation (000's MWh)	Solar as Percentage of State Generation
Arizona	3,151	469,000	4,764	108,770	4.38%
California	18,920	4,885,000	25,011	199,038	12.57%
Colorado	940	189,000	1,020	54,394	1.88%
Hawaii	748	188,000	821	9,607	8.55%
Minnesota	432	57,000	57	60,148	0.09%
New Mexico	677	168,000	976	33,010	2.96%
Oregon	272	34,000	183	59,425	0.31%
Washington	96	10,000	89	112,784	0.08%
Montana	26	3,000	11	28,153	0.04%
Notes http://www.seia.org/policy/state-solar-policy https://www.eia.gov/electricity/monthly/					

The above table and chart show that Montana, among many of the states have some ways to go before solar reaches even one percent of state generation. The following section highlights policies in these selected states that are meant to promote additional community scale solar in most cases, and in the case of the Salt River Project in Arizona has resulted in a halt in the demand for new residential solar installations.

California

California boasts two pieces of community scale solar legislation. The first, the Green Tariff Shared Renewables (GTSR) Program, allows the three major in-state IOUs to develop their own large solar arrays up to 20 MW and offer customers the choice to receive either 50 or 100 percent of their generation from renewables.[30] Utilities can set their own rates for this special, green rate class. This

[30] http://www.utilitydive.com/news/inside-californias-plans-to-jump-start-community-solar-development/370218/

utility-centric approach to community solar achieves the same impact as other community solar programs by allowing customers to opt-in.

The second policy, the Enhanced Community Renewables (ECR) program, works to bridge the gap between developers and interested customers without access to rooftop solar.[31] The program enables participants to purchase between 25 to 100 percent of their monthly electric demand directly from a solar developer via subscription. Customers pay for their subscribed commitment and then receive a credit on their electric bills.[32]

Colorado

Colorado has three critical bills for promoting community solar. The first, House Bill 10-1342 introduced in 2010, initiated a pilot program for shared renewables in Colorado.[33] After shares in the first facilities sold out within thirty minutes of becoming available, Colorado opted to expand the scope of shared renewables within the state by simplifying the geographical nexus between participants and project sites.[34, 35] The state passed the expanded law, House Bill 1248, to continue these projects in 2015.[36] In 2014, the state passed another piece of legislation, House Bill 1101, that exempted community solar gardens from property tax.[37]

Colorado has also developed a low-income community solar model. Under House Bill 10-1342, community solar gardens must allocate at least 5 percent of each project to low-income subscribers.[38] In a report summarizing the effect of the low-income solar carve-out, the Colorado Energy Office's

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[31] https://www.green-e.org/programs/energy/ca-ecr

[32] https://www.green-e.org/programs/energy/ca-ecr-customers

[33] http://www.leg.state.co.us/clics/clics2010a/csl.nsf/fsbillcont/490C49EE6BEA3295872576A80026BC4B?Open&file=1342_01 .pdf

[34] http://www.sharedrenewables.org/community-energy-projects/

[35] http://www.ncsl.org/Portals/1/Documents/energy/Solar_Pereira_present1.pdf

[36] https://legiscan.com/CO/text/HB1284/2015

[37] http://www.leg.state.co.us/clics/clics2014a/csl.nsf/fsbillcont3/4DB7B4397EFCB0BC87257C3000071AF8?Open&file=1101_enr.pdf

[38] Lotus Engineering and Sustainability. *Analysis of the Fulfillment of the Low-income Carve-out for Community Solar Subscriber Organizations.* November 2015. Page 2. Available at https://www.colorado.gov/pacific/sites/default/files/atoms/files/Low-Income%20Community%20Solar%20Report-CEO_0.pdf

consultant identified several pathways to improve upon Colorado's program. Montana can consider some of the report's recommendations, summarized below, in its own policy-making:[39]

- Apply the 5 percent carve-out to a developer's portfolio, rather than on a project basis, to encourage the development of projects tailored for low-income participants;
- Increase the 5 percent low-income carve-out;
- Guarantee bill credits;
- Invest a portion of the state's Department of Energy Low Income Home Energy Assistance Program (LIHEAP) funding into low-income solar installations; and
- Encourage the development of community solar projects at brownfield sites across the state.

New Mexico

New Mexico has a renewable portfolio standard that requires major utilities to get 20 percent of their energy from renewable sources by 2020. Co-ops are required to use 10 percent renewable sources. There's also a requirement that 4 percent of retail electric sales must come from solar power.[40] New Mexico does not offer a statewide solar power system rebate; however, the state provides a 10 percent tax credit on the cost of purchase and installation with a cap of $9,000. This is in addition to the 30 percent federal investment tax credit. New Mexico allows residential solar to qualify for 100 percent sales tax and property tax exemptions.[41]

While customer-sited solar projects have increased, community scale legislation has been less successful in New Mexico. In 2017, New Mexico failed to pass by three votes House Bill 338 (Communities Solar Act), which would have allowed the development community solar projects within the state.[42] The legislation appears similar to Colorado's House Bill 1248.

Oregon

Oregon's renewable portfolio standard (RPS) is a major driver to the development of solar within the state. The Oregon RPS requires large utilities to source 25 percent of their energy from renewable

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[39] Ibid. Page 27.

[40] http://www.solarresourceguide.org/new-mexico/

[41] Ibid.

[42] https://www.cvnm.org/press-releases/new-mexicans-respond-to-community-solar-gardens-bill-failing-on-the-house-floor/

sources including solar power by 2025. Smaller utilities must have at least 5 to 10 percent renewable energy by 2025. Utilities that do not comply with the RPS targets will have to pay an alternative compliance rate, currently set at $50 per MWh.[43]

For community-scale solar, Oregon passed House Bill 2941 in 2015 that authorized electric utilities to offer different rate options to customers that are specific to a certain energy resource.[44] Consequently, utilities can now offer "green" rates or follow the California method of developing their own solar arrays and allowing customers to opt-in. Additionally, the Oregon Public Utility Commission was directed to examine the range of costs and benefits for different types of community solar programs. The state legislature went one step further in 2016 with Senate Bill 1547, which, in addition to requiring the elimination of coal generation from the electric supply, required the Commission to actively establish a rule for an in-state community solar program.[45]

In response to that bill, the Oregon Public Utilities Commission issued order number 17-232 in Docket AR 603 on June 29, 2017, establishing rules for community solar in Oregon.[46] These rules include the following provisions:

- Projects must be sited within the service territory of an electric company and participants are limited to projects in their same contiguous service territory;
- The initial capacity tier of the program for each electric company is equal to 2.5 percent of the electric company's 2016 system peak;
- Projects must have a nameplate capacity of 3 MW or less, including systems aggregated into a single project within a single electric company's service territory;
- 50 percent of projects must be allocated to residential and small commercial customers;
- The community solar program must allocate at least 10 percent of the program to serve low-income customers (5 percent per project and 5 percent overall);
- Start-up costs associated with the development of community solar projects are recoverable through rates;
- The bill credit rate is determined for each project and based upon the resource value of solar applicable to the project;

[43] http://www.solarresourceguide.org/oregon/

[44] https://olis.leg.state.or.us/liz/2015R1/Measures/Overview/HB2941

[45] https://olis.leg.state.or.us/liz/2016R1/Downloads/MeasureDocument/SB1547/Enrolled

[46] http://apps.puc.state.or.us/orders/2017ords/17-232.pdf

- A participant's excess generation at the end of the annual billing cycle must be donated to low-income programs of the electric company serving the participant; and

- An individual customer participant's generation is capped at the average annual consumption in the service territory where the project is located.

These rules are just now in place, so it will take some time to see the impact of the newly enacted rules on community scale solar in Oregon.

Washington

Washington's community solar policy was enacted within the framework of the state's overall net metering policy, which enforces a cap of 0.5 percent of a utility's peak demand in 2014.[47] All the state's community solar projects must operate within this net metering framework. By law, community solar is eligible for Washington's state production incentive, which provides thirty cents per kilowatt-hour payment for community solar projects built in-state. This incentive is then scaled for in-state economic development factors to encourage Washington-based manufacturers.[48] Current legislation limits the incentive payment to $5,000 per year per participant in a community solar project.[49]

Washington differentiates community solar projects between (1) utility-sponsored and (2) LLC-sponsored.[50] Utility-sponsored programs require participants to purchase a share of the project, which is sited at a location chosen by the utility. Participants can claim the federal tax credit, bill credits through net metering, and payments from Washington's state production incentive. LLC-sponsored projects must be located at a public entity facility. While participants may claim the federal tax credit and the Washington state production incentive, the incentive payments are made to the owning entity, which then pays participants.[51]

Passage of recent legislation in the state provides certainty for the solar industry within the state.[52] This will help the solar industry to help meet the state's RPS target of 15 percent by 2020 from the 9 percent renewables in 2016.[53]

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[47] http://www.sharedrenewables.org/community-energy-projects/

[48] A community solar project in Washington could receive up to $1.08/kWh if it utilizes solar modules and inverters manufactured within the state. See http://apps.leg.wa.gov/WAC/default.aspx?cite=458-20-273

[49] Ibid.

[50] http://www.solarwa.org/community_solar

[51] Ibid.

[52] http://www.seattletimes.com/business/solar-incentives-bill-has-industry-seeing-sunny-days/

[53] http://www.solarresourceguide.org/washington/

Minnesota

Minnesota stands out as being the first state in the country to mandate the use of a value-of-solar (VOS) tariff for certain distributed generation customers. [54] On June 21, 2016 the Minnesota Public Utilities Commission mandated the use of a VOS methodology to determine compensation rates for Community Solar Garden (CSG) customers.[55] This made Minnesota the first state in the country to put in place a VOS rate for investor-owned utility (IOU) solar customers. Xcel's proposed VOS tariff[56] is based on the VOS methodology previously approved by the state in 2014.[57, 58]

Minnesota's Community Solar Garden (CSG) program was launched in 2014.[59] A CSG is simply a large array of solar PV panels in which subscribers may purchase shares, called a "subscription," of the project's total capacity.[60] CSGs must have at least five subscribers; be entirely located within the service territory of the utility administering the program; and are capped at 1 MW in size. Subscribers must reside in the county in which the CSG is located,[61] and no one individual subscriber can subscribe to more than 40 percent of the CSG's output.[62]

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[54] electricpulp.com, "MN Regulators Adopt First of Its Kind Value of Solar Rate | Fresh Energy," accessed August 9, 2016, http://fresh-energy.org/2016/07/mn-regulators-adopt-first-of-its-kind-value-of-solar-rate/.

[55] "Order Denying Request for Clarification," E-002/M-13-867 § (2016), https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={8B1522DD-6411-4C16-8274-42540E8B2C31}&documentTitle=20166-122455-01.

[56] Northern States Power Company, "Standard Contract for Solar*Rewards Community," July 21, 2016, https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={52CB3982-8A73-4C21-BB79-269DEA68278A}&documentTitle=20167-123482-01.

[57] Benjamin L. Norris, Morgan C. Putnam, and Thomas E. Hoff, "Minnesota Value of Solar: Methodology," January 30, 2014, https://www.cleanpower.com/wp-content/uploads/MN-VOS-Methodology-2014-01-30-FINAL.pdf.

[58] "Order Approving Distributed Solar Value Methodology," Pub. L. No. Docket No. E-999/M-14-65, E-999/M-14-65 (2014), https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={FC0357B5-FBE2-4E99-9E3B-5CCFCF48F822}&documentTitle=20144-97879-01.

[59] "Order Approving Solar-Garden Plan with Modifications" (2014), https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={10BA0886-4539-4BC2-B896-8E0D8D26E5F4}&documentTitle=20149-103114-01.

[60] "How It Works," accessed August 9, 2016, http://mncommunitysolar.com/how-it-works.

[61] Minnesota Public Utilities Commission, "Order Adopting Partial Settlement as Modified," E-002/M-13-867, August 6, 2015, https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={43AC9E59-AD57-44FE-A57A-5F8A572D3C74}&documentTitle=20158-113077-01.

[62] Northern States Power Company, "Standard Contract for Solar*Rewards Community."

By June 2015, there were 900 active applications pending, representing 912 MW in capacity,[63] and all but one solar garden project had been approved for interconnection.[64] Delays were attributed to several factors. These included the volume of applications, inadequate staffing at Xcel, Xcel's failure to conform to the usual interconnection timelines, and developers not knowing how much available capacity exists at a specific point on Xcel's grid or how many projects are in the interconnection queue to a particular substation.[65] If there had been more transparency of the latter, developers would have been less likely to file applications with a lower probability of success and thereby avoided wasting both developers' and Xcel's resources. As part of the Partial Settlement Order of August 2015, the Commission required Xcel to comply with a more streamlined and transparent process, including providing monthly updates related to the solar garden interconnection queue. It further required Xcel to grant or deny developers permission to interconnect within 50 days of the application date.[66]

Hawaii

In 2007, installations of net metered distributed generation on the Hawaiian Electric Companies' (HECO's) territory topped 1 MW for the first time.[67] By the end of 2015, the HECO Companies reported that net metered installations had grown to 383 MW of capacity.[68] As of 2016, approximately 17 percent of customers on Oahu and 18 percent on Maui have installed solar photovoltaics (PV).[69] Over the past decade, distributed solar has become increasingly economic for Hawaiian residents as technology costs have fallen and electricity prices have soared.[70] Until recently, Hawaii's net metering policy allowed residents to reduce their electric bills by allowing them to offset their consumption from the grid with generation from their solar panels on a one-to-one basis. High electricity prices effectively increase the value of generation from solar panels for distributed generation (DG) owners, and prices across Hawaii

[63] Minnesota Public Utilities Commission, "Order Adopting Partial Settlement as Modified."

[64] Ibid.

[65] Ibid.

[66] Ibid.

[67] Hawaiian Electric Company, Inc., Key Performance Metrics: Renewable Energy, Number of NEM Program Participants and Capacity of NEM Program, Historical Data Workbook, downloaded August 23, 2016, available at https://www.hawaiianelectric.com/Documents/key_performance_metrics/03/historical_NEM_080116.xlsx

[68] Hawaiian Electric Company, Inc., Key Performance Metrics: Renewable Energy, Number of NEM Program Participants and Capacity of NEM Program, Historical Data Workbook, downloaded April 11, 2016, available at https://www.hawaiianelectric.com/Documents/key_performance_metrics/03/historical_NEM_020516.xlsx

[69] Hawaii Public Utilities Commission, Docket No. 2014-0192, Order No. 33258, Decision and Order Resolving Phase 1 Issues, October 12, 2015, page 161.

[70] A large percentage of electricity costs in Hawaii are driven by fuel costs, and thus the electricity rates rise and fall with the price of crude oil. Prices in 2016 are now much lower than they were a few years ago, but this could change quickly.

have been the highest in the nation. The effective price of electricity on Oahu rose from approximately $0.17/kWh in 2006 to approximately $0.32/kWh by late 2008, largely due to increases in crude oil prices.[71] Other islands have experienced even greater price increases.

Hawaii has modified compensation for distributed solar generation. Under the transitional Grid Supply option, compensation for exports has been reduced to $0.15/kWh. For an average customer who purchases a solar array outright, this will increase the payback period from approximately 6 years under the previous net metering arrangements to 8 years. Such an increase in the payback period will likely slow, but not stall, additional solar development, since customers may be able to finance or lease a system to achieve a shorter payback period (albeit with lower overall savings).[72] Further reductions in the compensation for exports would lengthen the payback period further, increasing it to approximately 13 years if compensation for exports were reduced to zero.[73]

Arizona

Under net metering, customers are effectively compensated at rates based on kilowatt-hour energy usage (and possibly also kilowatt demand) applicable to their rate class. However, changes to the underlying rate structure can profoundly impact customer economics. For example, increasing the fixed charge or adding a demand charge will reduce the customer's variable rate (assessed on kilowatt-hours), thereby reducing the effective compensation for customer generation. The Salt River Project (SRP) is an example of a solar policy that drastically *reduced* the number of customers seeking to build rooftop solar through adjusting the rates applicable to customers with distributed generation. In December 2014, SRP introduced a new price schedule called the Customer Generation Price Plan.[74] Plan participation is mandatory for all customer-generators who do not purchase all their energy from SRP. The new pricing plan added a fee averaging approximately $50 per month to all leased and owned solar systems, mainly via a new monthly demand charge.[75] The subsequent drop in new rooftop solar applications was dramatic. In the year before the new fees were implemented, an average of 675 solar systems were

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[71] Hawaii Public Utilities Commission, Responses to Frequently Asked Questions Concerning Electricity Rates and Oil Prices, August 2, 2012.

[72] For example, according to Clean Power Research's WattPlan (available at https://hawaiianelectric.wattplan.com/), a system may have a payback period of 7 years if purchased outright, but a payback period of 3 years with a 20-year loan, or one year with a lease.

[73] These estimates assume that the effective retail rate for electricity remains at approximately $0.24/kWh. Were this to decline to $0.20, the payback period would lengthen by approximately one year.

[74] Salt River Project Agricultural Improvement and Power District, "E-27 Customer Generation Price Plan for Residential Service," June 23, 2016, http://www.srpnet.com/prices/pdfx/April2015/E-27.pdf.

[75] Peter Fairley, "Utilities and Solar Companies Fight Over Arizona's Rooftops," IEEE Spectrum: Technology, Engineering, and Science News, June 19, 2015, http://spectrum.ieee.org/green-tech/solar/utilities-and-solar-companies-fight-over-arizonas-rooftops.

installed per month. In 2015, after the new fee went into effect, solar installations fell to 39 per month, a 94 percent decrease.[76]

[76] Analysis of data from "ArizonaGoesSolar.org Salt River Project (SRP)," accessed June 24, 2016, http://www.arizonagoessolar.org/UtilityPrograms/SaltRiverProject.aspx.

Montana Community-Scale Solar Developments

Introduction

Across the United States, residential solar photovoltaics (PV) have increased dramatically in the last few years from approximately 2 GW in 2010 to 28.5 GW at the end of 2016. The benefits of these installations are clear: they reduce a customer's need for electricity from the grid, lower electricity bills, and, in some cases, even allow customers to sell their own excess generation back onto the grid. For customers who are not homeowners or who own homes that are not well-suited for a solar array, these benefits may seem out of reach. Community solar presents these customers with an option to harness the benefits associated with solar panels without needing to install panels onsite at their homes. As a form of "shared renewables," community solar facilitates a way for customers to pool their commitment to clean energy and support larger, centralized installations of renewable energy.

Community Solar is a solar electric system that provides power and/or financial benefit to multiple community members who have voluntarily participated in the program. Community solar enables individual who may not be able to host a solar array on his/her rooftop to participate in solar.

Virtual net-metering is a **bill crediting** system that enables customers to receive a credit for solar production not located at the customer premises. For a community solar project, the bill credit is based on an individual proportional ownership in the project. For example, a utility may credit an electric bill at a rate of $0.10 per kWh for each kWh generated by the solar array. In a month, the customer owned panel generates 300 kWh of electricity. The resulting bill credit for that month would be $30 ($0.10/kWh times 300kWh).

Community Solar Hub, a clearinghouse of online resources for community solar stakeholders has identified 101 community solar projects across 26 states, totaling a combined capacity of almost 110 megawatts. According to the SEIA, that value will increase tenfold over the next five years, with the industry slated to add 1.8 gigawatts of capacity by the early 2020s. These projections pale in comparison to residential PV projections (32.9 GWs by 2018), but demonstrate that there is the potential for substantial growth in community solar.

As of 2017, Montana currently has four operational community solar projects—Ravalli Electric Cooperative, Flathead Electric Cooperative, Missoula Electric Cooperative, and Fergus Electric Cooperative. In addition, NorthWestern's Bozeman 338 kW solar project provides virtual net-metering for approximately 60 residential and commercial customers.

Montana can learn from the experiences of other states with higher levels of solar penetration.

Case Study Summary

All four projects in Montana are fully subscribed—despite the fact that the payback periods for the projects range from 9 years to approximately 23 years.

Four of Montana's electric cooperatives have successfully installed community solar projects within their respective service territory. Each of the four cooperatives has utilized a panel ownership model that enables participants to purchase panels from the cooperative. Montana-Dakota is in the preliminary stages of studying a community solar project to be located within its integrated system. Because Montana-Dakota never deregulated, the net metering rules that apply to the utility allow for it to implement community solar projects.[77] Conversely, there are specific Montana laws regarding net metering that apply to NorthWestern, because of its re-regulation a decade ago, that specifically rule out the most common community solar project structures, limiting the utility's ability to implement these types of projects.[78] All four cooperatives view their respective projects as a success based on interest from their respective members. While all four cooperatives do not have current plans to add additional projects, all four would undertake additional projects should their members want additional projects.

[77] Montana-Dakota's net metering policy is set forth in the Montana Public Service Commission's 2007 Order 6846f in Docket 2007.7.9. Available at http://www.psc.mt.gov/Docs/ElectronicDocuments/pdfFiles/D2007-7-79_6846f.pdf

[78] NorthWestern Energy's net metering rules are mandated under statute, Montana Code Annotated (MCA) 69-8-601. Available at http://leg.mt.gov/bills/mca_toc/69_8_6.htm

A summary of the four cooperative projects is below:

Table 5. Summary of Montana Electric Cooperative Community Solar Projects

	Ravalli Electric	Missoula Electric Cooperative	Flathead Electric Cooperative	Fergus Electric Cooperative
Project	Valley Solar (Phase I and II)	Community Solar (Phase II)	SUN Community Solar	Cooperative Solar
Year	2016	2016	2015	2017
Project Size	50kW	50kW	101kW	100kW
Number of Panels	176	184	356	324
Cost Per Panel	$750	$700	$900	$595
Outside Grant Funding	Yes	Yes	Yes	No
Approximate Payback per Panel (Inclusive of Federal Investment Tax)	20 years	23 years	21 years	9.4 years
Notes http://www.ravallielectric.com/valley-solar/ http://missoulaelectric.com/Our%20Community%20Solar%20Program https://www.flatheadelectric.com/community/sun-community-solar-program/ http://www.ferguselectric.coop/content/cooperative-solar				

Ravalli Electric Cooperative

Ravalli Electric Cooperative's Valley Solar is a two-phase 176-panel 50 kW project developed based upon feedback from its cooperatives members.[79] In 2015, the Cooperative undertook a survey to measure interest for a community solar project. The results of the survey indicated that there were enough cooperative members willing to pay for solar panels that Ravalli proceeded with the Valley Solar project.[80] During the design stage of the project, the cooperative received grant funding from the Bonneville Environmental Fund (BEF) and the United States Department of Agriculture (USDA) to help defray some of the initial costs of the project.

[79] http://www.ravallielectric.com/valley-solar/

[80] http://www.ravallielectric.com/wp-content/uploads/2015/09/2015-Solar-Survey-Results.pdf

Figure 15 Ravalli Electric Cooperative Solar Array

Ravalli's system is approximately 98 percent hydropower from energy purchased from the Bonneville Power Administration (BPA). As a result, Ravalli's electric rate

is approximately $0.07/kWh. Ravalli's low electric rate means that the payback period for its community solar project is expected to be over 20 years based on an anticipated annual output of 350 kWh per panel.

The two phases of the project are located on land adjacent to one of the cooperative's substation as shown in photograph of the project. This avoided the need to acquire additional land for the project and allows the Cooperative to expand the project should there be sufficient interest for additional future phases. Ravalli's design incorporated adjusted tilt axis to enable the co-op to adjust the panels during the year to increase the electricity generation of the project.

Missoula Electric Cooperative

Missoula Electric Cooperative's (Missoula Electric) solar program was also developed in two phases. Phase I is located at one of the cooperative's substation. Missoula Electric obtained both USDA and BEF grants to offset some of the costs associated with the first phase of the project. The 174 panels sold out quickly in 2015, even with an expected 25-year payback period.

In the fall of 2016, the cooperative initiated its Phase II community solar project, a 184-panel 50 kW project. Missoula Electric worked with the Frenchtown school district to install all the panels on one school building. In return, the co-op gifted one of the panels to the school. Phase II did not receive any grants. The cost per panel, however, was the same as Phase I due to decreased project capital costs. Missoula Electric structured the project to receive credits from the panels over 25 years.[81]

[81] http://missoulian.com/news/local/sun-on-the-roof-frenchtown-schools-mec-partner-on-solar/article_3409954b-dd06-502f-99a6-13ffbd178f50.html

Figure 16 Missoula Electric Cooperative Solar Array at Frenchtown

Missoula Electric limits the number of panels that individual may purchase to the equivalent of 80 percent of their 12-month electric bill based on a panel production expectation of 338 kWh per year. In addition, Missoula enabled participants to obtain zero percent financing through the co-op for their panel purchases.

Missoula Electric has indicated that it believes it is not feasible to purchase land for future projects, but that it is willing to work with municipalities to identify suitable rooftops. This strategy has garnered support from municipalities that purchased panels in the Phase I and Phase II projects. Missoula Electric has also expressed an interest in partnering with local schools and entities to develop community solar projects.

Like the other cooperatives, Missoula Electric has structured its community solar projects to enable participants to claim the federal investment tax credit.

Missoula Electric's current system is predominantly hydro and wind. As a result, the co-op has advertised that the carbon free aspects of its solar projects would only offset approximately five percent of the cooperative's remaining carbon dioxide emitting generation.

Flathead Electric Cooperative

Flathead Electric Cooperative developed its 324 panel 100 kW Solar Utility Network (SUN) community solar project in 2015.[82] During Flathead's investigation process, Ravalli Electric Cooperative gave Flathead access to its community solar survey results. Because Flathead considers the profiles of Ravalli's members like its own, Flathead extrapolated the Ravalli survey results to its service territory. With 50,000+ members, Flathead is a significantly larger cooperative than Ravalli, so it felt confident that it could generate sufficient interest in its territory to support a community solar project akin to Ravalli's project.

Figure 17 Flathead Electric Cooperative Solar Array

Flathead's system is approximately 97 percent carbon-free based on energy purchased from the Bonneville Power Administration (BPA). Flathead's low electric rate means that the payback period for its community solar project would be approximately 21 years based on an anticipated annual panel output and current electric rates. The cooperative provided a 12-month on-bill payment plan at zero percent financing for participants.

The project is located on land owned by the cooperative. This avoided the need to acquire additional land for the project. For future projects, the cooperative is interested in access to rooftops within its territory.

Fergus Electric Cooperative

In August 2017, Fergus Electric Cooperative (Fergus) energized its 100-kW Cooperative Solar array based upon feedback from its cooperatives members. In August 2016, the Cooperative undertook a telephone

[82] https://www.flatheadelectric.com/community/sun-community-solar-program/

survey to measure interest for a community solar project among other issues. The results of the survey indicated that there were enough cooperative members willing to pay for solar panels that Fergus Electric proceeded to propose a solar project before its governing board.[83] In June 2017, the Company broke ground on the project.

Figure 18 Fergus Electric Cooperative Solar Array

The project is located on land adjacent to the cooperative's headquarters outside Lewistown, MT. This avoided the need to acquire additional land for the project and allows the Cooperative to expand the project should there be sufficient interest for additional future phases.

Of the 324 solar panels installed, the cooperative has sold 236 panels at a cost of $595 per panel. Cooperative members are limited by his/her annual energy consumption in the number of panels that one may purchase. Fergus did not seek any grants any specific grants for the project.

Fergus has set a 20-year length to the program currently, however the cooperative may extend the program beyond the 20-years depending on the performance of the array. During the 20-year period, Fergus will credit each kWh generated by a panel at $0.10 per kWh. Fergus estimates that each panel will generate about 450 kWh/year.[84] This implies a payback period of 13.2 years before including the 30% federal investment tax credit for solar panels.

Other Community Scale Projects

Municipal procurement of solar has many advantages that can spur distributed generation for the benefit of all customers. Electricity bill reductions resulting from the installation of solar reduce the operating revenues required, thereby freeing up taxpayer funds for other public uses, or lowering the overall tax revenues that must be collected. In addition, many municipal properties offer useful real estate space for solar PV panels in terms of area and technical requirements. For example, many public

[83] http://www.ferguselectric.coop/content/cooperative-solar

[84] http://www.ferguselectric.coop/content/frequently-asked-questions

buildings such as schools and police stations tend to have flat rooftops or surface parking lots make them ideal for the installation and housing of solar panels. Cost is an obvious barrier to the development of municipal solar. For one, local governments cannot take advantage of federal tax incentives because the cities/towns are tax-exempt entities.

Other entities within Montana have also developed solar projects across the state. The Montana Renewable Energy Association (MREA) provides detailed profiles of several solar projects that represent a cross-section of the types of solar projects that have been installed across Montana.[85]

[85] http://montanarenewables.org/profiles/

Missoula Parking Commission

In 2013, the Missoula Parking Commission broke ground on the Park Place parking garage in downtown Missoula.[86] The 85 kW project on the roof deck of the garage was the largest solar array in the state when the project was completed later in 2013. The Parking Commission believed that a solar array would help differentiate the design of the parking structure and promote awareness of renewables within the community. The Missoula Parking Commission estimates that the solar array currently offsets approximately 80 percent of the electricity needs of the garage. Separately, NorthWestern Energy has installed electric vehicle chargers in the garage on separate meters.

Figure 19 Park Place Parking Garage Solar Array

Initially, the Missoula Parking Commission did not have the funding available to include the solar array as part of the project. However, the Missoula Parking Commission financed the costs associated with the solar array installation by selling off a portion of the garage to a local establishment. In addition, the Missoula Parking Commission received funding from a NorthWestern Energy grant for $57,500 to help defray the cost of the solar array.

With the rooftop design, the Missoula Parking Commission has experienced some challenges with snow damage to cars parked below the panels during winter. Their solution has been to install snow deflectors to avoid parking spaces.

[86] https://www.ci.missoula.mt.us/489/Parking-Structures

Darby Library

In 2004, the town of Darby completed its new library. At the time, the steering committee desired to install solar, but could not due to costs. The library revived planning for a solar installation in 2016 after members learned about the positive experience with a solar installation at the Hamilton Council of Aging. In reviving the project, the library obtained a NorthWestern Energy grant that helped to defray almost 90 percent of the project's cost. In addition, local engineers, architects, and installers donated time to the project. The combination the grant award and donations of time enabled the library to energize the 20.15 kW solar project in 2017 without incurring any debt. [87]

Figure 20 Darby Library Solar Array

NorthWestern Energy Bozeman Solar

The 2016 300 kW Bozeman Solar project located on land at the Bozeman sewage treatment plant represents a partnership between NorthWestern Energy and the city of Bozeman. [88] NorthWestern committed up to $1 million for the project and assumed the construction and operating costs of the project. The City of Bozeman provided use of the land. Montana State University will help with research tied to the five-year pilot project.[89]

[87] http://montanarenewables.org/profiles/system-profiles/#darbylibrary

[88] http://www.northwesternenergy.com/news/2016/09/30/NorthWestern-City-of-Bozeman-MSU-Launch-Solar-Project

[89] https://explorebozeman.com/bozeman-solar-project/

Figure 21 NorthWestern Energy and Bozeman Solar Array[90]

NorthWestern Energy estimates that Bozeman Solar pilot project will have energy output of approximately 533,000 kilowatt-hours per year, or enough to power about 54 homes. As part of the project, NorthWestern Energy also installed 40 residential and 20 commercial advanced meters to help the project partners better understand how solar power aligns with customer needs.[91]

Montana-Dakota Utilities

Montana-Dakota is currently investigating the potential development of a community solar project within its territory for the 25,000 Montanans it serves.[92] As part of its investigation process, the company has commissioned a survey to gauge customer interest. Preliminary results indicate that there is interest in specific communities for a subscription-based solar project. Unlike the cooperative projects, Montana-Dakota is considering a larger project that would have a community solar component. Montana-Dakota indicated that it would need to acquire land to proceed with any future solar development.

Montana-Dakota's current generation fleet is approximately 20 percent renewables, but the company expects to increase to 25 percent renewables by the end of 2017. Montana-Dakota noted that one of its

[90] http://onsiteenergyinc.com/project-24

[91] http://www.northwesternenergy.com/news/2016/08/11/Installation-Work-Begins-on-Bozeman-Solar-Project

[92] MDU serves customers in Wyoming, North Dakota, South Dakota, and Montana.

challenges with solar is that its rates are in the $0.10/kWh range, making the economics of solar more difficult to justify in their analyses.

Common Themes across Montana

The four community solar projects within the state share several common themes that may be useful for future community solar project development within the state.

Ownership Structure

All four cooperatives structured their community solar projects to encourage members to purchase the panels or their output. The ownership structures enable members of the Flathead Electric, Fergus Electric, and Missoula Electric projects to claim the federal investment tax credit and allow cooperatives to recover the cost of the solar project development from members interested in the project. Because Ravalli Electric members purchased the output of the solar panels, while Ravalli Electric retained direct ownership of the panels, its members were not able to claim the federal tax credit. All four cooperatives strived to structure the community solar projects to avoid cost shifting—or even the appearance of it. They accomplish this by having the participants pay for the upfront costs associated with project. As a result, non-participant cooperative members do not pay for the project costs. Montana-Dakota is currently evaluating the use of a subscription service, where the utility would maintain ownership of the project, but participants would subscribe for the output at the panel. All the projects limited the number of panels any one participant may own to prevent any one person from making money from the solar project. The limitation ranges from 80 to 100 percent of annual electricity consumption.

Outside Funding

Three projects received outside grant funding to help defray some of the associated project costs. Each project received grant funding from the Bonneville Environmental Fund. In addition, two of the projects received U.S. Department of Agriculture Rural Energy for America Program (REAP) grants.

No Land Acquisition Costs

Each of the four projects utilized either existing parcels of land owned by the cooperative or rooftop areas of local municipal buildings to help minimize total project costs. Ravalli's site can also accommodate additional phases.

Project Siting

Three projects are located next to existing substations or other property owned by the co-op, which obviates distribution system concerns at the interconnection point. One of projects is located on the roof of an existing school, also moderating challenges of acquiring land for the project. All of projects are in high visibility areas of their respective territories, thereby increasing awareness and acceptance of the projects while locating solar panels at a school also increases community awareness of the project. The four cooperatives have indicated that the energy fed back to the distribution system has not been a concern.

On-bill Payments

Ravalli Electric Cooperative implemented an on-bill financing mechanism, anecdotally, the option of having on-bill payments accelerated subscription to the project. The on-bill payments allow participants to spread payments for solar panels over the course of the year at zero percent interest.

Long Payback Periods

All four entities noted that the payback period for their respective projects were in the range of 9 to 23 years. In addition, the cooperatives noted that economic reasons were not the primary motivation for implementing the projects. For all the cooperatives, member support was significant enough to proceed forward with a community solar project.

Transferability

All four cooperatives have policies to enable the transfer of panel or output ownership for members moving out of the service territory to any other member of the cooperative.

Income Tax Considerations

The community solar projects are ineligible for Montana's $500 income tax credit for renewable energy systems under 15-32-201 MCA, because they are not sited on property owned by the participants.[93] This ineligibility has hurt the economics of the projects for participants. The cooperatives note that a change in Montana legislation to accommodate community solar projects would be helpful.

The four community solar projects do enable participants to qualify for the 30 percent federal income tax credit for solar since the participants have purchased the panel from the cooperative.

[93] http://www.mtrules.org/gateway/Subchapterhome.asp?scn=42%2E4%2E1

Successful Community Solar Projects

A recent *Utility Dive* article highlighted key takeaways from several successful community solar projects.[94] We have summarized some of the lessons for consideration in Montana.

- Utilities sited projects in areas of high visibility to build awareness of the project.
- While payback periods of projects vary by project, pricing of the project is key to success.
- Complicated pricing schemes may reduce demand for community solar projects.
- Some projects have found that a 19-year payback period is too long. Given that such projects may have exceeded demand, they likely were not sized adequately.

Ultimately, the article concludes that the key driver for a successful community solar project is the underlying customer demand for such a project.

Case Studies Summary

The four community solar projects installed in Montana to date have used cooperative customer information to structure projects that were ultimately considered successful. Economically, the largest barrier to community scale solar in Montana may be the long payback period of investments in solar energy. Although the solar resource is abundant in Montana and the costs of solar panels are declining nationwide, Montana's low electricity rates mean that ownership of a share of a community solar project in Montana will generate less savings on customer utility bills than in states with equivalent solar resources but higher electricity rates. The four community solar projects examined here demonstrate that there is sufficient interest in community solar. The key goal for policymakers is to maintain and expand interest for additional community solar projects in other parts of the state.

Because Montana-Dakota never deregulated, the net metering rules that apply to the utility allow for it to implement community solar projects. Conversely, there are specific Montana laws regarding net metering that apply to NorthWestern, as a result of its re-regulation a decade ago, that specifically rule out the most common community solar project structures, limiting the utility's ability to implement these types of projects.

[94] http://www.utilitydive.com/news/what-makes-a-successful-utility-led-community-solar-program/442663/

Appendix A: Solar Variability Estimate

An estimate of Montana solar variability is presented in Figure 22, in which “variability” is meant the typical change of total, aggregated solar power production from the state’s combined BTM and QF solar fleet on a 1-minute basis. Other variability metrics could also be defined for other purposes with different time scales or aggregations, for example, 10-second variability on a distribution feeder.

The analysis is based on a method developed by CPR using field data collected by CPR in Napa, California, on what was believed to be a worst-case, short-term variability day, i.e., a day with many fast moving patchy clouds. Data was collected using a network of 25 sensors on November 10, 2010 at 12:00 noon.

Similar worst-case variability is assumed here for Montana. Note that California (where the data was collected) would be expected to have fewer high-variability hours and higher solar production in general, but the issue described here relates to the changes in power output caused by clouds alternatively shadowing and exposing solar panels. Actual Montana variability would require a separate data collection project using a high-speed sensor network (such high-speed data was not available for this assessment).

Plant Density	100	Watts/sq. meter
Time Interval	1	minute
Clear Sky Irradiance	580	Watts/sq. meter
Std. Dev. Of Change in Clearness Index at 1 Location	0.165	

(1) Number of Plants	(2) Plant Capacity (kW)	(3) Plant Output (kW)	(4) Std. Dev. of Change in Clearness Index	(5) = $[(3) \times (4)]^2$ Variance Per Plant	(6) = (1) x (5) Variance All Plants
1700	5	3	0.163	0.2	385
170	10	6	0.162	0.9	151
3	100	58	0.157	82.6	248
6	3000	1740	0.128	49,634.0	297,804
Total	**28,551**	**16,560**			**298,587**

(7) = SQRT(Total Variance All Plants)	**Standard Deviation (kW) =**	546
(8) = (7) / Total Plant Capacity	**Standard Deviation (% of Capacity) =**	1.91%

Figure 22. Estimated 1-minute solar variability for Montana

Based on this data, the standard deviation in the 1-minute change of clearness index[95] for a single point measurement was 0.165. This means that at a single point the output of a small PV module will typically change by about +/- 16.5% of its maximum possible output per minute during a highly variable hour.

Using scaling methods developed separately that represent the inter-point diversification as a function of distance, this value was applied to plants of different sizes. This accounts for the fact that larger resources have lower variability than smaller resources due to cloud transition time. The calculation assumes that, while each plant exhibits that same point variability, 1-minute changes in power output at each plant is uncorrelated with the others. That is, each plant is spaced sufficiently far from the others to assume uncorrelated power fluctuations.[96]

The estimate is made as follows. A distribution of sizes is assumed for Montana in the first two columns. This data is approximate as it was not available for the study. Total capacity is about 28 MW, corresponding to Montana's current estimated installed BTM capacity of 11 MW plus its 17 MW of QF capacity. At an assumed irradiance of 580 W per square meter (at the time of high variability), the clear sky plant output is calculated for each resource in column 3. Column 4 shows the standard deviation of the change in clearness index for each resource, based on the standard deviation at a point location and

[95] Clearness index is the ratio of actual solar irradiance to the irradiance that would be observed in the absence of clouds. Thus, plant output at any time is the rating of the plant times the clear sky irradiance times the clear sky index.

[96] CPR has developed methods for calculating variability with correlated resources. Such a study could be performed in the future if system data and locations are available.

the corresponding physical resource size in square meters. The variance of each resource is calculated, and these are summed for the whole state.

The estimated variability is 546 kW or 1.9% of the total state solar fleet rating. This is calculated as the square root of the sum of squares of individual plant variability. In other words, the typical 1-minute variation in total power output for the 28 MW of solar resources would be about +/- 546 kW on a worst-case day. An additional regulation reserve of 546 kW is required in Montana to handle this variability over and above the resources required to handle variability of load alone.

A similar calculation can be performed for a future set of resources corresponding to the 55 MW of solar capacity estimated for 2027 (38 MW BTM plus 17 MW QF). Scaling the resource counts in column 1, the statewide variability becomes 548 kW, or 1.0% of fleet rating. Thus, the increase in dispersed solar resources, without additional large QF projects, does not materially affect the total variability, so no additional regulation reserves would be required relative to the required amount today.

Appendix B: Payback Calculation Details

Simple payback for the selected scenarios is calucated as follows. First, the scenarios are for average electricity consumption by utility and class. These were calculated from EIA data of total sales and total usage, and the results are shown in Table 6. The target electricity production from PV was assumed to be 80% of total annual electricity consumption, typical for NEM customers. The hourly fleet simulations were then summed to give total annual solar energy production per kW (AC-CEC) of rated capacity. Dividing the target energy by the production rate gives the assumed rating of the PV system, and this is then converted to a DC rating using typical performance assumptions.

The cost of the systems are based on current NREL published installed costs of $2.93 and $2.13 per Watt-DC for residential and commercial systems, respectively. From this, the total system costs were calculated. Finally, inverters were sized at 110% of the CEC-AC system rating.

CPR’s PowerBill calculation engine and rates database was used to determine bill savings and payback period as shown in Table 7. This engine uses internal hourly consumption profiles relevant to each rate, and hourly PV production for typical generation years.

Table 6. PV system sizing

Entity	Customer Class	(A) Average Annual Usage (kWh)	(B) Target Energy Production (kWh)	(C) Typical Production (kWh per kW AC-CEC)	(D) PV System Size (kW AC-CEC)	(E) Array Rating (kW DC-STC)	(F) System Cost ($/W-DC-STC)	(G) Total System Cost ($)	(H) Inverter Max Power Rating (kW AC)
Flathead Electric Coop Inc	Residential	12,939	10,351	1,310	7.9	9.1	2.93	26,657	8.7
Flathead Electric Coop Inc	Commercial	42,784	34,227	1,322	25.9	29.8	2.13	63,478	28.5
Montana-Dakota Utilities Co	Residential	9,429	7,543	1,379	5.5	6.3	2.93	18,458	6.0
Montana-Dakota Utilities Co	Commercial	51,363	41,090	1,389	29.6	34.1	2.13	72,572	32.6
NorthWestern Energy LLC - (MT)	Residential	8,205	6,564	1,370	4.8	5.5	2.93	16,162	5.3
NorthWestern Energy LLC - (MT)	Commercial	45,744	36,595	1,383	26.5	30.5	2.13	64,878	29.1

(A) **Average Annual Usage (kWh)** is the EIA-reported total sales in Megawatt-hours times 1,000 to convert to kWh, divided by EIA-reported number of customers.

(B) **Target Energy Production (kWh)** is 80% of the **Average Annual Usage** (A)

(C) **Typical Energy Production (kWh)** was obtained by taking the average production for each of the PV fleets that were modeled.

(D) **PV System Size (kW AC-CEC)** equals **Target Energy Production** (B) divided by **Typical Energy Production** (C)

(E) **Array Rating (kW DC-STC)** equals **PV System Size** (D) divided by a typical average CEC inverter efficiency rating of 96.5%, divided by a typical module derate factor of 90%.

(F) **System Cost ($/W DC-STC)** is based on current NREL published installed costs of $2.93 and $2.13 per Watt-DC for residential and commercial systems, respectively

(G) **Total System Cost ($)** equals **System Cost ($/W DC-STC)** (F) times 1,000 to convert to $/kW, times **Array Rating (kW DC-STC)** (E)

(H) **Inverter Max Power Rating (kW AC)** equals **PV System Size** times 110% (to avoid output clipping during modeling)

Table 7. Calculation of simple payback

	A		B	C	D	E	F	G		H			I
Scenario	Current Total Bill ($)	Proposed Total Bill ($)	Energy Produced (kWh)	Energy Exported (kWh)	Energy Used On-site (kWh)	Energy from Utility (kWh)	Energy Consumption (kWh)	First Year Bill Savings ($)	Bill Savings ($ per kWh Produced)	Federal Tax Credit ($)	State Tax Credit ($)	Total System Cost ($)	Simple Payback Period (Years)
Flathead Residential	$ 1,204	$ 412	10,948	5,853	5,095	7,844	12,939	$ 792	$ 0.072	$ 7,997	$ 500	$ 26,657	22.9
Flathead Non-Residential	$ 2,967	$ 925	34,203	14,461	19,741	23,043	42,784	$ 2,042	$ 0.060	$ 19,043	$ -	$ 63,478	21.8
MDU Residential	$ 965	$ 155	8,443	4,695	3,749	5,680	9,429	$ 811	$ 0.096	$ 7,934	$ 500	$ 18,458	12.4
MDU Non-Residential	$ 3,914	$ 745	42,694	18,382	24,311	27,052	51,363	$ 3,170	$ 0.074	$ 22,672	$ -	$ 72,572	15.7
Northwestern Residential	$ 968	$ 137	7,420	4,150	3,270	4,935	8,205	$ 831	$ 0.112	$ 4,849	$ 500	$ 16,162	13.0
NorthWestern Non-Residential Non-Demand	$ 5,578	$ 954	38,400	16,823	21,577	24,167	45,744	$ 4,623	$ 0.120	$ 19,463	$ -	$ 64,878	9.8
NorthWestern Non-Residential Demand	$ 4,465	$ 1,328	38,400	16,823	21,577	24,167	45,744	$ 3,137	$ 0.082	$ 19,463	$ -	$ 64,878	14.5

A — **Current Total Bill ($)** is the total annual electric bill calculated for a customer, based on the Average Annual Usage from Table 4. **Proposed Total Bill ($)** is total annual electric bill calculated for a customer based on **Average Annual Usage** (A) from Table 6 minus energy production from the system described in Table 6.

B — **Energy Produced (kWh)** is the total annual energy produced by the PV system described in Table 6.

C — **Energy Exported (kWh)** is the portion of **Energy Produced** (B) that was exported to the grid and not used on-site.

D — **Energy Used On-site (kWh)** is the portion of **Energy Produced** (B) that was used on-site and not exported to the grid.

E — **Energy from Utility (kWh)** is the total annual energy that could not be supplied by the PV system and needed to be purchased from the utility.

F — **Energy Consumption (kWh)** is the total annual energy used by the customer. This is the same as the Average Annual Usage from Table 6 and is equal to **Energy Used On-site** plus **Energy from Utility**.

G — **First Year Bill Savings ($)** is the amount the customer would save on their electric bill in the first year. **Bill Savings ($ per kWh Produced)** is equal to **First Year Bill Savings** divided by **Energy Produced** (B)

H — This section shows the calculated **Federal Tax Credit ($)**, **State Tax Credit ($)**, and the **Total System Cost ($)**, which is the same as **Total System Cost** (G) in Table 6.

I — **Simple Payback Period (Years)** is calculated as the net cost (**Total System Cost** minus **Federal Tax Credit** plus **State Tax Credit**) divided by the **First Year Bill Savings** (G)