Solar Photovoltaic Power in North Dakota

A market oriented solution to enable small scale commercial Solar PV generation in North Dakota

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Grassroots Development

Citizens Local Energy Action Network (CLEAN)

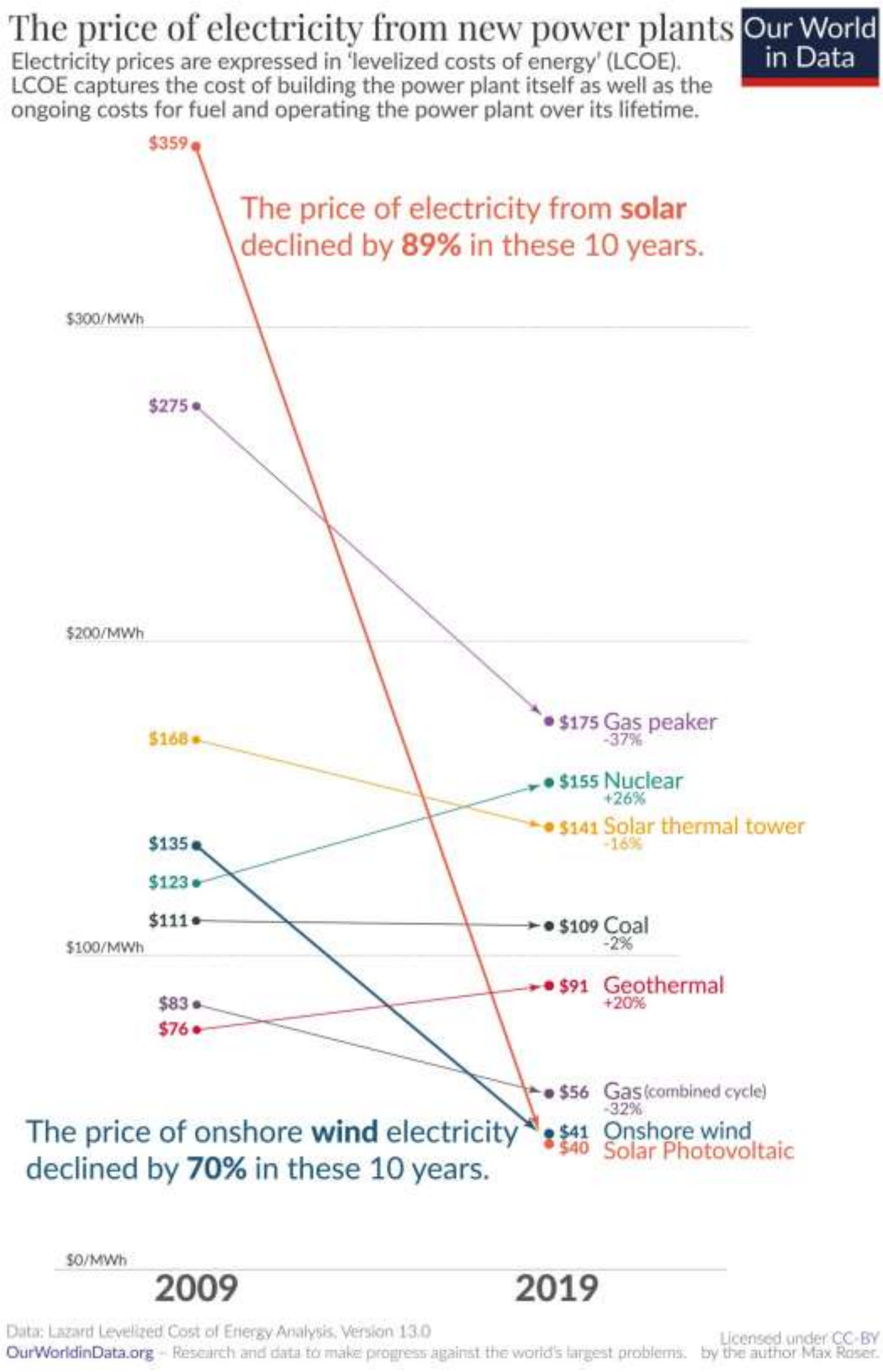
There are several important differences between the governing arrangements for privately owned Solar Photovoltaic (SPV) arrays in North Dakota and Minnesota. These differences have caused North Dakota to trail Minnesota significantly in its rate of solar adoption, despite North Dakota having a more favorable physical environment for SPV development. This paper will detail the differences in policy between these states and several others regionally and nationally, demonstrate their quantitative effects on solar viability, and to demonstrate the long term effects of these policy differences on the residents of the state. Before delving in to the details on policy, it is important to survey the state of the industry both globally and in each state, the relative quality of the solar resources available, the nature of the economics, and SPV's ability to fit to the demands of each state.

Since the mid-2000's, when the development of the solar PV manufacturing industry become a topic of strategic national importance, the economics of solar PV have improved at an unprecedented rate. This improvement has come from many facets of the technologies themselves and the broader industry. First, the technology and operational scale for the refinement of silicon has improved, reducing material costs, while increasing the quality of silicon being used in panels. This and other advances in material science have decreased panel cost while increasing the yield of solar energy converted to electrical current. High-end monocrystalline panels now have efficiencies in excess of 22%, compared to yields in the low teens a generation ago, and efficiencies in the high teens is common for mass market grades. Inverters, which convert the Direct Circuit (DC) current produced by panels into the Alternating Current (AC) used by most electrical implements, have seen advances in design and durability, and the vast increase in production has improved economics there as well. A wide variety of mounting units have proliferated to utilize the improved panels. Distribution and installation networks have increased vastly in scale and scope. New legal mechanisms to aid the financing and management of arrays have been created a proliferated. The net result is an enormous decline in the cost of installed solar, and a solar industry producing orders of magnitude more power than the experts expected a decade ago.

Levelized Cost of Energy (LCOE) estimates, like those from Lazard, if anything overstate the cost of power from SPV. With SPV most of the costs of operation are upfront, in materials and installation, and requires little in operation costs beside insurance and land maintenance. 'Hurdle rates' used in financial analysis significantly warp the analysis for solar versus other technologies, placing little economic value on potentially decades of low maintenance operation and undervaluing the high late-life upkeep costs of other technologies.

A comparison to the rental housing market is apt. In a strong market, the clearing rate for market rate rentals is the construction cost of new units, and this is independent of whether an individual unit is still paying debt. Thus, once the debt on the building is repaid, its profitability can be very high, and buildings typically vastly outlast their debt financing instruments. Like a building, an array will need insurance, and will require a new inverter about as often as a home needs a new furnace. Like a rental property, a solar array is a durably long lasting, revenue generating asset, but will lower maintenance costs.

Mass usage of solar power however will require significant improvements in energy storage technology capacity, as the sun only shines for portions of the day. Storage technology has also improved in recent years due to economies of scale in production and distribution of lithium based batteries. A number of alternate battery technologies are in various stages of development which could offer dramatic decreases in cost and improvements in lifespan and energy storage density.



The price of electricity from new power plants
Electricity prices are expressed in 'levelized costs of energy' (LCOE).
LCOE captures the cost of building the power plant itself as well as the ongoing costs for fuel and operating the power plant over its lifetime.
Our World in Data
The price of electricity from solar declined by 89% in these 10 years.
$300/MWh
$200/MWh
$100/MWh
$0/MWh
$359
$275
$168
$135
$123
$111
$83
$76
$175 Gas peaker -37%
$155 Nuclear +26%
$141 Solar thermal tower -16%
$109 Coal -2%
$91 Geothermal +20%
$56 Gas (combined cycle) -32%
$41 Onshore wind
$40 Solar Photovoltaic
The price of onshore wind electricity declined by 70% in these 10 years.
2009
2019
Data: Lazard Levelized Cost of Energy Analysis, Version 13.0
OurWorldinData.org – Research and data to make progress against the world's largest problems.
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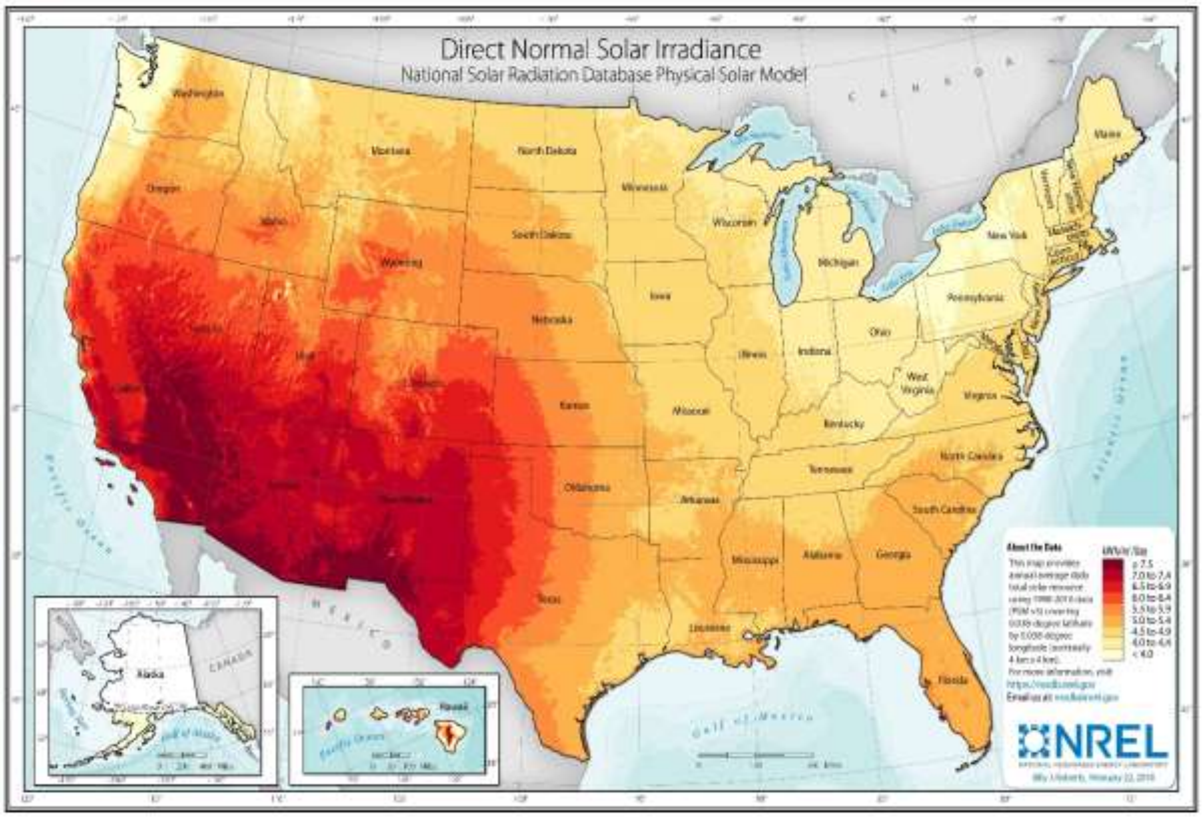
North Dakota has superior solar potential to Minnesota, with particularly good potential in the south and west in oil and coal country. This region already has the infrastructure to transmit electricity to Minnesota as a result of its existing coal and natural gas generation industry, including an HVDC line. As a rule, both North Dakota and Minnesota have better solar potential going south and west.



Despite this, the rate of SPV adoption in North Dakota is significantly behind that of Minnesota, or for that matter virtually every other state in the union. Minnesota in fact leads several regional states in its percentage of power from solar sources, and this is led by investor-owned generation. Utility solar production capacity in the state in 2019 was a mere 2.3 MW, compared to 892 MW from private investors. Net-metered solar arrays add 86 MW of solar generation capacity. The scale of investment in solar compared to its neighboring states, all with better natural amenity, shows the scale of the policy differences between the states.

These policies also effect who owns the solar generation capacity, and thus the returns. In New York most of the generation capacity is small and midsized net-metered arrays, while in Minnesota and North Carolina private investors own a majority of the capacity. These policy differences are stark, and as this report will later demonstrate, these policy differences have major economic consequences.

Table 1: Solar Generation and Capacity for Regional and Selected States									
	ND	SD	MN	MT	NE	MI	NY	NC	AZ
Total Electricity Production (MWh)	41,147,324	14,506,647	59,379,390	27,797,079	37,297,615	116,701,343	131,603,289	131,173,861	113,551,987
Total Solar Generation Except Net Metering (MWh)	0	1,829	1,248,833	29,393	31,706	142,961	523,640	7,451,338	4,486,377
Total Solar Capacity (MW)	0.392	1.666	980.8	37.2	30.9	230.958	2,000.7	4,609.0	3,356.9
Utility Owned Solar Capacity (MW)	0	0	2.3	0	2.6	62.5	0	309.0	300.8
Investor-Owned Solar Facility (MW)	0	1.0	892.3	17.0	20.7	102.0	482.5	4,168.8	1,564.5
Net Metered SPV Capacity (MW)	0.392	0.666	86.163	20.242	7.562	66.458	1,518.199	131.195	1491.562

Net metering is the core state policy for the promotion of small scale independently owned solar arrays. Under net metering, the owner is connected to the electricity utility, and draws from the power grid as needed, and returns any surplus generation to the grid. The owner pays or is paid for their net usage of electricity. There is some controversy here, as net-metering opponents accuse solar panel owners of not paying for their share of grid operation and forcing other utility customers to subsidize their panels and profits with other's rates.

There is some truth to this, as utilities use their retail rates to maintain the electrical lines that connect users to the powergrid. However, if solar power producers were to simply reduce their consumption by a similar amount, other customers would still have to make up for the loss of revenue. Even in Minnesota, home to some of the richest rewards for net metered customers, net metered solar generation is only 9% of total solar capacity and a mere 0.2% of total power generation. This means that there is very little real cost to a generic retail electricity customer through this mechanism. Furthermore, the specifics of the net metering policy differ between states, varying by the rate of compensation for surplus generation, the period of accounting, the maximum size of a connected array, and often with different rules for investor and cooperatively owned utilities. Other states are less generous, offering average cost or 'avoided cost' rates or even complete seizure of surplus generation at the end of the billing period, as in New York or Montana.

Aside from the major federal tax benefits and granting programs, states have been free to adopt a wide variety of policy to encourage the construction of SPV generation capacity. These sets of policies can be categorized as demand side or supply side interventions. Minnesota is a good example of a state that has taken a demand side approach. Policy in the state encouraged construction of new arrays with the promise of rich revenue rewards, primarily through its net metering policy, which is generous compared with many of its peers. Minnesota offers full retail net metering, meaning that any surplus generation by the array owner must be reimbursed at the retail rate. The 40 kW maximum net-metered capacity is also well above average. Additionally, the state strongly encourages offsite net-metered Community Solar Gardens, which allows for net metered customers to take advantage of the economies of scale of a larger array, as if it were on their own property. Minnesota's policies are designed to create mid-scale distributed generation, and profits for small investors.

Other states have taken a different approach. New York, Montana, and others focused on supply side incentives to encourage investment, while limiting net-metering to the array owner's personal usage, with surplus power at the end of the net metering period being surrendered to the utility. New York gives farms (100 kW) and industrial operations (2 MW) higher net metering limits than homes and businesses (25kw), in order to enable operators to take advantage of federal tax credits and grants to the scale of their needs. In both these states and many others, there are modest tax credits (generally $1000 or less) that benefit the installation of smaller rooftop arrays, rather than the larger, revenue generating arrays encouraged by Minnesota, North Carolina and other states. This has been successful, and both these states have extensive small scale generation. Both also give support to utility scale generation as well, while leaving out the middle-scale arrays.

Other common programs that have been used around the country include the trade of Renewable Energy Credits and Solar renewable Energy Credits, Property Assessed Clean Energy (PACE) programs, low-interest loan and grant programs, statewide generation quotas, and incentives for equipment sales taxes, property taxes, and generation taxes.

No state followed exclusively a supply or demand side platform, with Minnesota having small supply side programs and New York having a reasonable demand side program. In the early phases of the solar boom, many states had strong pieces from both platforms, including various rates of net metering, production bounties, grant programs, tax credits and a variety of other policies. As production and logistics have improved, these states have moderated their incentives to conform to supply and demand. Many early adopting states built phase-outs for many public benefits into the law, and have since reached those phase-outs, and federal benefits are in the process of phase out.

There are several states, mostly major oil and coal producers, which have solar policies that seem to be designed to prevent the adoption of SPV at all, including both Dakotas. These states offer neither meaningful supply side support nor any plausible means to generate revenue from the arrays. Even utility-scale generation has been stymied by state and utility policy.

Table 2: Selected State Policies

	Net Metering	Net Metering %	Net Metering Max Size	REC's Belong to:
Minnesota	Yes	100	40 kw	Generator
North Dakota	Utility Customers	Avoided Cost	100 kw	End User
Nebraska	Yes	Avoided Cost	25 kw	Generator
South Dakota	not required	-	-	-
Montana	not required	0% after annual net	50 kw	-
Michigan	Yes	retail under 20kw, average cost of generation to 150 kw	150 kw	Generator
New York	Yes	voided cost or forfeited	25kw Residential, 100 KW farm, 2 MW commercial	No Trading
North Carolina	yes	0% after annual net	1 MW	Utility
Arizona	yes	avoided cost of total production	125% of annual load	Customers

North Dakota has a very generous maximum net-metered array size, 100 kW. This is 4 times the size of the typical 25 kW and 2.5 times the maximum array size in Minnesota. Under North Dakota's variation of net metering, at the end of each month, any surplus power is reimbursed at the 'voided cost' rate, which is generally around 20% of the retail electricity rate. This is only available to customers of investor owned utilities, and is not mandated by law for members of the state's power cooperatives, who include many of the farmers and landholders most able to take advantage of their natural resource. Cooperatives must allow connection under current policy, but are reported to require all generated power be sold to the cooperative at the lowest wholesale rate before selling it back at the retail rate. Generators in North Dakota only receive the renewable energy credits for the share of power they use themselves, the remainder are forfeited to the utility. This low compensation rate and seizure of rights is a critical reason for the lack of solar adoption in the state, and have been the primary targets of criticism from advocates.

Advocates have a point, as not all policy in the state is bad. The state has adequate easement regulations, a property tax exemption, renewable energy credits exist, and unlike South Dakota it at least has a net-metering policy, and the capacity limit is very high compared to other states. There are a number of ways that the state can go about accelerating its solar adoption, and these proposals will be detailed and analyzed in turn, followed by the author's recommendation. The effect on the financials of several different scales of array by each of these policy changes will be demonstrated.

Over the last several years advocates have favored the implementation of a net metering regulation that would be effectively identical to the state of Minnesota, with a high maximum generation capacity and full retail net metering. There should be no doubt that this would be extremely lucrative for investors in the state, particularly the south and west. This policy could provide such a strong incentive that it could significantly distort local power markets very quickly in the rural west, while being only modestly effective in the populous and comparatively dimmer northeast. Others have advocated a compromise rate, such as a percentage of the retail rate, an alternate calculation of 'avoided cost', or the average wholesale rate paid by the utility. These might still be too much to avoid over-saturation in the rural southwest, while not being adequate to drive small scale generation in the populous east.

The example of New York and many other states can serve as inspiration, the net-metering rate should be governed separately by region in the state, with the rate declining in each region as SPV production climbs as a share of electrical consumption. This is not a suitable solution for the western portion of the state however, who will still face significant limits on their capacity to generate in the most productive region of the state.

The other policy change most commonly critiqued is the treatment of renewable energy credits, which are in most cases forfeited to the utilities, and otherwise difficult to trade. The law should return these credits to the generator and ease their trade through creation of a formal marketplace. This would significantly improve the ability of investors to monetize a SPV investment, especially in the circumstances of a reduced Net-Metering reimbursement rate. For similar justification, the electrical generation tax exemption should be extended to apply to all scales of production.

These policies mostly favor larger scale generation, while not adequately encouraging the small scale rooftop generation common in cities or for smaller use, such as a cabin or garage, or grid-independent uses. Several states have offered small cash grants, on the order of $500-$1000, in order to encourage this smaller localized generation. Low interest loans and PACE programs have also been a common means to enable home and business owners to install larger capacity arrays with less money down, and Community Solar has been very successful when combined with net-metering.

While it has only been alluded to thus far, the primary support programs for SPV generation are federal programs, and are primarily represented by three primary policies. First, tax credit programs credit a fraction of the cost of the array toward future tax bills, whether personal or corporate. A Solar Photovoltaic array contracted in 2021 will receive a 22% tax credit. On a $100k array, this would count $22k toward future tax bills. This credit will decline to 10% for arrays contracted in 2022 or after. A corporate owned array will also allow its value to be depreciated across 5 years and a non-taxable expense. Finally, there are several federal grant programs, including but not limited to a 25% rural energy grant from the USDA, which will be used representatively in this analysis.

Grassroots Proposal

Recognizing the differences between the requirements of cooperatives and for-profit entities, and the differences in power demand and generation capacity, the author recommends the following proposals for Solar Photovoltaic Generation be adopted by the state.

Renewable Energy Credits

That all renewable energy credits should belong to the generator. For-profit entities must track and buy renewable energy credits from their customers at the average market rate unless the customer opts out. Cooperatives must track renewable energy credits for their members and sell them on their behalf. The state and utilities must assure that North Dakota's renewable energy credits are cross compliant with other state markets to ensure strong demand for their RECs. For cooperative members, this alone could shift the margin on many projects, as will be demonstrated later on.

Net Metering

That Net metering rules should vary by region, utility type, and whether for-profit or cooperative/municipal. For-profit utilities must pay the retail rate on net-metered generation up to 40kW capacity, and must net meter farms up to 100 kW and industrial operations up to 1 MW, with reimbursement for these at the average wholesale rate across the net-metered billing period. This is a simple, straightforward, and fair, and in most cases will limit array size to the needs of the building or for small scale revenue. It also places Xcel Energy's North Dakota customers on a similar playing field to those in their primary markets of Minnesota and Colorado, rather than allowing Xcel to use Fargo to subsidize clean energy elsewhere.

Cooperatives operate differently than for-profit entities, and here as elsewhere should have a different set of rules to match to suit that method of ownership's liabilities and advantages. To begin with, the state must mandate that cooperatives offer net metering to all customers. There is no viable mechanism to enable small and medium scale adoption without such a policy. This path should be twofold, one path for those looking to offset their own use, and another for those looking for a large-scale revenue generation investment.

The scale of the array in the case of an off-set user will be limited to the lessor of 25kw or perhaps 100% or 125% their own annual consumption, as to prevent this from being a measurable burden on the rest of the members. For farm and industrial operations these could be limited at 100 kW and 1 MW as before, or 100% of minimum monthly consumption, in order to allow these operations to participate in a scale proportionate to their needs. As discussed before, setting net metering reimbursement rates regionally by their share of electricity consumption makes a lot of sense for the state. Beginning with the retail rate, this can fall to the average wholesale rate for all generation or a market determined rate as production increases, again a fair system that benefits that allows members their energy independence and resiliency, while benefiting the entire state by allowing more of our native electrical generation to be exported.

North Dakota's cooperative utility landscape allows a means for a market determined rate for those interested in investor scale solar photovoltaic generation. The cooperative model that exists to service its member's electrical needs should also service its member's revenue-generation needs. As mentioned before, cooperatives should be required to track and sell their member's renewable energy credits on their behalf. From this it is not an insurmountable step to market their generation itself. This aspect of the cooperative would effectively operative as a distributed solar array. An ambitious cooperative could even incorporate maintenance and installation services to guarantee members competitive prices and regular service. Revenue after expenses would be returned to generators in proportion to their generation. Ownership of arrays under the arrangement would limited to North Dakota residents and registered farms, or otherwise be limited under net-metering rules as a market rate option.

Such a scheme would allow cooperative members to profit from their investment in SPV generation at a fair market value without burdening their fellow members with the costs of subsidy, and create jobs to manage and market this resource within the cooperative. As our analysis will show, this framework has the potential to create a lucrative, low cost export commodity from distributed small-investor solar photovoltaics. In order to fast track the development of the industry, the Bank of North Dakota should be required to open a lending window open to North Dakota farmers, ranchers, and other residents.

Table 3: Proposed Net-Metering Reimbursement Schedule

	Array Size	Restriction's	Opening Reimbursment Rate	Final Reimbursement Rate	RECs
Cooperative	100% of annual consumption, or 25kw	none	Retail	Retail	Owned by Generator, sold by co-op on their behalf
	100 kW	Farm	Retail	Average Wholesale	
	1000 kW	Industrial	Average Wholesale	Avoided Cost	
	unlimited	None	Market	Market	
For profit	40 kW	None	Retail	Retail	Bought by utility at market rate
	100 kW	Farm	Average Wholesale	Average Wholesale	
	1000 kW	Industrial	Average Wholesale	Average Wholesale	

Associated Policies

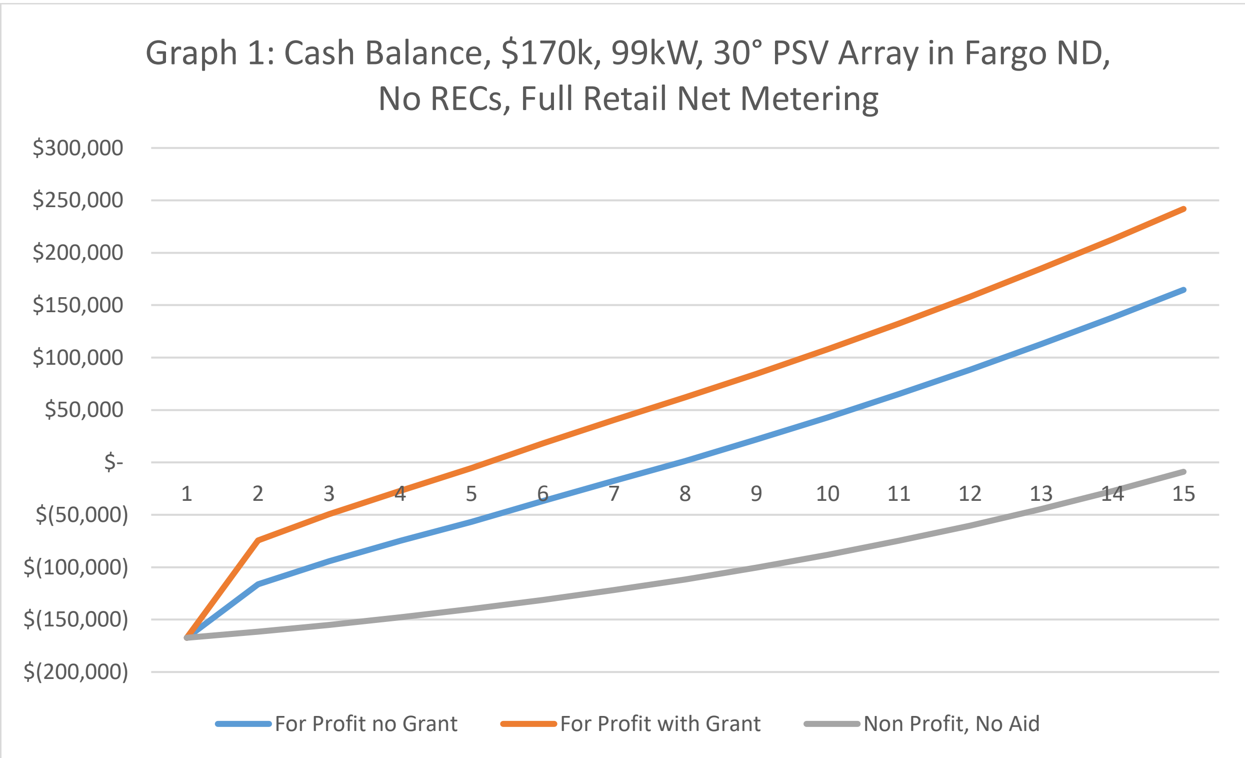
That North Dakota's net-metering regulations should be expanded to include Community Solar Gardens, and the state should adopt a Property Accessed Clean Energy program as an option. These programs combined would allow new housing developments to be built with a share of a community solar garden attached to each lot, financed and repaid through special assessments. This would allow North Dakota homeowners to take advantage of utility scale pricing on generation equipment and ties any debt from the purchase of the array to the property rather than the purchaser.

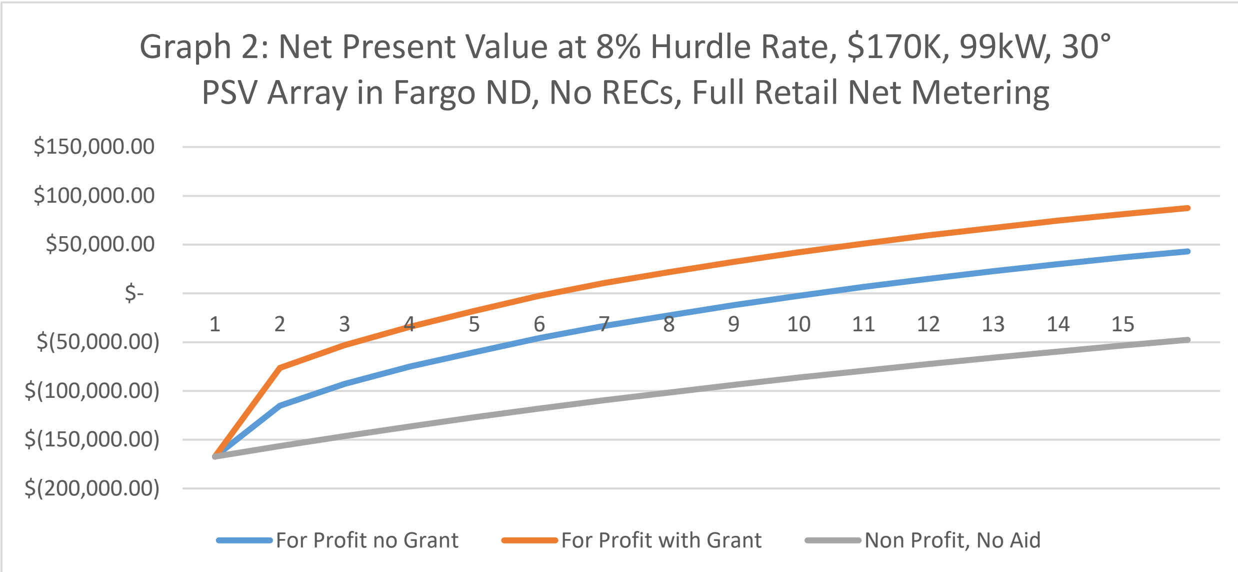
In addition to these policies, North Dakota would do well to encourage small scale rooftop generation. Montana and others have had significant success with small scale subsidies in the form of refundable tax credits. When combined with Federal tax programs and grants, small rooftop arrays can affordably offset local power needs without severely warping energy markets. The Bank of North Dakota should be mandated to provide low or no-interest loans, with small down payment for qualified installations, and should also have staff assigned to assist in applications for grant money. This would allow the state to rapidly build out its infrastructure with little risk to the Bank, as they would be purchasing a durable asset whose revenue could easily be garnished. The Bank, Legacy Fund, and Industrial Commission could grant-finance the creation the commercial SPV management operations within the electric cooperatives and coordinate a deliberate buildout of a midsized, North Dakotan-owned for profit generation. All the proposals and regulations won't accomplish a thing without execution.

Analysis of Policies

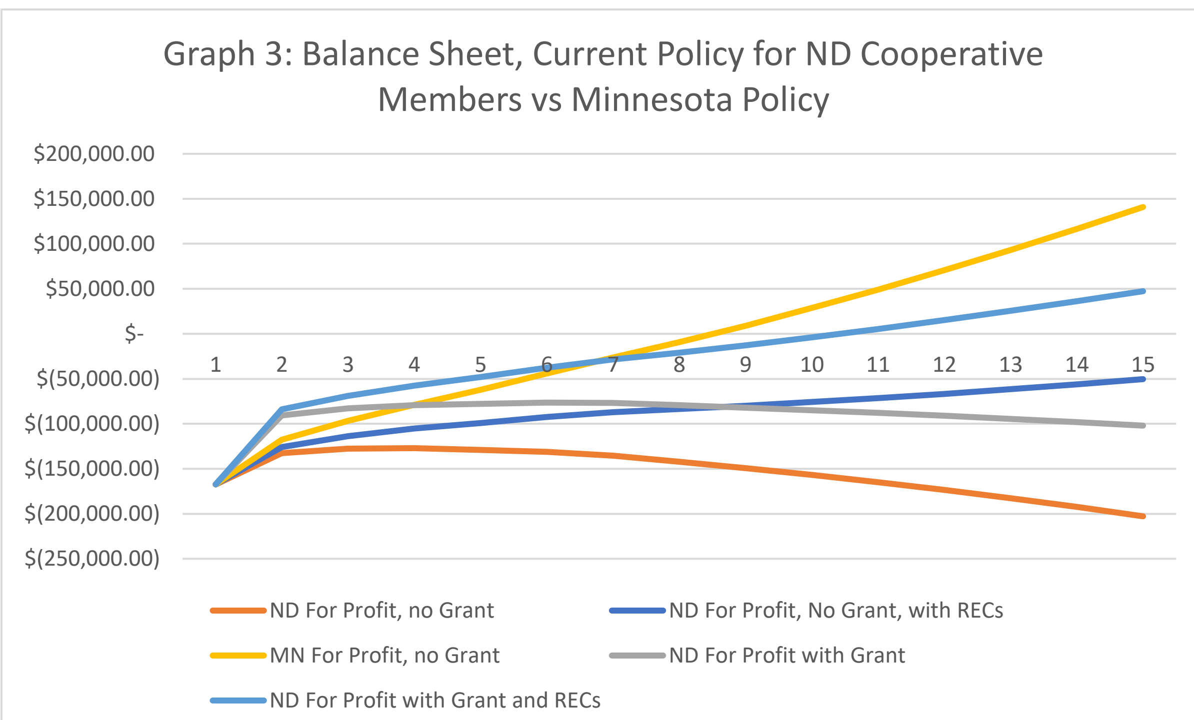
For the following analysis, a 99 kW solar array was designed to represent the case of a large farm-sized array. Equipment include three hundred and twelve 325W Canadian Solar panels, three SMA 33kW Tripower inverters, and a 30° Unirac Groundmount mounting system, which were quoted from a regional wholesaler, along with a local bid for delivered concrete, and a labor bid from a local contractor at $35/hr and per diem, among other costs, including generous profit for the installer. Calculations for Minnesota assume that that state has retail net metering to 100kw rather than 40 kW. Prices for Renewable Energy Credits, wholesale electricity, and solar generation are sourced from publicly available data. The array was calculated to cost $170,000 dollars.

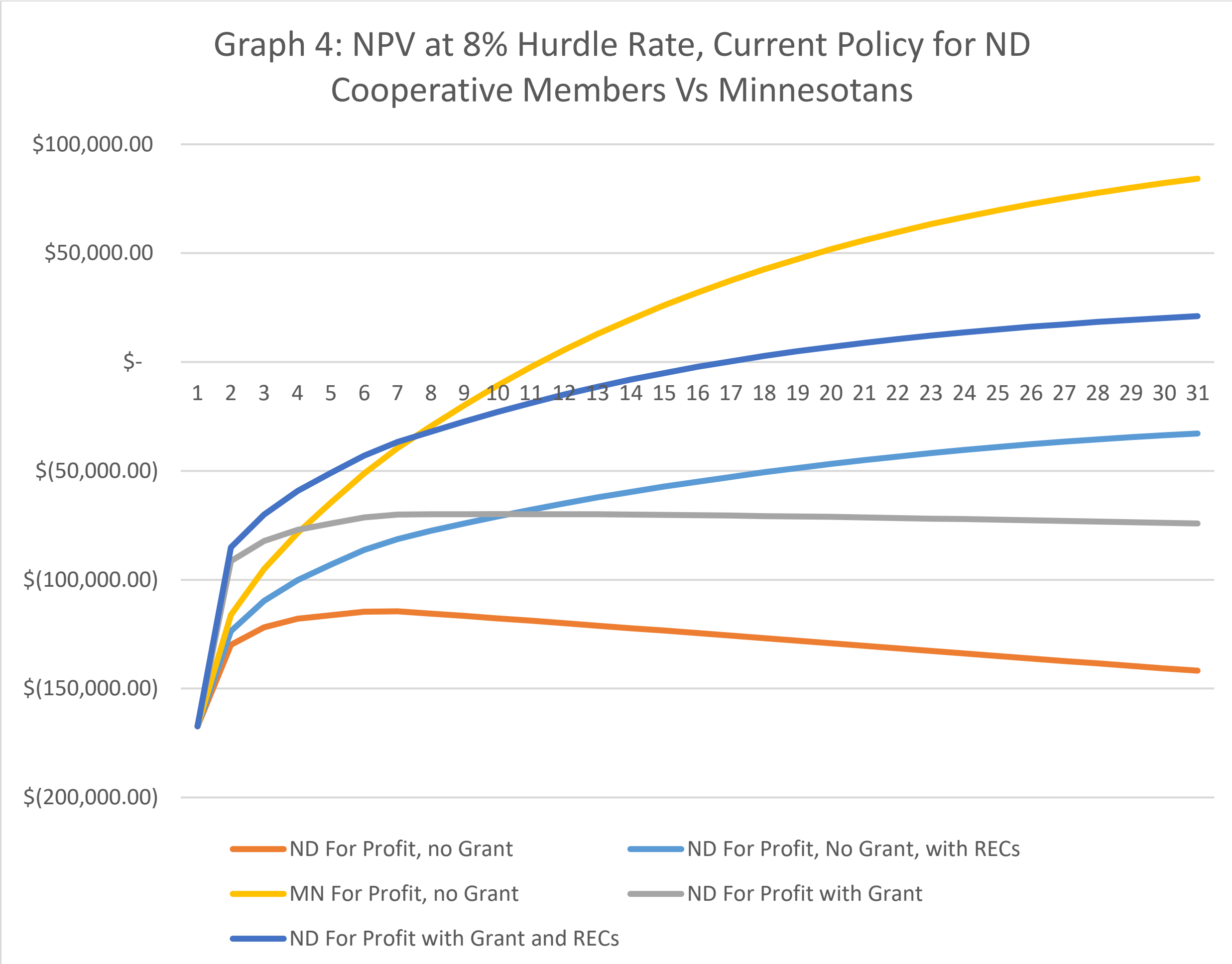
Graphs 1 and 2 show the degree to which federal policy drives the economics on solar photovoltaic generation, and assumes full retail reimbursement. Nonprofits cannot debt finance solar photovoltaics and generate a meaningful cost savings without aid, which is more limited than business or personal assistance. For this reason non-profit ownership will be excluded from further analysis. It is worth noting that this method of public assistance, as with wind power, only benefits for-profit or personal ownership, meaning that non-profit electric cooperatives cannot take advantage of tax credits for utility scale production, and must work with private investors to develop solar arrays effectively.



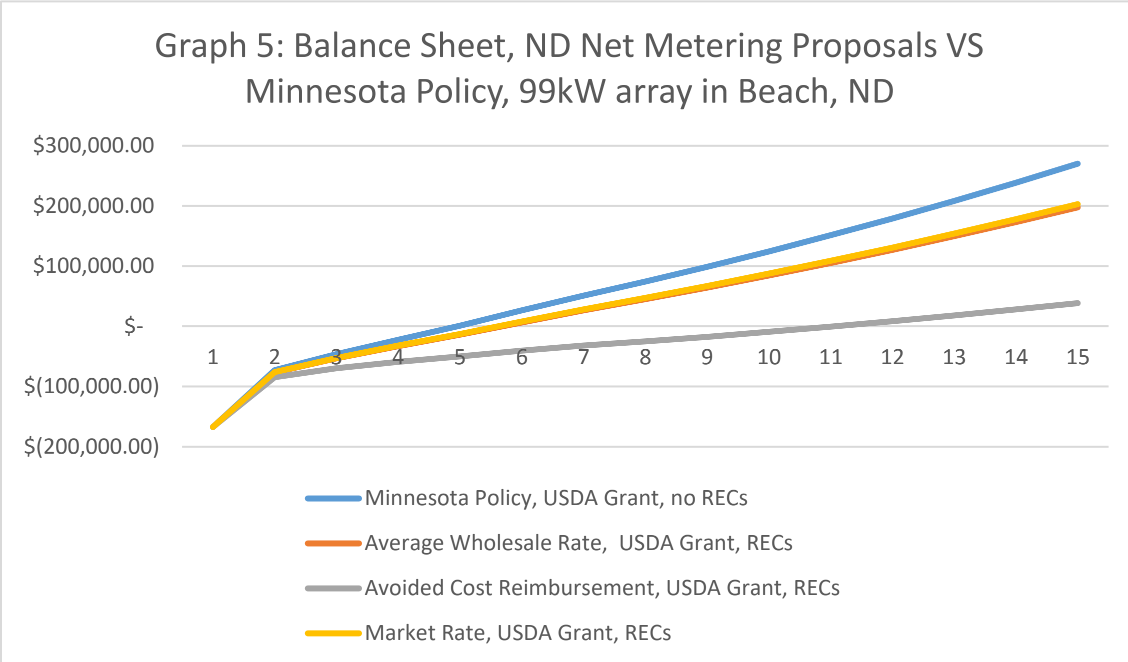


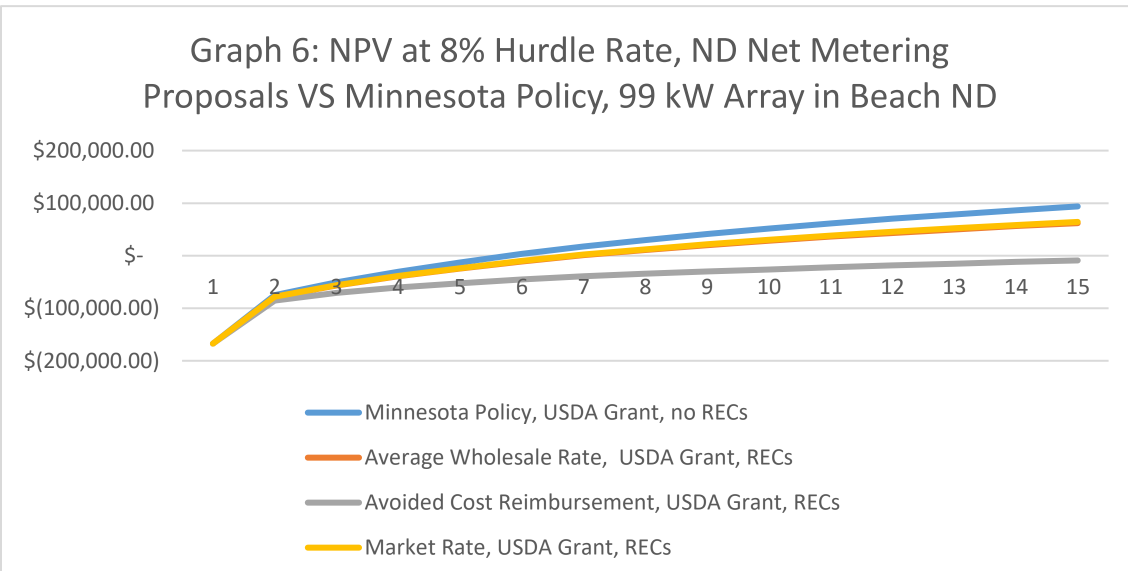
The difference in policy between cooperative members in North Dakota and residents of Minnesota is quite stark, as shown in Graphs 3 and 4 for our 99kW array. Even without changing metering policy, granting Renewable Energy Credits to the generator shifts the economics significantly, however not enough to make up for a much lower reimbursement rate on generation.



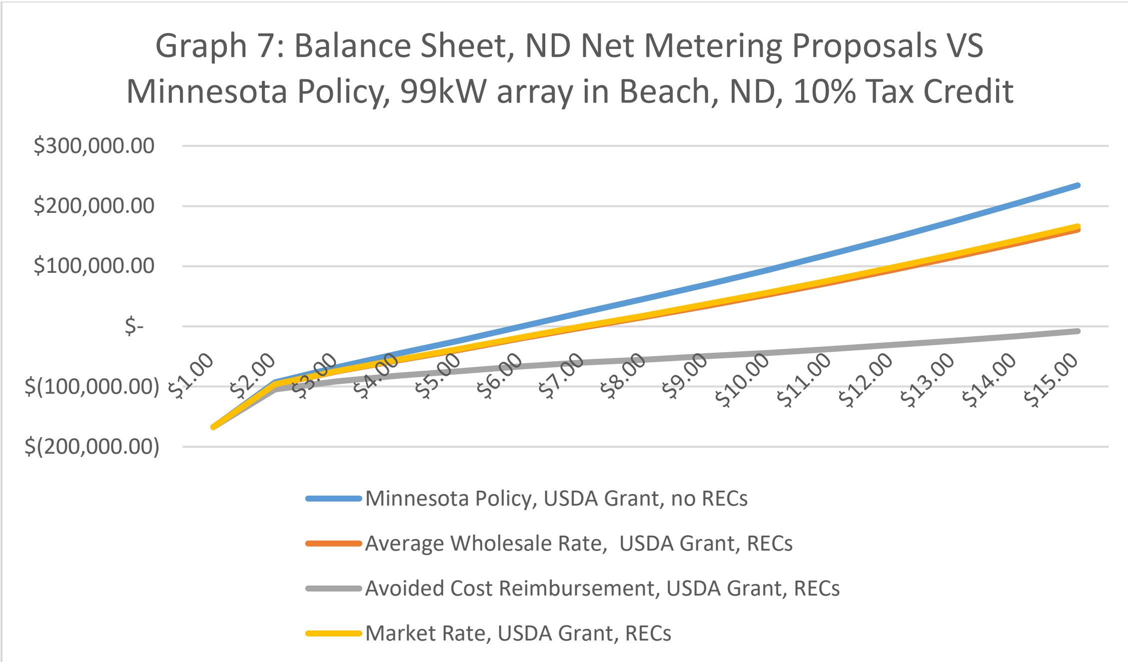


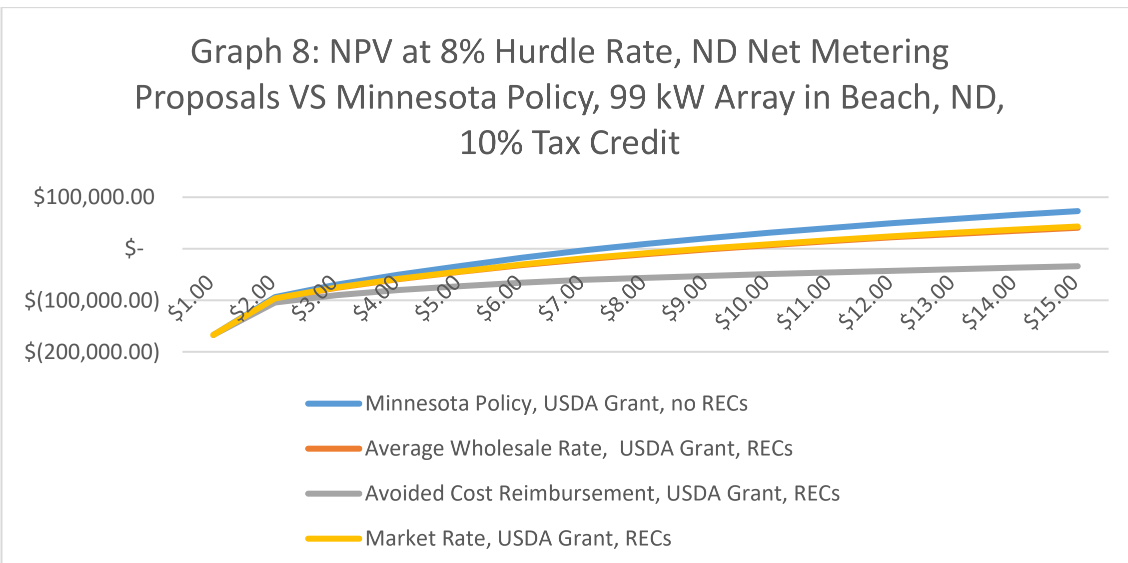
Under this paper's proposal, net metered generation will be subject to a series of declining prices with increased net metering. In Graphs 5 and 6, these prices are combined with RECs and are compared to the policy platform of Minnesota. The location is changed to Beach, North Dakota for the same array as before. The southwestern portion of the state has the best potential for for-profit solar development, whose potential revenue schemes have been described. These graphs show that medium scale generation can quickly repay investments and be a large revenue source for landholders. It is perhaps worth noting that much of the cost of construction of the SPV is labor and equipment, and many landholders have the skills and equipment to do much of this labor themselves. As mentioned before, the cooperative itself could do construction and maintenance of arrays, which would remove profit taking and ensure the quality of installation and components. The combination of a market rate for generation and renewable energy credits makes cooperatively managed solar power a major winner for the state and its residents.





Perhaps the strongest argument against this proposal lies in the fact that federal tax credits will be permanently reduced from 22% to 10% at the start of 2022, and that the state and utility will not be able to act quickly enough to take advantage of these critical benefits. Aside from the ugly hopelessness and defeatism embodied in this position, it also isn't true for the rural user, and certainly not in the southwest of the state. In Graphs 7 and 8 we see the economics with a 10% tax credit for energy investments, rather than the 22% rate for solar investments which expires at the end of the year. While payback times are slightly longer, an array will repay itself in 6-8 years and continue to generate revenue for decades.





The data make clear that cooperatively managing distributed, medium scale solar arrays is a viable industry in North Dakota. With the imminent and ongoing decline and collapse of much of the fossil fuel industry on which the western portion of the state depends, it is essential that North Dakota further diversify its energy generation mixture and develop this potential export commodity. With low down payment financing and low rates, the Bank of North Dakota could finance a distributed investment in a marketable commodity with little direct cost, creating jobs and revenue for the state, with little risk to anyone involved and the potential for large, lucrative investments for North Dakotans. Table 4 shows the net benefit for the state should 500 residents each build a 100 kW array and participate in the program. Even at the small scale of 50 MW, there is plenty of revenue from which pay the staff needed to run this program.

Table 4: Distributed Generation Plan, centered on Beach, ND				
	MWh/year	Electricity $/Year	REC $/Year	Total $/Year
100 kW array	183.2	$ 11,250	$ 7,329	$ 18,580
50 MW distributed generation	91,615.0	$ 5,625,161	$ 3,664,600	$ 9,289,761

These reforms aren't going to save the environment, aren't going to kill the fossil fuel industry, they will barely effect the North Dakota electrical market. What they will do is finally allow North Dakota residents to participate fully in the national market for renewable energy, and to have a greater degree of energy independence, and to do so in a market mechanism rather than a regulatory regime. This paper shows that as a concept, North Dakota can participate in the renewable energy revolution without placing a burden on other utility members, ensuring liberty for all utility members.

EIA State Electricity Profiles 2019 https://www.eia.gov/state/analysis.php?sid=ND

DSIRE: Database of State Incentives for Renewables & Efficiency https://www.dsireusa.org/

PVWatts, Solar Energy Industries Association https://www.seia.org/

PV Magazine "Utility scale solar power as cheap as 70¢ per watt and still falling" 12/20/2019