STATE OF MINNESOTA
PUBLIC UTILITIES COMMISSION

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John Tuma	Commissioner

In the Matter of the Petition for approval of Northern States Power Company, dba Xcel Energy, for approval of its Community Solar Garden Program

August 23, 2019

MINNESOTA SOLAR ENERGY INDUSTRIES ASSOCIATION'S REPLY COMMENTS

Docket Nos. E-002/M-13-867; E-999/M-14-65

REPLY COMMENTS OF THE MINNESOTA SOLAR ENERGY INDUSTRIES ASSOCIATION

I. MnSEIA's Initial Comments Set Forth Our Concerns And Intention To Respond With A Formal Counter Proposal For The Commission's Consideration And Adoption.

In our initial comments on this matter, the Minnesota Solar Energy Industries Association (MnSEIA) argued that Xcel Energy's (Xcel or the "utility") May 1, 2019 proposal for an alternative method of calculating the Value of Solar (VOS) avoided distribution cost "does not yield accurate results that are fair and reasonable".[1] We also notified the Minnesota Public Utilities Commission ("PUC" or the "Commission") that MnSEIA:

- had retained an expert, CrossBorder Energy's Tom Beach, to help facilitate the development of a new distribution capacity component;[2] and

[1] COMMENTS, THE MINNESOTA SOLAR ENERGY INDUSTRIES ASSOCIATION, Docket No. E-002/M-13-867, Doc. Id. 20197-154532-01 at 1 (Jul. 19, 2019) (emphasis in original).

[2] *Id.*, at 5. The expert's credentials have been previously filed in the docket along with our prior Commentary Doc. Id 20197-154532-02.

- planned to submit (in our reply comments) a counter proposal to Xcel's proposed new VOS formula for avoided-distribution-capacity costs, which "can be integrated into an easy-to-read decision option."[3]

At the time of our initial comments, Xcel had not yet disclosed what the 2020 VOS component value would be under the *status quo* formula, leading to our statement that "There does not appear to be an immediacy in altering this VOS variable."[4] But according to Xcel's August 2 petition, absent any change the 2020 component value would be 13.73 cents/kWh (in 2020 dollars).[5] That means this rate component is even more volatile than was acknowledged leading into 2017 and 2019, when MnSEIA and others expressed a similar concern when this methodology twice resulted in an approved $0.00 cents per kWh. We thus agree with Xcel that this new information lends additional urgency to the need to improve the formula for this component of the VOS before the Commission can approve a VOS rate for 2020.

In these Reply Comments, we present the expert witness's counter proposal ("Expert Proposal") and respectfully request that the Commission adopt the proposed Decision Options summarized in Section IV.c. (below). The Expert Proposal is built on three of potential modifications that MnSEIA identified and discussed at length in our initial comments:

1) adding a longer data period (10 years instead of five);
2) removing the arbitrary 50% discount factor; and
3) including the associated costs for avoided distribution O&M and general plant that will accompany any avoided investments in distribution plant.[6]

II. <u>The History Of S*RC Subscriber Rate Trends Shows That The VOS Has Been Declining Rapidly, While Offering Zero Value For Avoided Distribution Capacity In 2017 And 2019</u>

Once again, as in the previous three years, Xcel's latest VOS proposal includes several proposed changes to the VOS methodology and its implementation, each of which would tend to

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3 *Id.*, at 2.

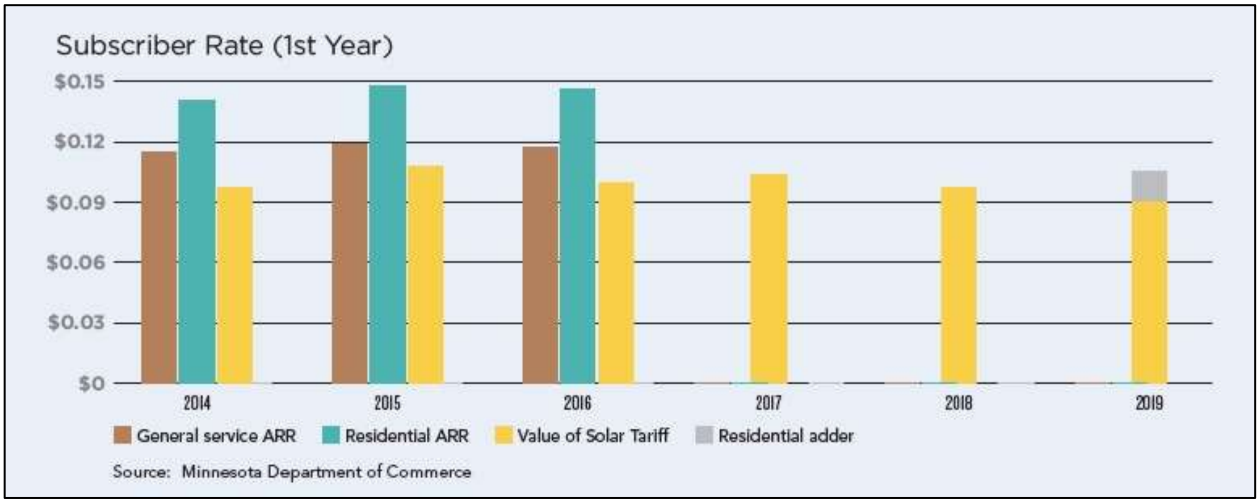
4 *Id.*, at 5.

5 INITIAL FILING – PETITION PUBLIC, XCEL ENERGY, Docket No. E999/M-14-65, Doc. Id. 20198-154920-01 at 7 (Aug. 2, 2019) [herein after *Xcel's August 2, 2019 Petition*].

6 *Id.*, at 6-9. Our initial comments also identified two other proposed modifications (around the reasonableness of Xcel's sorting and bucketing of relevant capacity related distribution projects). We do not address those modifications herein, but they may be addressed by other stakeholders in their reply comments.

reduce the bill credit rate available to subscribers of new Community Solar Gardens (CSG). To be sure, the rate available to CSGs has steadily gone down with each successive program year since 2015, as shown in Figure 1 below:[7]

Figure 1



As pointed out in our initial comments, "The current 2019 VOS has an effective distribution capacity value of $0. This is a big part of the reason the 2019 VOS dropped 13% in a single year." And it is a strange result, given that Xcel itself has spent $199 million on capacity-related upgrades to its Minnesota distribution system over the past ten years.[8]

Note that to MnSEIA's knowledge there are approximately 28 new 1MW S*RC applications that have been filed under the 2019 VOS rate to date. That is far lower than the annual average of 100+ MWs of CSGs built each year since the S*RC program opened in December 2014. This large reduction in garden applications illustrates the challenges that developers face when various components of the VOS are inadequately capturing real-world value to the utility, ratepayers or society.

Here is the VOS avoided distribution capacity component value that was approved for the six years 2014-2019, plus Xcel's calculated 2020 component values:[9]

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7 Bentham Paulos (May 2019), "Minnesota's Solar Gardens: The Status and Benefits of Community Solar", at 5. The report, prepared for MnSEIA and others, describes and quantifies the benefits of Minnesota's competitive third-party community solar market, and is attached hereto as Attachment 1.

8 *Id.*, at 3 ("And it is a strange result, given that Xcel itself has spent $199 million on capacity-related upgrades to its Minnesota distribution system over the past ten years.").

9 *See Xcel's August 2, 2019 Petition*, *supra* note 5 at 7.

Table 1: Avoided Distribution Capacity Component

	Current VOS Methodology					
VOS Vintage	2015	2016	2017	2018	2019	2020*
Distribution Capacity Component per kWh	2.28	0.00	0.00	0.82	0.00	13.73

* 2020 value is calculated per the VOS methodology but not approved

If the Commission were to simply take the mean value of the distribution component as calculated over the seven years from 2014 to 2020, that would result in a 2020 component compensation rate of **$0.0252 per kWh** – as represented by the flat blue line in the figure below:

Figure 2 (distribution capacity value as approved and 2020 calculated in cents/kWh)

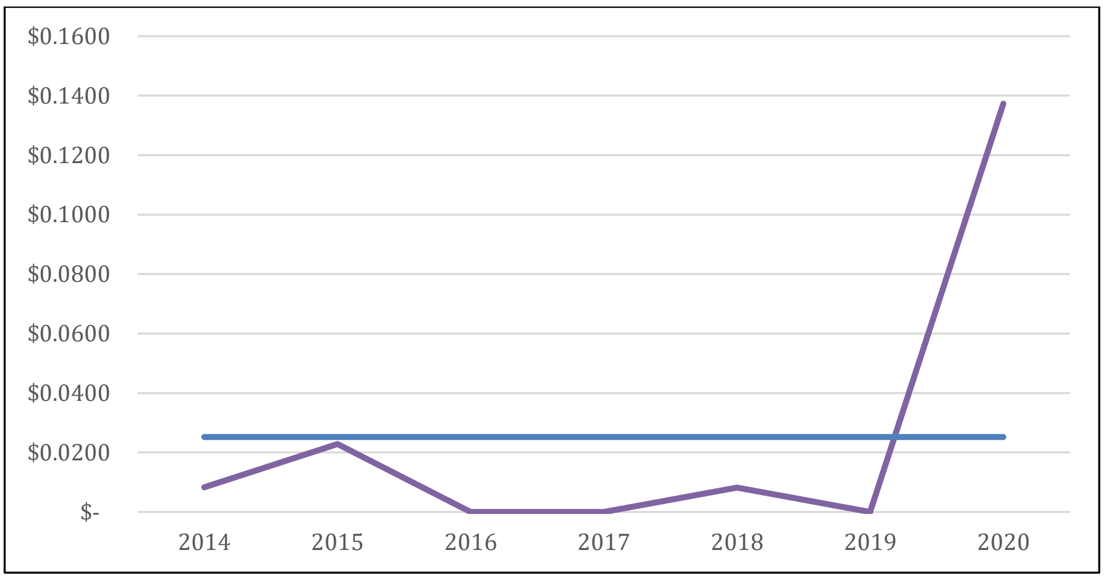

Figure 2 shows that the current formula for the distribution component properly recognizes that distributed solar leads to avoided distribution capacity costs, but the formula is also flawed because it leads to a volatile and predictable rate that likely under-compensates in some years and over-compensates in others.

III. <u>MnSEIA's Competing Expert Proposal Should Be Adopted</u>

Because MnSEIA is proposing this competing Expert Proposal, we contend that both our methodology and Xcel's must be evaluated and considered by the Commission.[10]

[10] As described in our Initial Comments, MnSEIA and others did attempt to negotiate these substantive details directly with Xcel, but the Company was not (at that time) open to our position.

a. The "just and reasonable" standard

Under the governing state statute, "Every rate made . . . by [a public utility] shall be just and reasonable." Minn. Stat. 216B.03. The statute also states that, "To the maximum reasonable extent, the commission shall set rates to encourage energy conservation and renewable energy use and to further the goals of sections 216B.164, 216B.241, and 216C.05."

We appreciate that, under a traditional just-and-reasonable analysis, the 23-cent 2020 rate calculated by Xcel could be determined to be excessive. By the same token, we would argue that any rate that is less than 2.52 cents/kWh (the 7-year mean of the component value calculated under the current approved formula) should *not* be considered excessive or outside the "zone of reasonableness."[11]

Also, the Commission should consider the reasonableness of the process thus far. The 2019 VOS had a $0 valuation for distribution capacity value, despite the utility, the Department of Commerce and stakeholders all acknowledging that this component is a problem and that there is annual value to the utility. But it is only now that they scale is tipped towards protecting the utility that this item will likely be amended when in past years the scale was tipped against small power production and cogeneration. The outcome of the methodology should not dictate when a change in methodology is warranted. <u>As such, if the Commission is to adopt an alternative to the 2020 distribution capacity component, MnSEIA suggests that the Commission amend the 2019 VOS to include the newly ratified method for calculating the distribution capacity value.</u>

Lastly, the Commission's review of how to handle the application of the distribution capacity component should consider Xcel's other proposed changes to the current VOS methodology or its 2020 VOS application. For instance, at the July 31 Xcel Energy meeting, Xcel informed the work group that they are again attempting to change from the utility modeling to actual performance data, which we assume would lower the 2020 VOS. Undoubtedly there is more data available to the utility this year, but MnSEIA is still not certain that there is sufficient data to warrant a change.[12] Regardless this issue should also be aggregated under the transition away from the current distribution capacity component and viewed from the light of CSG developers and

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11 MnSEIA will submit a decision option on this point. With the procedure of the 2020 VOS approval and this distribution capacity component being unclear to some extent, MnSEIA suggests that this 2.52 cents/kWh value would make a viable interim rate if a distribution capacity component methodology is not determined before the 2020 VOS is approved, or if the application of the new distribution capacity component would be otherwise problematic for the 2020 VOS.

12 For example, it may be important to distinguish and treat single-axis-tracker systems differently from fixed-tilt systems (since the two classes differ significantly in terms of capacity factor at our latitude), but we will opine on these matters more when the Commission notices Xcel's 2020 VOS calculation.

potential subscribers taking a cut in 2020 that they have been legitimately waiting for and relying upon.

b. MnSEIA's Expert Proposal

Upon reviewing the 2020 VOS's distribution capacity component with our expert, MnSEIA thinks an approach that improves Xcel's proposed new methodology is the optimal pathway forward. Building on the methodological discussion in our initial comments, and based on the discussion with the other commenters and further internal considerations since the initial comment period, we provide these additional thoughts:

First, MnSEIA and our expert did study Xcel's Information Requests regarding additional years of data, and we propose that 10 years of data is appropriate here to determine the distribution component. A 10 year look finds a better middle ground between the current methodology, which compares today's values with numbers 10 years ago, and Xcel's arbitrary 3-year look back and 2-year look forward. Instead, we propose to use 8 years of historical data and two years of forecast data.

While it is important to acknowledge the challenges of the current methodology, it is also not necessary to completely separate the methodologies either. There were, after all, sound reasons for adopting it initially. One of the strengths of the initial approach is its use of a robust, longer-term data set on distribution investments. Furthermore, this approach would reduce component volatility to a greater degree than Xcel's proposal, gives a better representation of avoided distribution costs over the expected solar module life, and it better aligns the 25-year life of a panel with the expected distribution upgrades of Xcel's distribution system.

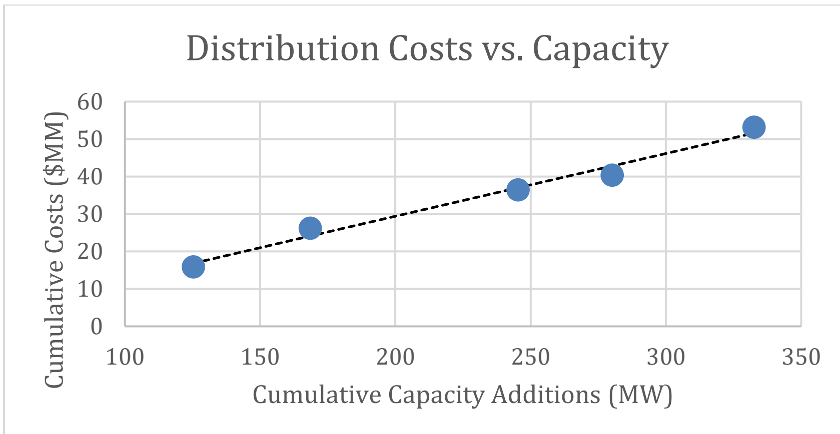
Second, MnSEIA seeks to highlight the non-Xcel parties' universal opposition to Xcel's 50% discount factor. Fresh Energy, IPS Solar and the Department of Commerce all found this methodological choice baseless and indefensible. The general consensus appears to be that it unnecessarily reduces the distribution capacity valuation by 50% - especially considering that the 2014 VOS Methodology *already* assumes that solar projects will only be "installed in sufficient capacity to allow this investment stream to be deferred for one year."[13] In other words, the methodology already uses a conservative 1-year assumption to discount the value of this component. Furthermore, Xcel Energy has all of the information available to guide developers to where siting will be the most beneficial. This is exactly why Xcel was initially directed to develop a viable locational component. Yet, Xcel's rationale for implementing a 50% reduction appears to be that developers may not know where to optimally locate their gardens. This justification for the 50% discount is predicated solely upon the utility's inability or strategic unwillingness to accurately communicate to the developer community where these gardens should be situated.

Third, MnSEIA would like to improve upon Xcel's methodology by requesting that the calculation of the avoided distribution capacity cost in $ per kW use a regression of investments

13 2014 VOS Methodology, at 36 ("PV is assumed to be installed in sufficient capacity to allow this investment stream to be deferred for one year.").

versus capacity as opposed to an average. The purpose of using a linear regression rather than a simple average is to identify the costs that vary with the kW of capacity additions over the entire period. In the example below, based on the five years shown, the linear regression estimate of cumulative costs produces a slope of approximately **$168 per kW**, instead of the $160 per kW produced using a simple average of the distribution costs per kW of added capacity over these five years:

(Estimated Cumulative $MM) = (167.75 $/kW) x (Cumulative MW) - (4.19 $MM)



Fourth, our expert suggests that the distribution capacity component of the VOS should be grossed up to include the avoided distribution O&M and general plant costs that would have been otherwise be associated with the avoided distribution capacity. This reflects the common sense fact that the utility has to operate, maintain, and administer any distribution plant that it adds to its system. If distribution investments are avoided, then the associated O&M and general plant costs also are avoided. Data on distribution O&M and general plant costs per unit of distribution plant are readily available from FERC Form 1.[14]

MnSEIA believes that if our positions are adopted as they are proposed, it will strike an optimal balance between Minn. Stat. §216B.164's requirement to maximize small power production and cogeneration and the requirement that all rates are consistent with the public interest and ratepayers, and is an otherwise reasonable rate as required by Minn. Stat. § 216B.03. If our expert's recommendations are followed regarding the distribution capacity value, we estimate that the distribution capacity component would fall consistently in the 1-2cents/kWh range from year to year. Our expert believes that based on the five years of data that Xcel provided, eliminating the 50% discount factor, using a linear regression, and adding the distribution O&M and general plant loaders, the MnSEIA distribution capacity component recommendation would result in a 2020 distribution capacity component of $0.0174/kWh (*$0.0174 per kWh = ($0.0055*

14 *See* Attachment 2 for a description and details on this data.

per kWh) x 1.033 + ($$0.0117 per kWh)).[15] This lands far below the 2.52cents/kWh "zone of reasonableness" we proffered above.

Furthermore, this range yields a number that is similar to and consistent with Xcel's 2020 VOS's Avoided Transmission Capacity value, which is 1.75 cents/kWh.[16] So the value is reasonable in comparison with other similar items in the VOS value stack. It is also similar to avoided distribution capacity costs calculated for Xcel's system in Colorado.[17] We believe that our formulation identifies the true value that solar provides to the distribution grid year after year, and we request that the Commission adopt our expert's methodology outright.

c. Decision Options Reflecting The Adoption Of MNSEIA's Expert Proposal

In order to facilitate an expedient Commission hearing and understanding the complexities of this component, MnSEIA has provided our decision options below:

A. The Commission will adopt the following changes to Xcel's Distribution Capacity Component methodology for use in future vintage years:
   a. Use more (e.g. 10) years of cost and distribution capacity data, including adding historical data for 2011 to 2015, and the per unit rate for avoided distribution capacity would be derived from the cumulative distribution investments (in $) added over a 10-year period and the cumulative distribution capacity (in MW) added over the same period.
   b. Eliminate the 50% factor.
   c. Use a linear regression to determine the $/kW slope when cumulative costs are compared to cumulative capacity additions.

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15 *See* IR 17 docket 13-867 to be filed concurrently with these reply comments. MnSEIA would have used 10 years of data, but Xcel did not provide it. *See also* IR 18 docket 13-867 to be filed concurrently with these reply comments. This value shows that $168/kW corresponds to $0.0055/kWh.

16 2020 Value of Solar Overview Stakeholder Meeting, Xcel Energy, July 31, 2019 at 2. Presumably this information will be filed on or around Xcel's September 1, 2019 compliance filing date for their 2020 VOS approval.

17 *See* Crossborder Energy, *Benefits and Costs of Solar Distributed Generation for the Public Service Company of Colorado: A Critique of PSCo's Distributed Solar Generation Study* at pp. 9-11, esp. Table 5 (December 2, 2013). This study was filed in Colorado Public Utilities Commission Docket No. 13A-0836E on behalf of The Alliance for Solar Choice. The study calculated an avoided distribution capacity cost of $46.10 per kW-year. Assuming annual solar output in Colorado of 1,765 kWh per kW-year yields an avoided distribution rate of $0.026 per kWh. We note that the load match factor for distribution in Colorado in this study (23.1%) was much lower than the factor used in the NSP VOS (55.2%).

d. Add distribution O&M and general plant costs to the $/kWh distribution capacity component from FERC Form 1 data. The recommended general plant loader shall be 3.3%, inflating the economic value of avoided distribution capacity by 3.3% for general plant. The distribution O&M adder would be $17 per kW-year, or $0.0117 per kWh = $17 per kW / 1,452 kWh/kW-year where 1,452 kWh/kW is the assumed annual PV production.

AND

B. The Commission directs Xcel to re-calculate the 2019 avoided-distribution cost component using the same changes as listed above and apply it to the 2019 VOS;

OR

C. The Commission will not implement a new distribution capacity component methodology at this time, and directs Xcel to implement an interim 2.52 cents/kWh avoided-distribution cost component in the 2020 VOS rate.

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David Shaffer, Esq.
Executive Director
MnSEIA
612-849-0231
dshaffer@mnseia.org

Elizabeth Lucente, Esq.
Program Director & Counsel
MnSEIA
763-367-0243
llucente@mnseia.org

Tom Beach
Crossborder Energy
Principal
510-549-6922
tomb@crossborderenergy.com

Attachment A

MINNESOTA'S SOLAR GARDENS

The Status and Benefits of Community Solar

MAY 2019

ILSR MnSEIA VOTE SOLAR

Report written by Bentham Paulos of PaulosAnalysis.com

Layout and design by José Fernandez.

Cover photo: Prairie Restorations Inc. manages more than 3,000 acres of low-growing flowering meadows on solar farms. Photo by Rob Davis, Fresh Energy.

EXECUTIVE SUMMARY

Minnesota is the national leader in community solar, with 208 projects around the state, more than a third of all community solar projects in the US. The Community Solar Garden policy is the best in the nation, making it easy to develop and subscribe to solar power.

Community solar allows residents, businesses, and non-profit organizations to invest in solar power even if their own home or building is not suited to hosting solar panels, or if they are renters. Customers can subscribe to the output of a "solar garden" located somewhere else, and get the power counted toward their monthly electricity consumption through a credit on their utility bill.

This innovation has made it easy to go solar, and has led to an explosion of growth as customers leap at the chance to save money and save the planet at the same time. With this growth has come big benefits to consumers, workers, landowners, and local government, as well as helping to clean up the environment and protect public health.

- **Customers:** More than 14,000 Minnesota customers have signed up for community solar, to save money, create local economic development and jobs, and to protect the environment. That includes almost 12,000 households and 2,000 business, non-profit, and public-sector customers. Public sector customers, like schools, city facilities, and hospitals, account for almost half of the non-residential subscriptions.
- **Workers:** Community solar employed over 4,000 workers in Minnesota in 2018, including many family-wage construction jobs. "Solar installer" was the fastest growing job category in the country.
- **Landowners:** Community solar projects currently pay about $5 million a year to landowners for leases and royalty payments. Counting all projects operating or currently under construction, about 354 landowners will receive a total of $182 million in leases and royalties over the next 25 years.
- **Local Governments:** Community solar projects will pay over $1 million this year to counties and towns through the state Solar Production Tax Credit, plus increased property tax revenues likely to exceed $2 million per year.
- **Environment and Public Health:** Community solar systems cut global warming emissions by almost a million tons per year, plus over 400 tons of sulfur and nitrogen oxide emissions that harm public health and the environment.

As a modular technology, solar power can be developed in many ways, from small systems on the roofs of buildings, to mid-sized community solar gardens, to huge solar power plants. To fully tap the benefits of solar power we will need all of these options. While opponents of community solar tout the lower cost of much larger, utility-scale solar projects, they are missing two key benefits of community solar.

First, community solar is not just a way to deliver electrons, it is a way to build community and share the wealth. Community solar allows for more "energy democracy," where individuals, non-profits, and businesses can invest and build wealth, rather than ceding control of this 21st century technology to big corporations and Wall Street investors. Community solar can be seen as a way to strengthen small businesses and the middle class, the backbone of a free society.

Second, community solar delivers technical benefits to the grid that big solar can't. Because it is distributed around local low-voltage power grids, it delivers power to directly to local consumers, improving efficiency and helping to avoid the need for more grid infrastructure.

That's why the state utility commission has found, time and again, that the value of power from community and distributed solar is higher than big central-station plants. Utilities and other stakeholders participated fully in those proceedings and their input has been taken into consideration.

Third, community solar introduces a new form of competition, which can spur technical and business innovation. While traditional monopoly utilities provide reliable power at a reasonable cost, they have never been strong at innovation or marketing, since it is not part of their business model. Private companies are better able to develop and market innovative products that meet customer needs. By forcing community solar marketers to compete with each other, customers will benefit.

But the Community Solar Garden program could be improved. Currently gardens must be built in the same or adjacent county as the subscriber. Since most customers are in the Twin Cities, this has resulted in many projects clustered around the Metro Region, rather than spread around the state where they could provide the most benefits to the grid, and financial benefits to more landowners and county governments. Also, there are no provisions in the program to help low-income customers participate, or to direct development and jobs to disadvantaged communities.

To meet Governor Walz's goals of a transitioning to a completely clean energy system, through the "One Minnesota Path to Clean Energy" plan, Minnesota will need a lot of solar, along with wind power, energy efficiency, and other clean sources. There will be plenty of opportunities for big companies and big banks to participate in solar energy. But policymakers should make sure that the rest of us are not left out of the transition. We need to keep the community in community solar.

BOX I

How does community solar work?

Minnesota has made it relatively easy to develop and market community solar projects, and very easy for subscribers to sign up. As a result, Minnesota has the most successful community solar policy in the country.

To start the process, a community solar developer must find a project site in Xcel Energy's service territory (or the service territory of another utility that allows for community solar) and apply for utility approval. The developer works out an arrangement with a landowner, applies for permits, and does an engineering analysis to show how they will interconnect to the grid. Once the application meets all criteria, the utility will approve the project under a standard form agreement. For many municipal and cooperative utilities, the utility itself owns and markets the community solar.

The next step is to sign up a sufficient number of customers to fully subscribe the community solar project. In Minnesota, some early projects offered an up-front subscription model where the subscriber buys up to 25 years of output with a one-time payment and breaks even after a certain number of years. But the market quickly transitioned to a "pay as you go" model where a subscriber pays a monthly fee. That rate can be pegged below the estimated bill credit rate, to allow for cost savings, starting in the first month. Sometimes the two options are mixed. Either way, a customer is officially renting the solar panels from the developer.

Once the community solar garden is up and running, the subscriber receives a credit on their bill for the energy generated. Under Minnesota statute, the bill credit value is determined by the state utility commission, using either the subscriber's class-average retail rate or the "value of solar" tariff. (See sidebar on *The Value of Solar*). Each developer has their own subscription price and terms, and customers can shop around for the best offer.

THE GOALS AND GENESIS OF THE CSG PROGRAM

Solar power can be deployed in many ways. Since solar panels are modular, they can be put on everything from watches to space stations. They can be put on the roof of a home or business, mounted on racks in a field, or be deployed in huge numbers to make large power plants.

Each of these deployment pathways has implications for who can participate, who can invest, and who can benefit from solar power.

Minnesota has made a policy commitment to make the benefits of solar available to all Minnesotans, not just shareholders of large utilities. Minnesota was the first state in the country to adopt "net metering," a billing method that makes it easy for customers to install solar. And while utilities in many states have attacked net metering, Minnesota has stayed true to its vision of making solar widely accessible.

But in other regards, Minnesota was lagging in solar power. Minnesota had emerged as a national leader on wind energy and energy efficiency, but was doing little to promote solar.[1] Spurred on by the Clean Energy Jobs campaign, the legislature adopted major clean energy legislation in 2013 that gave a big boost to all forms of solar power.[2]

One aspect of the bill was aimed at the problem that not all homes and businesses can or want to put solar panels on their roof or property. Apartment renters and office tenants, for example, don't own their roof. Many urban buildings are shaded with trees, or have roofs facing the wrong direction.

To remove this barrier, lawmakers created the Community Solar Garden (CSG) policy, as part of the legislation. Analogous to community gardens for food, the CSG program allows Xcel Energy customers to subscribe to part of the energy output of a larger solar project located somewhere in their community. Subscribing customers can choose solar to provide some or all of their monthly electricity consumption, at a price that is comparable to – and sometimes less than – regular power.

The community solar law was adopted in 2013, with implementing rules finalized in December 2014 by the state Public Service Commission. Initially there was no limit to the number of projects that could be located next to each other, and developers proposed some very large projects. In response, the Commission limited "co-located" projects to five megawatts, but further constrained it in 2015 to one megawatt. Projects must be built in the same or adjacent county as the customers they serve, and must serve a minimum of five customers each.

A key part of the rulemaking was determining how to value the generation, in order to transfer the value to the subscriber. The legislation gave Xcel the option of using the retail price or a tariff based on the calculated value of solar. After a lengthy proceeding, in which utilities and others provided extensive data and analysis, those values were set and are updated annually. (See the sidebar on *The Value of Solar*).

Community solar has proven to be incredibly popular with customers, with landowners who host the solar systems, with the workers who install the panels, and with the communities that benefit from the economic development. Minnesota has by far the most community solar of any state, and leads the Midwest in solar power.

1 Ross Abbey and Brian Ross, *Market Transformation Pathways for Grid-Connected Rooftop Solar PV in Minnesota*, produced on behalf of the Minnesota Solar Challenge Program by Fresh Energy, 2013, https://www.osti.gov/servlets/purl/1225367

2 Bob Eleff, Legislative Analyst, Research Department, Minnesota House of Representatives, *Information Brief: Xcel Energy's Community Solar Garden Program*, October 2017, https://www.house.leg.state.mn.us/hrd/pubs/solargarden.pdf

BOX II

THE VALUE OF SOLAR

The fact that community solar delivers a wide range of benefits was a fundamental part of the design of the Community Solar Garden policy.

CSG introduced a new, albeit limited, form of competition to Minnesota's otherwise regulated monopoly utility system. In the past, either the utility owned the power plant or they bought power from another generation company on behalf of their customers. Now with CSGs, customers are able to come together to support a community-scale solar plant through an independent developer and receive direct economic benefits for the electricity produced. The customer continues to purchase their electricity use form the utility at the full retail price.

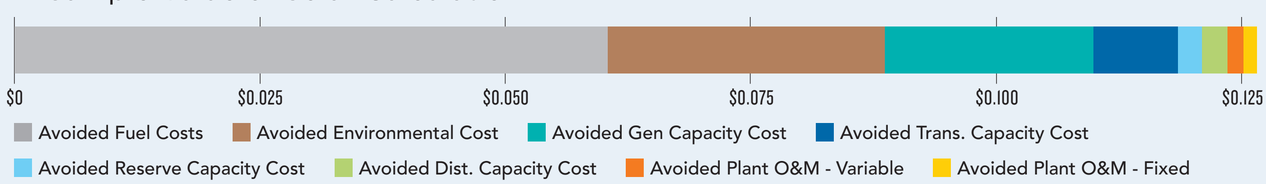
But this raised a question: How much should the utility compensate subscribers for the electricity it receives from the community solar garden, and how predictable should that compensation be over the 25-year project life?

The 2013 law stipulated that the power generated would be credited to the customer at the customer's applicable retail rate (ARR) or at the "value" of solar.[3] To calculate the value, and create a "value of solar tariff" or VOS tariff, regulators went through an extensive research process.

The state Department of Commerce developed a methodology that counted the costs associated with a typical gas-fired power plant that would be avoided by using solar power, such as the value of energy and its delivery, generation capacity, transmission capacity, transmission and distribution line losses, and environmental value, as shown in the figure. The Department was also permitted to consider the cost or benefit of solar operation to the utility, credit for locally manufactured or assembled energy systems, and systems installed at high-value locations on the grid.

continued on next page

A Sample Value of Solar Calculation



While the law applies only to Xcel Energy, many other Minnesota utilities have created their own community solar programs, especially rural electric cooperatives. Many coops give their members the ability to buy panels in coop-owned solar installations, and subtract the energy generated from their bill.

The growth of solar power in the North Star state has made the vision of a zero-emission power system viable. Solar is a key part of Governor Tim Walz's "One Minnesota Path to Clean Energy" plan announced March 4.[4] The plan would require all utilities to go carbon-free by 2050, while giving each utility the flexibility on how to reach the standard. Xcel Energy and 3M are just two major Minnesota institutions that have already made such a commitment.

3 Minnesota Statutes, 216B.164 Cogeneration And Small Power Production, https://www.revisor.mn.gov/statutes/cite/216B.164

4 Minnesota Department of Commerce, Press release: "Walz, Flanagan propose plan to achieve 100 percent clean energy in Minnesota by 2050," March 4, 2019. https://mn.gov/commerce/media/news/?id=17-374074

CURRENT STATUS

Solar power is not new to Minnesota, but it has only recently reached a considerable scale, due in large part to the Community Solar Garden policy.

The CSG policy was well-timed, since solar costs have plunged worldwide as the technology matures. The installed cost of solar has fallen 70 percent in the past decade, according to the Solar Energy Industries Association, with almost 2 million systems installed in the US. The industry now employs almost a quarter million workers, many more than work in the coal industry, for example.[6]

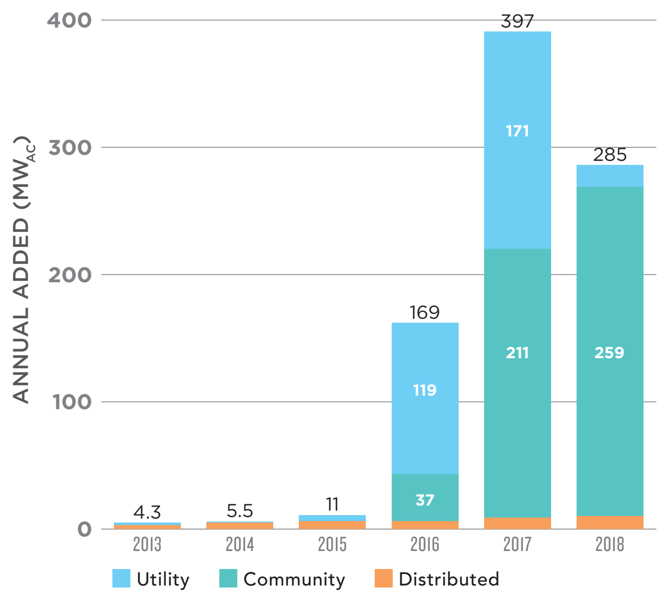
Solar installed on the customer-side of the meter to produce power on site is expected to be competitive with retail power prices in 42 states by 2020, depending on state prices and policies, according to consulting firm GTM Research.[7]

As a result of this commercial maturity, the US installed 10,600 megawatts (MW) of solar PV capacity in 2018 to reach 64,200 MW overall, enough to power 12.3 million American homes. Total capacity is expected to more than double over the next five years, with more than 15,000 MW installed annually.[8]

As a result of this commercial maturity, the US installed 10,600 megawatts (MW) of solar PV capacity in 2018 to reach 64,200 MW overall, enough to power 12.3 million American homes. Total capacity is expected to more than double over the next five years, with more than 15,000 MW installed annually.[9] Minnesota ranks first for community solar, hitting 513 MW in February 2019. Another 200 MW of projects are in the design and construction phase.[10]

Much of the community solar was installed in the last two years, as shown in Figure 1. Last year, Minnesota installed 285 MW of solar, 259 MW of which was spread among more than 100 community solar plants.

Figure 1 Minnesota's Annual Solar Installations



Source: MN Department of Commerce

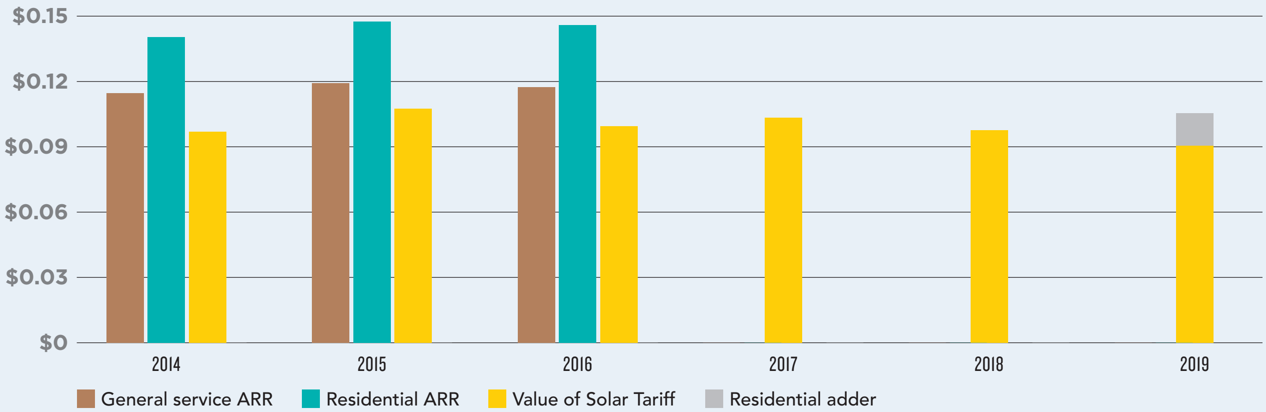
Utility Scale Solar

Utilities are also buying power from large solar projects, under the requirements of the state Renewable Portfolio Standard (RPS). The RPS requires that investor-owned utilities (Xcel and Minnesota Power) get 1.5 percent of their energy from solar power by the end of 2020. It also requires that 10 percent of the solar capacity must be from systems that are 40 kW or less.[11]

6 SEIA, "Solar State by State," accessed March 29, 2019, https://www.seia.org/states-map
7 Mike Munsell, Greentech Media, "GTM Research: 20 US States at Grid Parity for Residential Solar," February 10, 2016, https://www.greentechmedia.com/articles/read/gtm-research-20-us-states-at-grid-parity-for-residential-solar#gs.2vbgs1
8 SEIA, Solar Market Insight, accessed March 29, 2019, https://www.seia.org/us-solar-market-insight
9 Solar Foundation, Solar Jobs Census 2018: Minnesota fact sheet, https://www.thesolarfoundation.org/solar-jobs-census/factsheet-2018-mn/
10 Institute for Local Self Reliance. https://ilsr.org/minnesotas-community-solar-program/
11 Database of State Incentives for Renewable Energy (DSIRE). Accessed March 2019. http://programs.dsireusa.org/system/program/detail/2401

BOX II

Subscriber Rate (1st Year)



Source: Minnesota Department of Commerce

In late 2016, the Minnesota PUC ordered Xcel to transition from compensating subscribers of new solar gardens at the customer's retail rate to the VOS tariff, which lowered the compensation to subscribers. Moreover, the VOS has declined over time, dropping 10 percent between 2018 and 2019.

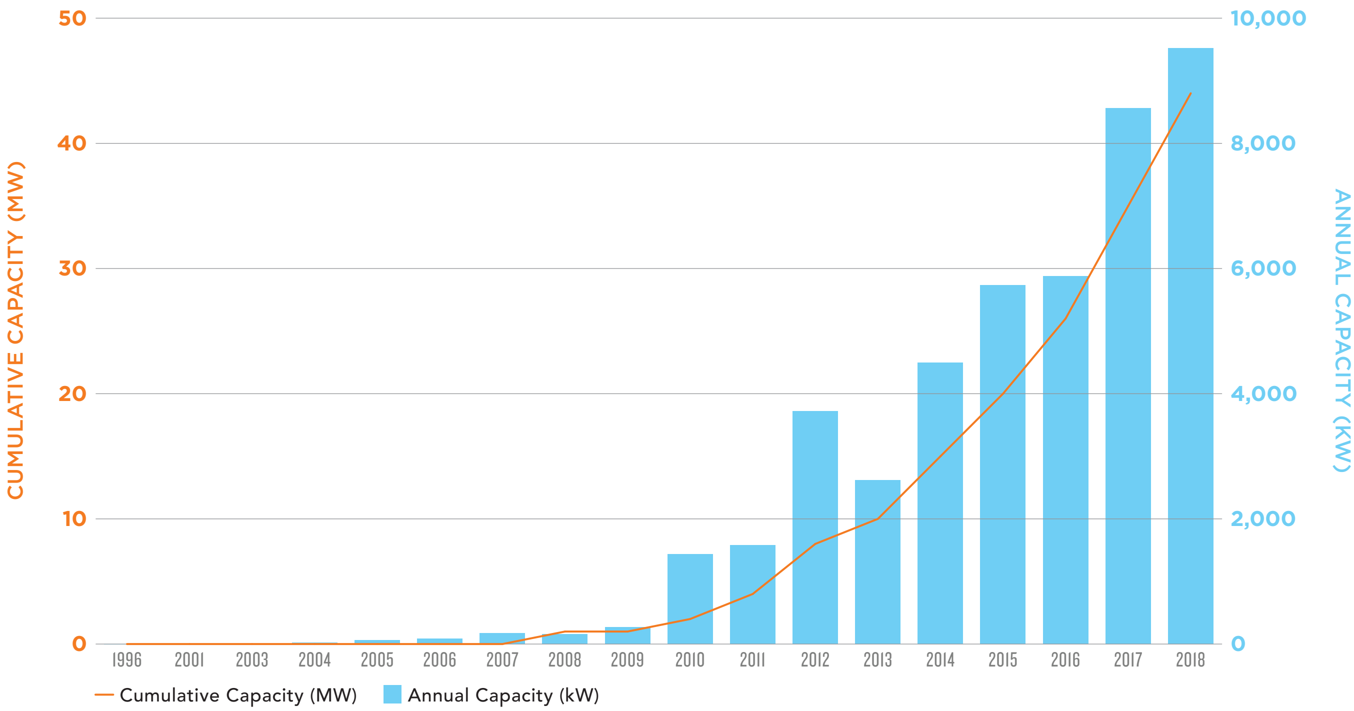
Xcel files a new VOS tariff each year, taking into account changes in fuel prices and other factors. Under ARR, the bill-credit rate varies by customer class and project size, while the VOS bill credit rate is the same for all subscribers and project sizes, and increases with inflation each year for 25 years. For projects that start in 2019, the first year bill credit value is 9.04 cents per kWh (in 2019 dollars), increasing to 11.05 cents in year 10 (in 2029 dollars). A typical residential retail rate is currently about 11.8 cents per kWh.

Ownership of the renewable energy certificates (RECs) from the solar garden passes to Xcel Energy in return for compensating the subscriber for the plant's avoided environmental costs, including the social cost of carbon. Xcel can use the RECs to show compliance with the state solar energy standard, or to monetize the value for the benefit of its ratepayers.

Because the VOS rate is not intended as an incentive, the rate does not vary depending on the subscriber's customer class, meaning there's little economic logic for CSGs to serve small many residential customers (instead of simply serving five large customers). To address this concern, in November 2018 the Commission increased the rate for residential subscribers by 1.5 cents per kilowatt-hour for new subscriptions in 2019 and 2020.[5]

5 Minnesota PUC Order in Docket No. 13-867 (ordering the creation of a residential rate adder), November 16, 2018.

Figure 2 Distributed Solar Growth



Source: MN Department of Commerce

A significant number of utility scale systems, selling power to Xcel and Minnesota Power, were installed in 2016 and 2017, but the number dropped off in 2018. There are currently seven large generation projects in the state, with the biggest being the 100 MW North Star Solar installation in Chisago County, which produces enough electricity for about 20,000 homes. North Star is currently the largest solar project in the Midwest.[12]

While the number of current utility-scale installations is modest, it is likely to rise significantly. In fact, the Mid-continent Independent System Operator (MISO), which manages the Midwestern grid, counts 30,188 MW of solar projects that have applied for interconnection to the high-voltage transmission grid, as of March 2019.[13] Minnesota has 26 projects in the queue, totaling almost 3000 MW. Not all of these projects will be built, but the queue shows a great deal of interest from developers.

Customer-sited Solar

Minnesota is also home to a growing number of smaller "distributed" solar installations, on the customer's side of the meter. As of the end of 2017, there were almost 4600 distributed solar systems of less than 40 kW in size, adding up to about 53 MW of total capacity.[14]

Although solar installations date back to 1996, almost 80 percent of the systems at the end of 2017 were installed in 2017. About two-thirds of small systems statewide were in Xcel's service territory, along with much of the recent growth. Rural electric coops and municipal utilities collectively hosted 1078 small solar systems, adding up to 13.8 MW.

Newer figures from Xcel show that an additional 854 systems were installed in Xcel's territory in 2018, boosting the number up to 3900 customers generating 44 MW of power, as shown in Figure 2. Data from other utilities is pending, but at current growth rates the total number of distributed solar customers could top 7500 by the end of 2019.

12 Community Energy, Inc., North Star Solar, https://www.communityenergyinc.com/projects/north-star-solar
13 MISO, Generator Interconnection Queue, accessed March 22, 2019 at https://www.misoenergy.org/planning/generator-interconnection/GI_Queue/
14 Minnesota Department of Commerce, Annual Distributed Generation Reports, "MN Utility Reported DG through 12/31/2018 (released 3/1/2019)," https://mn.gov/puc/energy/distributed-energy/data/.

BOX III

Community Solar Makes Good Pollinator Habitat, Boosts Crop Yields

Solar projects require roughly 7 to 10 acres of land per megawatt, meaning that the just-over 1000 megawatts of projects installed to date occupy over 7,000 acres of land in the state.

While that's less than 0.03 percent of Minnesota's 26 million acres of farmland, solar will have to grow six-fold to reach the current statutory target of 10 percent of state electricity demand by 2030.

Minnesota community solar developers and researchers have discovered that the land used by solar can do double duty, hosting meadows that provide a home for pollinators, like bees and butterflies. Spurred on by customers like the City of Minneapolis, developers started including "pollinator friendly" plantings with their projects.

In 2016, the Minnesota Board of Water and Soil Resources, with cooperation from the Department of Natural Resources, established the country's first standard for pollinator-friendly solar development. While this work was underway, the Legislature passed a statute that encourages solar developers to follow the standard.

More than 4,000 acres of commercial solar projects were installed in 2016 and 2017, and over half of them include pollinator habitat. Community solar marketers have found that pollinator friendly projects are an important selling point for subscribers, and they have become a point of competition.

These flowering solar farms are also hosting honey production from local beekeepers. Dustin and Grace Vanasse supply their Bare Honey brand from a bee apiary at a solar garden. They in turn provide the honey used to make Solarama Crush, a "hazy IPA" brewed by 56 Brewing, and for Solar Sweet Farm Cider, made by Milk & Honey Ciders in St. Joseph. Both 56 Brewing and Milk & Honey Ciders are powered by solar gardens.[15]

Dustin Vanasse of Bare Honey.
Photo Courtesy: Dennis Schroeder/NREL InSPIRE

New research by the Yale School of Forestry & Environmental Studies has found that these solar meadows provide a number of benefits, including boosting crop yields in nearby fields. They also improve ground water, provide habitat for songbirds and gamebirds, reduce erosion, and even boost solar power output by cooling the panels.

Minnesota's leadership on this issue has caused other states to follow suit. Illinois passed legislation in 2018 creating voluntary standards, as have half a dozen other states.

If Minnesota met the remainder of its 2030 solar installation target with pollinator-friendly projects, the study estimates environmental co-benefits ranging from $30-515 million, depending on the composition of surrounding farmland.

15 Fresh Energy, "Solarama Crush launch event: a hit for the bees and beer," March 21, 2019, https://fresh-energy.org/solarama-crush-launch-event-a-hit-for-the-bees-and-beer/

Ilan Klages-Mundt is the co-founder of Insight Brewing.

Community Solar

By far the largest kind of solar deployment in Minnesota is community solar, which has emerged rapidly over the past two years. Community solar is now offered by 30 utilities in Minnesota, with Xcel Energy customers accounting for the largest share of subscribers.

As of the end of 2018, there are 208 projects serving about 14,000 subscribers with 514 megawatts (MW) of community solar in Minnesota. The number of subscribers doubled between the beginning and end of 2018.

As shown in the figure, most subscribers are residential customers. Although the data is unclear, it is likely that many of these are renters. Minnesota-based companies like Minnesota Solar Connection and Sherman Associates are teaming up to provide community solar to thousands of individually-metered residential renters across the Twin Cities metro.[16]

Commercial, industrial, and public sector customers (called general service customers) account for 85 percent of the power sold through the CSG program. Just over 1000 general service customers have subscribed to 527 MW of new solar in Minnesota (a number of projects are still under construction). Public sector general service customers, especially schools, city facilities and hospitals, were estimated to account for at least 44 percent of non-residential CSG capacity, or at least 200 MW, as of January 2019.[17]

Strong interest from commercial customers is part of a global business trend toward corporate sustainability. Rocky Mountain Institute reports that the 276 corporate members of their Business Renewables Center have supported the development of over 15,000 megawatts of new renewable energy over the past five years.[18] IT companies like Apple, Google, and Facebook have led the way, powering the massive data centers that make the internet run. But other major corporations, including Walmart, GM, AT&T, and even oil giant Exxon-Mobil have made major renewable energy purchases.

Minnesota-based companies are part of that movement, from local coffee shops to Fortune 500 companies. Target plans to put rooftop solar panels on 500 stores by 2020

16 Sherman Associates, "Solar Garden - Carver County," accessed April 25, 2019, https://www.sherman-associates.com/properties/solar-garden-carver-county/case-study/
17 Xcel Energy 2018 Annual S*RC Program Report (April 1, 2019) in Docket. No. 13-867, page 21.
18 Rocky Mountain Institute (RMI), Business Renewables Center, accessed April 17, 2019, https://businessrenewables.org/

Figure 4a Community Solar Garden Subscribers, 2018

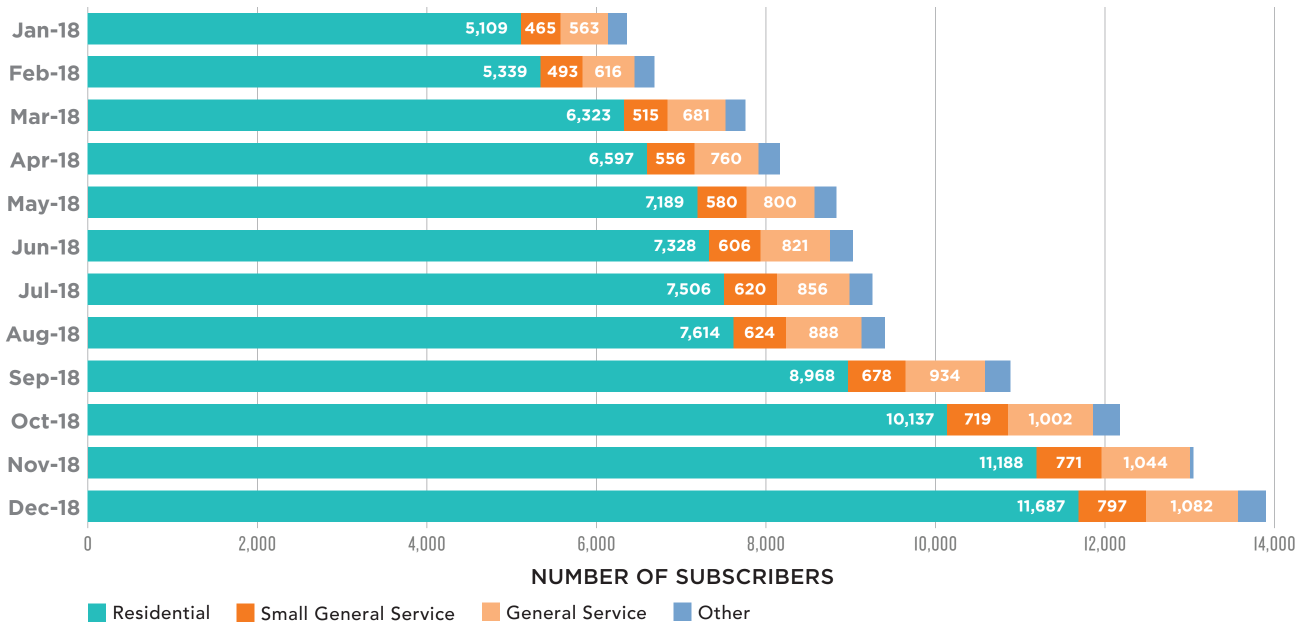
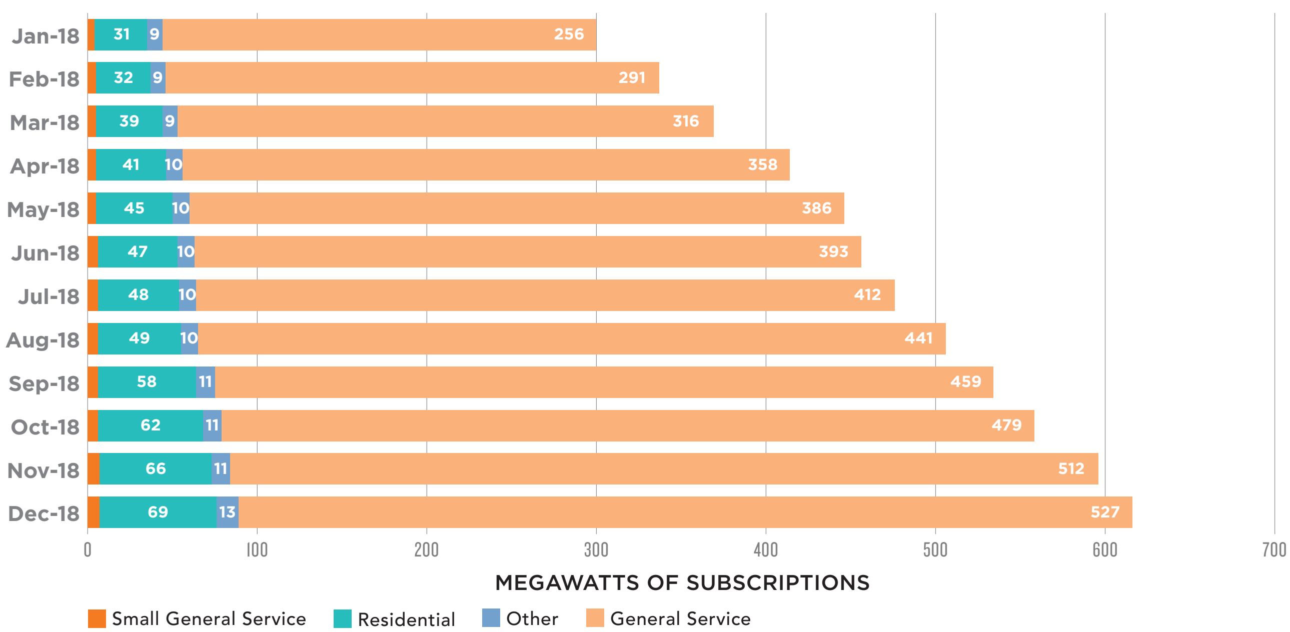


Figure 4b Community Solar Garden Subscribers in Megawatts



Source: Institute for Local Self Reliance analysis of Xcel Energy reports. Note: Subscriptions exceed current supply due to time lag in development.

Dodge Middle School in Farmington. Source: Farmington School District

on the way to being powered by 100 percent renewable energy overall.[19] In February, 3M committed to sourcing 100 percent of their electricity from renewables, with an interim target of 50 percent by 2025. As a first step, they agreed to fully power their St. Paul global headquarters – a 409-acre campus with about 12,000 employees across 30 buildings and research labs – with energy from Xcel wind farms near Pipestone, plus other wind and solar sources.[20] Even US Bank Stadium, home of the Minnesota Vikings, is fully powered by wind energy through purchase of renewable energy credits.[21]

Ecolab was the first big Minnesota company to sign up for community solar, subscribing to 5 MW of power from solar gardens in 2015. The company later went 100 percent renewable for their North American operations through a 100 MW contract with a new wind farm in Texas, cutting overall corporate emissions by 25 percent.[22] Ecolab employs 48,000 workers worldwide.

Now many big names have signed up, including Land O'Lakes, Macy's and US Bank. Andersen Windows currently subscribes to 26 solar gardens that, as of August 2018, supplied 6.5 megawatts of electricity for their Cottage Grove factory that makes Renewal replacement windows and doors—about 103 percent of that plant's electrical usage. This reflects about $49,000 of net cost savings for the company since January 2018.[23]

19 Target, "sustainable operations," accessed March 28, 2019, https://corporate.target.com/corporate-responsibility/planet/sustainable-operations

20 3M, Press release: "3M Announces 100% Global Renewable Electricity Goal with Headquarters Campus Converting to all Renewables Immediately," February 28, 2019, https://news.3m.com/press-release/company-english/3m-announces-100-global-renewable-electricity-goal-headquarters-campus

21 US Bank Stadium, "Sustainability," accessed April 17, 2019, https://www.usbankstadium.com/stadium-info/sustainability

22 Ecolab, Press release: "Ecolab Investing in Renewable Power Project with Clearway Energy Group," December 18, 2018, https://www.ecolab.com/news/2018/12/ecolab-investing-in-renewable-power-project-with-clearway-energy-group

23 Andersen Windows and Doors, Press release: "Renewal by Andersen Subscribed to 100 Percent Solar Energy," December 2018, https://www.andersenwindows.com/about/newsroom/2018-12-12-11-19-renewal-by-andersen-sources-100-percent-solar-energy-at-minnesota-plant/

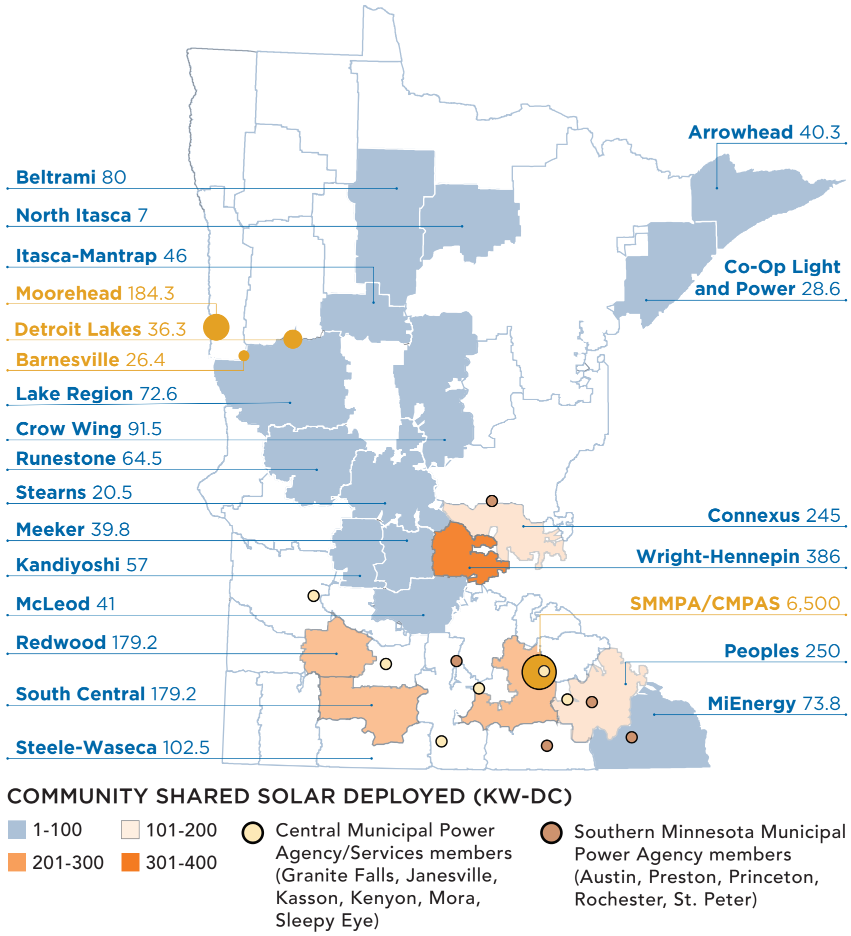
Renewal by Andersen President Paul Delahunt says "Community subscriptions and joint agreements mean that it isn't just the giant companies like Google or Facebook who can play a role in the renewable energy movement—small and mid-size companies can make a difference, too."

Smaller businesses too are attracted to community solar. Ilan Klages-Mundt is the co-founder of Insight Brewing, where 40 employees brew 10,000 barrels of craft beer each year in their Northeast Minneapolis brewery and taproom.

"When we opened the brewery in 2014 we cared about sustainability, but we didn't have the capital available," he says. "IPS Solar let us go solar with no money down, and with a reduced utility bill. It just makes sense. So we signed up to be the first Minnesota brewery to commit to going 100 percent solar."

Insight has 61 solar panels on their roof, to show their commitment, but get most of their solar power from a bigger offsite system in Carver County. Due to rapid expansion of their business, they haven't made it to 100 percent yet, and need to buy more. But because solar gardens must be in the same or adjacent county as the customer, IPS has struggled to find new sites that could supply the brewery.

Figure 5 Municipal and Cooperative Utilities Offering Community Solar



Source: Gabriel Chan, et al., Barriers and Opportunities for Distributed Energy Resources in Minnesota's Municipal Utilities and Electric Cooperatives, February 2019, https://bit.ly/2lBxdQa

Klages-Mundt points to the strong support from their customers for their switch to solar. But he says all need to play their part. "We need our elected officials to be the leaders," he told WCCO-TV in 2017.[24] "If they are not doing it, who are the leaders who are going to step up? For us it came down to business leaders."

The public sector is also an active supporter of community solar. The Metropolitan Council organized a collaborative of 31 local governments and public agencies to subscribe to 33 megawatts of community solar projects across a seven-county region.[25]

"The result is financial savings for local taxpayers and ratepayers, reduced air emissions from fossil fuels, and advancements in solar production in Minnesota," according to Met Council Project Manager Jason Willett. "It's just a big win all the way around."

Schools are also benefiting from community solar. Farmington is home to the largest school solar project, with 2,200 panels on the roof of Dodge Middle School, generating 60 percent of the school's electricity needs. More installations are on other schools and mounted on school grounds, so

24 WCCO-TV, "Northeast Minneapolis Brewery Going Solar With Beer," February 6, 2017, https://minnesota.cbslocal.com/2017/02/06/insight-brewing-solar-power/

25 Metropolitan Council, Press release: "Regional Collaboration Delivers Sustainable Energy," November 22, 2017, https://metrocouncil.org/News-Events/Communities/Newsletters/Regional-collaboration-delivers-sustainable-energy.aspx

Figure 6 Community Solar Projects Serving Xcel Customers

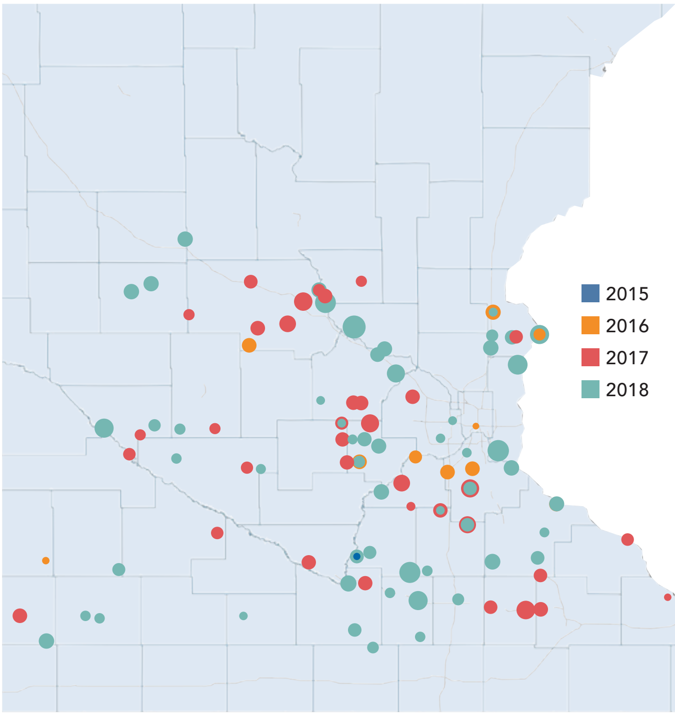
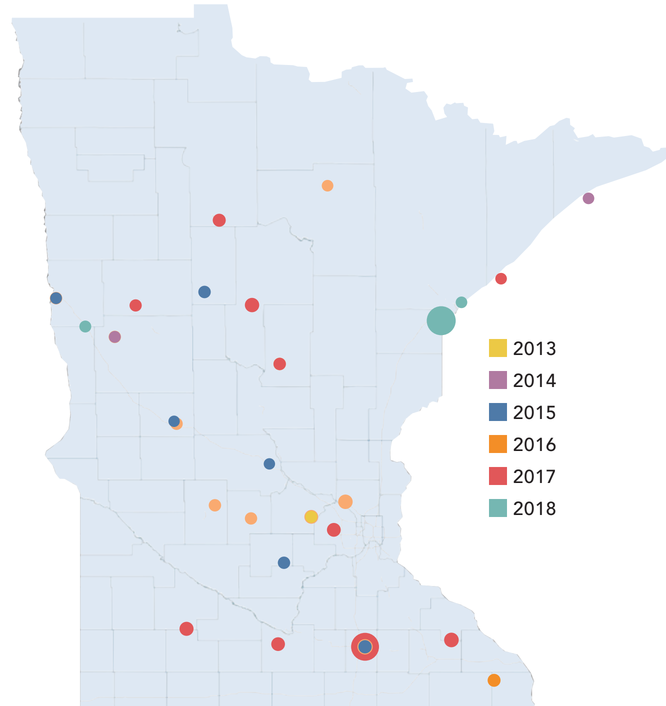


Figure 7 Public Utilities with Community Solar Projects



Size of circle reflects the size of the solar garden, ranging from 3.6 to 5,000 kilowatts. Some circles reflect multiple projects at one location. An interactive version is available online at https://tabsoft.co/2PqYTc1

they can be visible to students and part of the educational curriculum. In all, the district expects to save $2.7 million over 25 years, which can be spent on classrooms instead.[26]

Jon Kramer, CEO of Sundial Solar, the installer on the Farmington project, cites the educational and financial benefits to the district. "They want kids to develop an appreciation of clean energy," he said. "And they're going to save money, and that's an important aspect, because schools are struggling for money and this is a noble cause that pays a dividend."

Interest in community solar from business and public sector customers has been so strong that it has been hard to interest community solar developers in marketing to residential subscribers, despite strong demand from households. Almost 12,000 residential customers have signed up for community solar, and the potential is much greater. But faced with the relatively higher cost of outreach, education, and administration for residential customers, and the ease of signing up corporate and public customers, residential customers have been a lower priority.

To encourage more participation by households, in October the Minnesota PUC added a temporary two-year incentive of 1.5¢ per kilowatt-hour to cover the higher costs of marketing to and serving new residential subscribers.

As of year end 2018, there were 208 individual CSG projects adding up to 514 megawatts of capacity, including 169 projects serving Xcel Energy customers, 37 from rural coops and municipal utilities, and two from Minnesota Power.

While community solar projects are located throughout Greater Minnesota, the majority are clustered around the Twin Cities. Regulations require projects to be built in the same or adjacent county as the subscriber, and the majority of subscribers are Xcel Energy customers in and around the Metro region.

26 Frank Jossi, Midwest Energy News, "Investment in solar grows dramatically in Minnesota schools," November 14, 2017, https://energynews.us/2017/11/14/midwest/investment-in-solar-grows-dramatically-in-minnesotas-k-12-schools/. Deanna Weniger, Farmington Independent, "Solar panels coming to four Farmington schools," July 4, 2016, https://www.farmingtonindependent.com/news/4064408-solar-panels-coming-four-farmington-schools

THE BENEFITS OF COMMUNITY SOLAR

Solar power delivers many benefits – to consumers, to workers, to landowners and local governments, to the electricity system, and to the planet. The Community Solar Gardens approach extends those benefits to people who wouldn't be able to capture them otherwise.

Jobs

The rapid growth of community solar has been a major source of job creation in Minnesota.

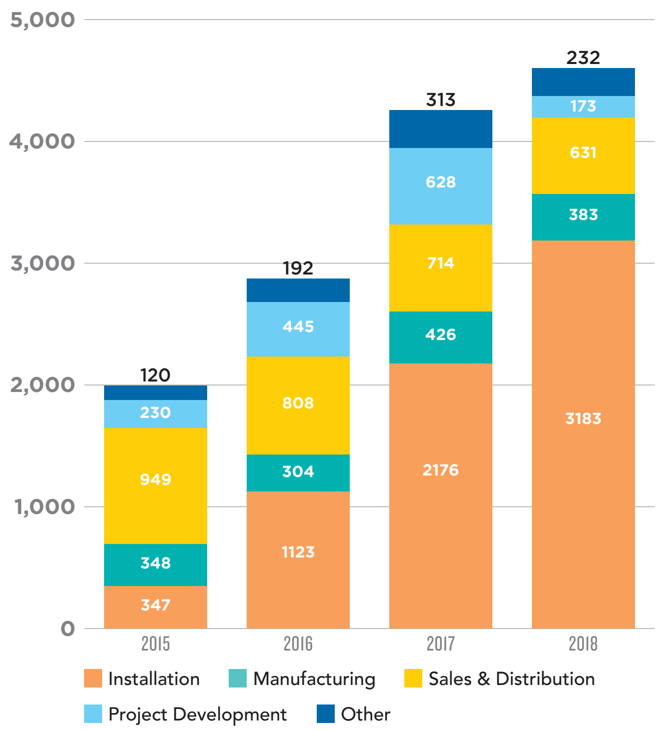
Minnesota ranks 13th in solar jobs per capita, according to the Solar Foundation's annual census, with 4,602 jobs counted last year.[27] "Solar Installer" is now the fastest growing job in the state, growing from 347 in 2015 to almost 3,200 three years later. Installation jobs accounted for 70 percent of all solar jobs last year. Another study, Clean Jobs Midwest, counted 4,917 solar jobs in Minnesota in 2018, up nine percent from the previous year -- bucking the overall national trend, where solar jobs declined by three percent.[28]

Since most of the solar installations have been clustered around the Twin Cities metro area, most jobs are there as well. The solar census counted 3,512 jobs in Hennepin county, with Stearns and Ramsey counties counting another 365 and 213 respectively.[29]

Community solar, by far the largest type of solar development in the state, counted for over 4,000 of these jobs. Rooftop solar projects counted for about 370 jobs while utility-scale development activity is currently very low, due to a lack of procurement by Xcel and other utilities.

MnSEIA, the Minnesota Solar Energy Industries Association, counts 128 business members, including 12 manufacturers, 25 developers, and 40 installation companies.[30] The list includes major engineering and construction firms that are headquartered in Minnesota, including Blattner, Mortenson, and Egan, who collectively employ 7,800 workers around the world. Three local chapters of the IBEW union are also members as are Stearns Bank of St. Cloud and other financial and legal companies.

Figure 5 Minnesota Solar Jobs By Category



Source: Solar Foundation

27 Solar Foundation, Solar Jobs Census 2018: Minnesota data, https://www.solarstates.org/#state/minnesota/counties/solar-jobs/2018

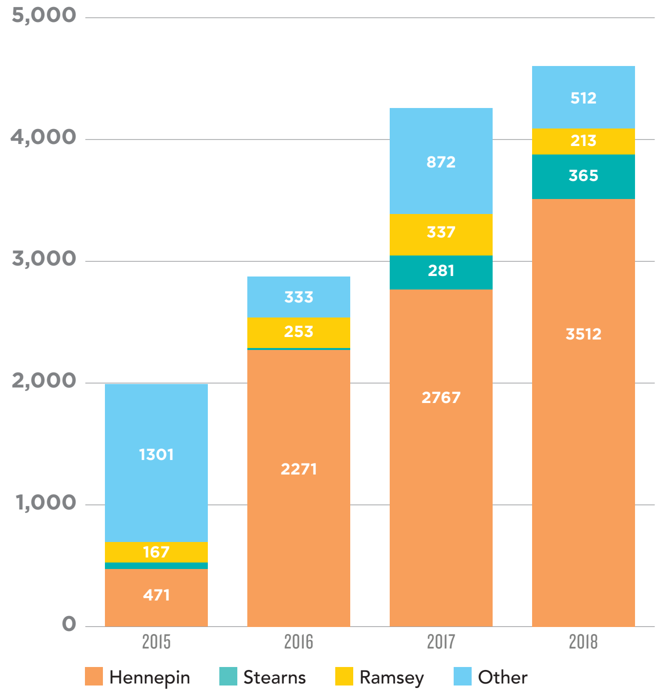
28 Clean Energy Trust, Environmental Entrepreneurs (E2), and BW Research, Clean Jobs Midwest study, Minnesota page, accessed April 9, 2019, https://www.cleanjobsmidwest.com/state/minnesota

29 The Solar Census sometimes counts jobs by the location of the headquarters of a firm, rather than by the home address of the worker or the exact location of the work. The Twin Cities is often the location of corporate headquarters. Also, solar construction jobs are somewhat itinerant, making the location of the "job" inexact.

30 Minnesota Solar Energy Industries Association (MinnSEIA), https://www.mnseia.org

While solar manufacturing is dominated globally by Chinese companies, Minnesota has worked hard to support local production. A panel manufacturing plant in Mountain Iron (in the Iron Range) was reopened in 2018 by Heliene, a Canadian company, hiring 120 workers with a $5 million annual payroll. The company reports that 60 percent of the panels they manufactured previously in Canada were sold in Minnesota, primarily for community solar gardens. Heliene is also aiming to supply the newly emerging Illinois community solar market, which was modeled in part on Minnesota's system.[31]

Figure 6 Minnesota Solar Jobs By County



Source: Solar Foundation

Choice, Competition, and Participation

While many states have introduced retail choice for electricity, Minnesota has not, sticking with monopoly service territories for regulated utilities. But even in a monopoly market, consumer-owned energy technologies, like solar power, batteries, and controllable demand (called demand response) are introducing a new, more active role for consumers and a new form of competition.

In our digital age, consumers increasingly want access to new technologies and business models like solar power. For those who can't or choose not to put it on their own property, community solar gives consumers the ability to choose solar. Consumers can own or subscribe to solar systems, getting solar power at a reasonable price.

As mentioned above, choice is especially important for Minnesota businesses, who must compete with rivals in other states and countries. While keeping costs low is always important, many companies are also committing to become more sustainable and reduce their carbon footprint, in order to be more attractive to customers and partners.

Greater competition helps spur innovation and drive down the cost of solar. While traditional monopoly utilities provide reliable power at a reasonable cost, they have never been strong at innovation or marketing, since it is not part of their business model. Private companies are better able to develop and market innovative products that meet customer needs.

In addition to competing with utilities, community solar developers must compete with each other to attract customers, to make deals with landowners, and to attract financing. This intense competition results in increased efficiency and lower deployment costs, and greater benefits for consumers.

Community solar also offers greater participation for citizens in the transition to renewable energy, sometimes called "energy democracy."[32] Julia Nerbonne, executive director of Minnesota Interfaith Power and Light, says more citizen involvement will make for a stronger energy system overall with greater public support for the changes that are needed. "We don't want one company to control our energy future," she told Minnesota Public Radio.[33]

31 Dan Kraker, MPR News, "Country's newest solar factory opens on the Iron Range," September 25, 2018, https://www.mprnews.org/story/2018/09/25/solar-factory-opens-on-iron-range

32 Institute for Local Self Reliance, "Energy Democracy: The Big Picture," https://ilsr.org/energy-democracy-the-big-picture/

33 Elizabeth Dunbar, "Xcel Energy, others push changes to state's community solar program," MPR News, March 1, 2019, https://www.mprnews.org/story/2019/03/01/xcel-to-state-community-solar-programs-needs-overhaul

Landowner and Local Government Revenues

Ed Eichten on his farm. Photo credit: IPS Solar

Community solar creates economic benefits for rural landowners and counties.

Landowners can lease their land to developers or get royalty payments for hosting solar projects. Depending on the location of the land parcel relative to the distribution grid, Minnesota landowners with an optimal site can command annual lease rates averaging $1,000 an acre or more. Given that community solar gardens typically take up to 10 acres per megawatt of solar panels, the 514 MW of projects in service as of the end of 2018 likely pay annual rents of over $5 million to the owners of the 208 project sites.

At that time, another 214 MW were under construction across 146 sites. Adding up all the currently finished and pending projects, the owners of 354 sites will receive about $182 million from community solar over the 25 year term of their contracts.

Additional revenues can come from utility-scale projects. Because community solar projects are size-limited under state policy, they tend to be spread among more landowners than utility-scale systems, creating more beneficiaries.

One area seeing big benefits from solar is Chisago County, northeast of the Twin Cities along the St. Croix river. The county is home to 20 community solar projects, plus the 100 MW North Star Solar project that sells wholesale power to Xcel Energy, making Chisago County the state leader in solar power.

One landowner who benefits is Ed Eichten, who raises bison and produces artisanal cheese on his farm in Chisago County. Working with IPS Solar, he started in 2011 with a 3,000 panel system on an odd-shaped four acre field that had been planted in hay, delivering a higher value use for the land. Over the years, he expanded it to a five megawatt community solar garden, enough to power 650 homes.

"It doesn't make sense to keep polluting the atmosphere," he says. "I thought it was a very good idea, not just for me but also for the environment. It's kind of a feel-good situation."[34]

"It's a good use of my land to help society."

Community solar creates benefits for county and local governments through tax payments, which support schools, roads, public health and safety, and other vital services.

Bruce Messelt, Chisago County Administrator, says "we can think about this as almost the next big crop."[35]

The Minnesota Solar Energy Production Tax collects $1.20 per megawatt-hour of generation, with 80 percent going to counties and 20 percent to cities and townships.[36]

In 2019, Chisago County will receive $320,742 from the Production Tax, in addition to the annual property taxes from the landowners who host the systems. About a third of those property tax payments would be attributable to community solar projects.[37]

State law exempts systems of one megawatt or less from the Production Tax. However, there are 112 community

34 IPS Solar, A Landowner's Story (video), https://ips-solar.com/landowners/
35 The Power of Minnesota (documentary), https://www.powerofmn.com
36 Minnesota Department of Revenue, "Energy Production Taxes," accessed April 17, 2019, https://www.revenue.state.mn.us/businesses/energy-production/Pages/File-and-Pay.aspx
37 Personal communication with Chase Peloquin, Assistant County Assessor, Chisago County, April 11, 2019.

solar projects around the state that are larger than one megawatt, for a total capacity of 464 MW, resulting in an estimated $1.13 million in annual Production Tax payments.

When farmland is used for a CSG, the tax status changes from Agricultural to Commercial, triggering a property tax increase. While the details are complicated, property taxes can increase substantially, resulting in greater revenues to the county. The solar developer usually agrees to pay the increased tax, rather than the landowner. Due to the complexity of local tax policies, the total increase is unknown, but based on anecdotal evidence is likely to be over $2 million per year.

To cite one example, US Solar has a pair of one megawatt projects, occupying 10 acres each, in Chisago County. The property tax bill rose from $1700 to $5000 for one and from $2100 to $8300 for the other, or a net increase of $9400 per year for the two projects.[38]

Solar is also helping the Chisago Lakes School District save money. The District is getting power from nearly 1,000 panels on the roofs of five schools, plus they subscribe to community solar gardens located on private land —all with no money paid upfront. Over the next 30 years, their developer IPS Solar predicts the district will save $3 million in electricity costs, or $100,000 each year.[39]

Social Benefits: The Environment, Public Health, and Equity

Under full sun, each one megawatt community solar garden provides clean, locally produced electricity for about 200 nearby households and businesses. This reduces the need for utilities to import costly electricity from remote power plants that burn out-of-state coal and natural gas.

As a zero-emission energy source, solar benefits the environment and public health, avoiding the many impacts that come from coal and natural gas power plants, including particulate, sulfur and nitrogen oxide air pollution, and the land and water impacts from mercury emissions, mining and gas drilling, frack sand mining, pipelines, coal piles, and coal ash disposal pits. And of course, solar does not contribute to global warming.

By reducing the "criteria" air pollutants that contribute to smog, solar can also contribute to public health. The share of power from polluting coal-burning power plants in Minnesota has fallen from 62 percent to 44 percent since 2005, largely due to the growth in wind and solar power. If we assume that the 505 MW of community solar currently operating is displacing coal, then community solar is cutting sulfur dioxide (SOx) and nitrogen oxide (NOx) emissions by 470 and 438 tons per year, respectively.[40]

This has helped clean up the air in Minnesota, putting the state in compliance with federal air quality standards. However, ongoing episodes of dirty air can harm vulnerable populations, such as the elderly and children with asthma. Poor air quality disproportionately impacts communities of color and those living in poverty.

One study estimated that 6-13 percent of all residents who died and 2-5 percent of all residents who visited the hospital or emergency room for heart and lung problems in the Twin Cities in 2008 did so partly because of fine particles in the air or ground-level ozone. This translated to about 2,000 deaths, 400 hospitalizations, and 600 emergency room visits.[41]

Community solar is also an important contributor to reducing global warming emissions. Minnesota's power sector emissions have fallen 29 percent between 2005 and 2016, surpassing the 2015 goal of the Next Generation Energy Act, and nearly reaching the 2025 goal. Additional coal plant closures that will drive further reductions.[42]

While much of the reduction has been driven by a state and regional shift toward wind and natural gas power generation, plus energy efficiency gains, community solar is contributing, currently cutting carbon dioxide emissions by about 920,000 tons per year.[43]

38 Personal communication with Ross Abbey, US Solar, April 18, 2019.

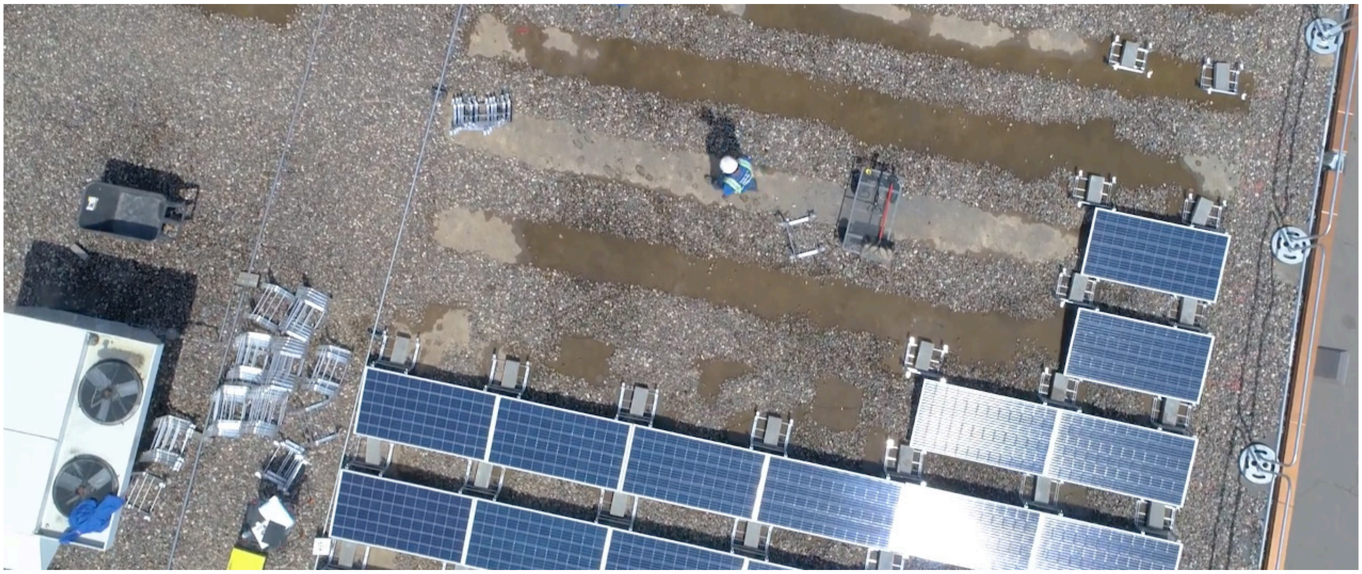
39 IPS Solar website, accessed March 28, 2019, https://ips-solar.com/projects/chisago-lakes-school-district/

40 Calculated using 2017 emissions from the Allen S. King coal plant (source: Energy Information Administration). Solar generation estimated based on the performance of the North Star Solar plant (2017 capacity factor of 21.6 percent, from Lawrence Berkeley National Lab data).

41 Minnesota Environmental Quality Board, *2017 Minnesota Environment and Energy Report Card*, https://www.leg.state.mn.us/docs/2017/other/171044.pdf

42 Minnesota Pollution Control Agency, Department of Commerce, Greenhouse gas emissions in Minnesota: 1990-2016, January 2019, https://www.pca.state.mn.us/sites/default/files/lraq-2sy19.pdf

43 Same sources as in footnote 25.



Community solar policies can also improve the equity of energy, cutting pollution in disadvantaged communities (including those located near coal and natural gas plants) and reducing the burden of utility bills for low and moderate income households. Solar can provide long-term savings to low-income customers, reducing the need for constant bill payment assistance. It can reduce energy bills for churches, governments, and non-profit agencies, allowing them to put the savings into their primary missions.

Cooperative Energy Futures (CEF), based in the Twin Cities, is especially focused on energy equity. CEF provides community solar to subscribers through a co-op model, where subscribers become members and share in the profits. They currently have 650 members who support eight projects. To attract low-income customer participation, CEF offers no-money-down subscriptions with no credit checks, delivering a bill saving of about eight percent. To help with financing, CEF partners with businesses or local government customers to act as backup subscribers; if a low-income subscriber misses a payment and drops out, the backup subscribers takes over that portion of the output until a new customer is found. CEF also emphasizes minority and low-income hires, with on-the-job training.[44]

Workers at Shiloh Temple. Source: Power of Minnesota documentary

CEF's first project was at the Shiloh Temple, a church in North Minneapolis. The 200 kW project on the roof of the building supplies the church, the nearby Masjid an Noor mosque, and 20 residential subscribers in the neighborhood. The project was built with over 90 percent minority labor, including many workers from the neighborhood.[45]

44 Cooperative Energy Futures, "Cooperative Community Solar Gardens Building Equity in Our Energy Future," https://cooperativeenergyfutures.files.wordpress.com/2012/03/certs-cef-csg-doc.pdf

45 Institute for Local Self Reliance, "Community Solar With an Equity Lens: Generating Electricity and Jobs in North Minneapolis — Episode 57 of Local Energy Rules Podcast," July 24, 2018, https://ilsr.org/community-solar-equity-ler-episode-57/

Technical Benefits to the Grid

Solar can also create benefits to the electric power system. The addition of solar energy to the generation mix increases fuel diversity, reducing the risk to consumers from increases to coal and natural gas prices. It also increases operating diversity, since more electric generators are available to meet demand, and since solar panels are not at risk of pipeline ruptures, train derailments, or mechanical breakdowns. Solar is especially good at providing power during summer peak demand periods, when electricity is very expensive, reducing costs for all customers.

Solar can also benefit local distribution grids. Under Xcel Energy's interconnection rules, community solar gardens are connected to the low-voltage distribution grid, the local part of the utility system that distributes electricity to homes and businesses. They can boost power on rural distribution lines, which often suffer from poor power quality. And they can reduce congestion when demand is too high, typically on hot and sunny summer days. Putting solar power in the right parts of the distribution grid can eliminate the need to make expensive upgrades to the wires and transformers, saving money for all customers.

In addition, many community solar gardens are required to spend private dollars upgrading Xcel Energy's distribution infrastructure to enable the project's interconnection. According to Xcel, the community solar gardens pay an average of over $386,000 per site to upgrade this local infrastructure. Multiplied across the 332 CSG sites built and currently under construction, this would amount to over $120 million in private capital going to upgrade the local infrastructure[46] (such as substation communication upgrades, extending three-phase distribution lines, and replacing older control systems). This investment improves the level of service for other customers on the local distribution circuit at no cost to them or to utility ratepayers more generally.

The 2013 law stipulated that the power generated would be credited to the customer at the customer's applicable retail rate (ARR) or at the "value" of solar.[47] To calculate the value, and create a "value of solar tariff" or VOS tariff, regulators went through an extensive research process.

The state Department of Commerce developed a methodology that counted the costs associated with a typical gas-fired power plant that would be avoided by using solar power, such as the value of energy and its delivery, generation capacity, transmission capacity, transmission and distribution line losses, and environmental value, as shown in Figure 7. The Department was also permitted to consider the cost or benefit of solar operation to the utility, credit for locally manufactured or assembled energy systems, and systems installed at high-value locations on the grid.

In late 2016, the Minnesota PUC ordered Xcel to transition from compensating subscribers of new solar gardens at the customer's retail rate to the VOS tariff, which lowered the compensation to subscribers. Moreover, the VOS has declined over time, dropping 10 percent between 2018 and 2019.

Xcel files a new VOS tariff each year, taking into account changes in fuel prices and other factors. Under ARR, the bill-credit rate varies by customer class and project size, while the VOS bill credit rate is the same for all subscribers and project sizes, and increases with inflation each year for 25 years. For projects that start in 2019, the first year bill credit value is 9.04 cents per kWh (in 2019 dollars), increasing to 11.05 cents in year 10 (in 2029 dollars). A typical residential retail rate is currently about 11.8 cents per kWh.

Ownership of the renewable energy certificates (RECs) from the solar garden passes to Xcel Energy in return for compensating the subscriber for the plant's avoided environmental costs, including the social cost of carbon. Xcel can use the RECs to show compliance with the state solar energy standard, or to monetize the value for the benefit of its ratepayers.

Because the VOS rate is not intended as an incentive, the rate does not vary depending on the subscriber's customer class, meaning there's little economic logic for CSGs to serve small many residential customers (instead of simply serving five large customers). To address this concern, in November 2018 the Commission increased the rate for residential subscribers by 1.5 cents per kilowatt-hour for new subscriptions in 2019 and 2020.[48]

46 Xcel Energy response to MnSEIA Information Request No. 11 in Docket No. 13-867, October 22, 2018.
47 Minnesota Statutes, 216B.164 Cogeneration And Small Power Production, https://www.revisor.mn.gov/statutes/cite/216B.164
48 Minnesota PUC Order in Docket No. 13-867 (ordering the creation of a residential rate adder), November 16, 2018.

OPPORTUNITIES AND BARRIERS TO FURTHER GROWTH

Solar power has a bright future in Minnesota, thanks to strong customer demand, advances in technology and falling prices, and renewed support from state policymakers.

On March 4, 2019, Gov. Walz announced his "One Minnesota Path to Clean Energy." His vision is to completely decarbonize the power system by 2050, while giving each utility the flexibility on how to reach the goal.[49]

"We are partnering with our energy utilities who are helping lead the way, who have set their own ambitious goals to cut carbon to zero right along with us," Gov. Walz said at the announcement. "We are working hand in hand with the people who will create the jobs and the innovators. And we're working with those who care about the stewardship of the planet in our faith community to understand that this is both an economic and moral responsibility as stewards of the planet."

Community solar is without a doubt a key part of this transition. But for community solar to reach its full potential and bring benefits to a greater number of Minnesotans, a number of policy improvements could be made.

Increasing Flexibility to Improve Economics

The Community Solar Garden policy has a number of provisions that were intended to result in a specific kind of development, but are turning out to be somewhat restrictive, resulting in higher costs, fewer benefits, and less consumer choice.

The first is called the "contiguous county restriction." CSG rules require subscribers to be located in the same county as their solar panels, or in an adjacent county. The rule has the conceptual benefit of connecting subscribers to their power plant, just as subscribers to a community garden are connected to their neighborhood garden. But it creates some problems and inefficiencies.

First, the vast majority of Xcel customers and thus CSG subscribers are in the Metro region, while the number of locations for solar projects in and around the Twin Cities is limited. While rooftop systems – on warehouses and big box retailers, for example – can be attractive for CSG projects, they are limited in size, have higher installation costs, and can run into barriers from ownership and structural issues. As a result, developers compete to get access to good land sites, sometimes driving up costs. Developers are less able to locate projects in ways that would benefit the local power grid. Indeed, local distribution grids can have a limited capacity to connect solar generators.

Providing more flexibility in the choice of location would also give developers more options to serve customers in a region, resulting in more competition, more choice, and better deals for customers. Customers can always choose projects that are local, if that is their preference.

Second, the financial benefits are limited to landowners and counties in the Twin Cities area, rather than spread around Greater Minnesota. As we have seen, landowners like family farms can make an average of $1,000 per acre per year by hosting CSG project each year, while also diversifying and de-risking their overall farm revenue.

Third, the employment benefits are also geographically limited. While a number of rural community colleges and tribal colleges offer job training programs for solar installers, their placement rate is low since more jobs are being created in the Metro area. As mentioned, about three-fourths of Minnesota solar jobs are in the Twin Cities area.

49 Minnesota Department of Commerce, Press release: "Walz, Flanagan propose plan to achieve 100 percent clean energy in Minnesota by 2050," March 4, 2019. https://mn.gov/commerce/media/news/?id=17-374074

Another constraint on community solar is the size limit of one megawatt per project. The size cap is intended to separate community projects from utility-scale projects, which typically deliver wholesale power to the utility under a different policy regime. But the fact remains that there are economies of scale when deploying solar, and larger projects can produce power at a lower cost than smaller projects.

The defining aspect of community solar is not the size of the project so much as the ownership and subscription model, with thousands of individuals and businesses seeing direct economic benefits, rather than a few big investors. If community solar gardens were allowed to be larger, it would create more opportunities for investment, more savings for consumers, and greater demand for solar power. It may make more sense to define project size limits based on the carrying capacity of local distribution grids rather than an arbitrary number.

Since policymakers may want to encourage more residential customers to participate in community solar, greater location and size flexibility could be offered as an incentive to projects that serve a higher portion of residential customers.

Making these changes would enable projects to be more flexible in their locations, lower costs for subscribers, and provide more benefits to more landowners, jobseekers, and local governments.

Extending the Benefits to Low-Income Subscriber

As solar power becomes more affordable, many are seeking ways to use it to cut electricity bills for low-income households.[50] Low-income households in Minnesota have the highest energy burdens of any customer class, sometimes paying over 40 percent of their monthly income on heat and power, compared to 7 or 8 percent for higher-income customers, according to federal Census and Energy Department figures. The highest energy burdens are found in rural counties in northern Minnesota.[51]

The federal Low Income Home Energy Assistance Program, LIHEAP, is the main vehicle for providing aid to struggling families. But Minnesota's LIHEAP allocation has dropped from $160 million dollars in FY2010 to $114.5 million dollars in FY2017. With 628,945 eligible households in the state, only 126,149 were served, leaving 79.9 percent of our most vulnerable households at risk of energy shutoff.[52]

While solar can save money in the long run, low-income households face barriers to getting access to it in the first place. They may not have the savings to pay cash for a system, they may not own their home or apartment, and they may have poor credit ratings, making loans or other financing off limits.

Community solar can be a great way to deliver energy assistance for low-income customers, if provisions are included that specifically target these barriers. A number of states are adopting strategies to do just that.[53]

- Program carve-outs have been included in Maryland and Oregon, which mandate a certain percentage of an overall program be dedicated to low-income customers.
- Incentives have been used to reduce the cost of low-income participation in states like Colorado, Illinois, and Massachusetts.
- Other states are trying new approaches. New York has proposed a program under which the state will serve as an intermediary buyer of community solar and allocate capacity to low-income customers.[54]

The Rural Renewable Energy Alliance (RREAL) in Backus, Minnesota, has developed the first community solar project devoted entirely to low-income customers. Working with the Leech Lake Band of Ojibwe, RREAL built a set of five solar systems totaling 215 kilowatts, owned by the tribal government. The revenues from the projects

50 Clean Energy States Alliance, Bringing the Benefits of Solar to Low-Income Consumers: A Guide for States & Municipalities," May 2017, https://www.cesa.org/projects/sustainable-solar/resources/resource/bringing-the-benefits-of-solar-energy-to-low-income-consumers

51 Dan Boyce and Jordan Wirfs-Brock, Inside Energy, "High Utility Costs Force Hard Decisions For The Poor," May 8, 2016, http://insideenergy.org/2016/05/08/high-utility-costs-force-hard-decisions-for-the-poor/

52 National Energy Utility Affordability Coalition, Minnesota Fact Sheet 2019, https://neuac.org/wp-content/uploads/2018/02/State-Sheet-FY19-Minnesota.pdf

53 GRID Alternatives, Vote Solar, and Center for Social Inclusion, *Low Income Solar Policy Guide*, accessed March 2019, https://www.lowincomesolar.org/best-practices/community-solar/

54 For more program ideas see Clean Energy States Alliance, *Directory of State Clean Energy Programs and Policies for Low- and Moderate-Income Residents,* December 7, 2018, https://cesa.org/projects/low-income-clean-energy/resources/resource/directory-of-state-clean-energy-programs-and-policies-for-low-and-moderate-income-residents

are used to offset bills by low-income residents, reaching between 70 and 100 families.[55]

Xcel Energy is developing its own community solar garden (as allowed under statute) with the goal of serving local low-to-moderate-income subscribers in St. Paul's Railroad Island neighborhood, with construction slated to start in late 2018.[56]

Unfortunately, there are few provisions to encourage solar for low-income customers in Minnesota's community solar garden program. In fact, the program doesn't even track the demographics of subscribers, so it is unknown if low-income households are participating.

To improve low-income household participation, some have suggested creating a new category of development called Community Access Projects that would value community solar at the full retail rate for eligible subscribers. In exchange, Community Access Projects would have at least half residential subscribers and would not require a credit check. They would also be required to track and report on participation by low-income subscribers.

Another idea is to encourage community action agencies to use solar power to provide energy assistance to the households they serve, like the Leech Lake project does. Investing in community solar can offset or stretch ongoing taxpayer-funded energy assistance, such as through the LIHEAP program.

Other Ideas to Improve Community Solar

As mentioned above, commercial and public customers ("general service") account for the bulk of community solar garden sales. While this is not a problem, some would like to attract more residential subscribers. Regulators recently added a temporary incentive to the bill credit for Xcel Energy residential customers. But it is hard to see what will change after the two year incentive ends. It will still be more expensive to market to and service thousands of residential customers, compared to managing a smaller number of commercial customers.

Illinois has adopted a tiered rate structure for projects that serve different customer classes. Their "adjustable block program" provides incentives in the form of renewable energy credits (RECs) which are purchased by a central agency, the Illinois Power Agency (IPA). To encourage marketing to all classes of customers, the IPA set REC prices higher for projects that serve small customers. REC prices for new projects step down as certain market goals are met, putting pressure on for constant cost reductions. Illinois also uses this mechanism to encourage low-income subscribers and for projects in disadvantaged communities.[57]

Minnesota regulators could likewise control the value of bill credits to meet policy goals, with higher values for residential and low-income customers.

Lastly, community solar policies could be extended to other technologies, most notably to wind power. Minnesota is a national leader in wind power, with Xcel Energy buying more wind power than any other utility. It was also a pioneer in promoting community wind projects. The Community-Based Energy Development (CBED) program, adopted in 2005, offered higher payments for wind projects that were owned by community members.

While CBED resulted in about 266 MW of projects, it was not the success that was envisioned at the start, and fell far short of the 800 MW goal set by the legislature.[58] One key problem was that CBED only allowed sales of power to regulated utilities, who were able to buy wind power from larger corporate-owned wind projects at lower prices. Individual consumers were never given the option to subscribe to the output from specific wind projects in their community. The definition of "community" in CBED applied to investors and owners, but not to customers.

Now that community solar gardens have shown substantial demand for clean energy from consumers, it would be possible to extend the statute and program rules to include community-scale wind generators. Consumer choice for both solar and wind power can enable more rapid progress toward Gov. Walz's goal of carbon-free energy by 2050, while fostering local ownership and community investment.

55 RREAL, Leech Lake Band Of Ojibwe, Community Solar For Community Action: Using Community Solar to Provide Low-Income Households with Solar Generated Energy Assistance, March 7, 2018. https://docs.wixstatic.com/ugd/eed9c8_67fe2f63d6d14cb0bd13804196455b41.pdf

56 Tad Vezner, Pioneer Press, "St. Paul's first community solar farm on track in Railroad Island development," April 5, 2018, https://www.twincities.com/2018/04/05/st-pauls-first-community-solar-farm-on-track-in-railroad-island-development/

57 Illinois Power Agency, Adjustable Block Program, http://illinoisabp.com

58 US Department of Energy, "Community-Based Energy Development (C-BED) Tariff," https://www.energy.gov/savings/community-based-energy-development-c-bed-tariff

CONCLUSION

Community solar has experienced strong growth in Minnesota, especially over the last few years. Minnesota's policy has exceeded even the most bullish initial projections, and is delivering significant community benefits, as described in this report. It has become a primary vehicle for solar deployment in the state, far outpacing customer-sited solar and even surpassing utility-scale solar capacity to date. Thanks to its market-based policy design and a supportive stakeholder ecosystem (including over 14,900 subscribers), Minnesota is the national leader on community solar.

Now that community solar gardens have shown substantial demand for clean energy from consumers, it would be possible to extend community participation in wind power to subscribers. Consumer choice for both solar and wind power can enable more rapid progress toward Gov. Walz's goal of carbon-free energy by 2050, while fostering local ownership and community investment.

While future growth trends are unknown -- like any consumer product -- maintaining a stable, consumer-friendly and business-friendly policy environment will be important. Relatively minor tweaks to create more flexibility for developers would lower costs and create more benefits.

Proposals to limit or slow the growth of community solar would undermine one of the state's biggest success stories in energy.

Policymakers should also focus on ways to increase the accessibility of community solar for residential and low-income customers. Policies and programs could be adopted to reach more residential subscribers, to enable low-income households to get over first-cost and financial hurdles, and to develop more job opportunities.

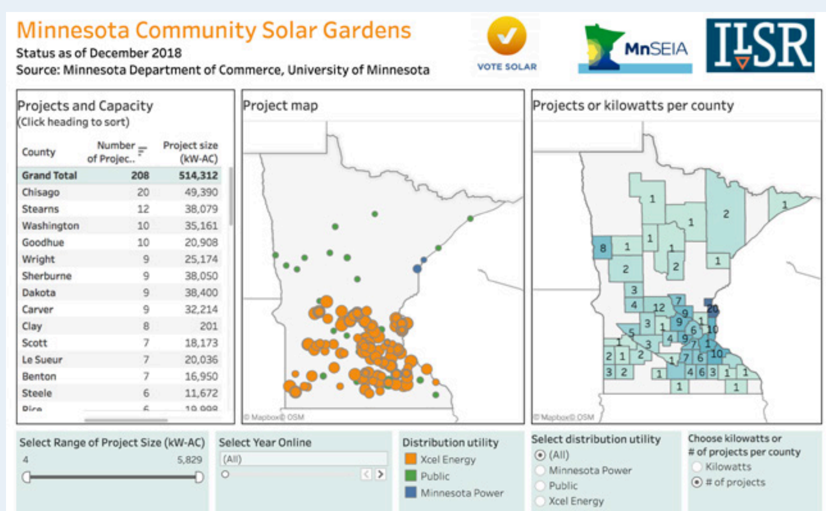
With such changes, community solar could extend benefits to all Minnesotans, urban and rural, and continue to build community.

BOX IV

Online Data Tool Available

More data about Minnesota's solar gardens is available online, through an interactive dashboard. The dashboard allows the user to see solar garden deployment by location, by size, by the local utility, and by the date it came online.

Go to tabsoft.co/2PqYTc1



Produced by PaulosAnalysis.com

Source of Distribution O&M Data for Xcel (NSP):

We used Xcel's forecast of FERC Form 1 data to estimate annual distribution O&M costs per kW of peak load. Specifically, data for the years 2019 to 2023, indicate an average value of about $17 per kW-year:

Table 1: *Forecast Distribution O&M Expense*

Year	Annual Peak *kW*	O&M Expenses *$Millions*	Per Unit O&M *$/kW-year*
2019	7,175	119.3	16.63
2020	7,188	119.5	16.62
2021	7,210	119.7	16.60
2022	7,260	121.7	16.76
2023	7,284	123.0	16.89
Average			**16.70**

The source of this data is: (1) MNSEIA's Information Request #13 from docket 15-115, which requested NSP's current five-year forecast of annual peak load, consistent with the data provided on FERC Form 1, page 401b, column d, and (2) budgeted distribution O&M expenditures from Table 2 at page 10 of NSP's November 1, 2018 Integrated Distribution Plan in Docket No. E002/CI-18-251, which was provided in response to Information Request #9 from docket 15-115.

This forecast estimate of distribution O&M costs is consistent with historical data (see Table 2). NSP's FERC Form 1 data for the years 2016-2018 also shows about $17/kW-year in distribution O&M expenses.

Table 2: *Historical Distribution O&M Expense*

Year	Annual Peak *kW*	O&M Expenses *$Millions*	Per Unit O&M *$/kW-year*
2014	7,540	166.9	22.1
2015	7,298	153.7	22.1
2016	7,680	160.0	20.8
2017	7,371	111.2	15.1
2018	7,534	122.7	16.3
Average 2014-2018			**19.1**
Average 2016-2018			**17.4**

We have also recommended a general plant loader of approximately 3%, based on historical FERC Form 1 data. The following Table 3 shows NSP Minnesota's ratios of general plant in service to all plant in service in 2016-2019. Specifically, we used the beginning-of-year data from rows 99-100 from page 204 of the Form 1 report, except for 2019 where we used end-of-year data for 2018, from page 207.

Table 3: *General Plant Loader*

Beginning of Year:	General Plant *$ millions*	All Plant *$ millions*	Ratio
2016	438.6	16,418.2	2.7%
2017	489.4	17,247.0	2.8%
2018	545.5	17,198.5	3.2%
2019	593.7	17,932.7	**3.3%**

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☐ **Public Document – Not Public Data Has Been Excised**
☒ **Public Document**

Xcel Energy		Information Request No. 9
Docket No.:	E999/CI-15-115	
Response To:	MN Solar Energy Industries Association	
Requestor:	David Shaffer	
Date Received:	December 14, 2018	

Question:
Please provide NSP's most recent plan for future investments in its distribution system. This should include:

a. The annual total dollars forecasted to be invested in distribution plant over the forecast period for the plan, by the year in which the investments are planned to be made;
b. The forecasted annual total dollars of distribution plant to be retired in each year of the forecast period;
c. NSP's current (2017 or 2018) noncoincident distribution substation capacity, in MW;
d. The expected MW of noncoincident distribution substation capacity planned to be added in each year of the distribution investment plan; and
e. For each distribution substation planned to be upgraded, please provide a recent calendar year (2017 if available) of hourly load data in Excel spreadsheet format for each of these substations, and indicate the maximum capacity of each such substation.

Response:
Please see the Company's Integrated Distribution Plan submitted in Docket No. E002/CI-18-251 on November 1, 2018.

Preparer:	Amber Hedlund
Title:	Case Specialist
Department:	Regulatory Affairs
Telephone:	612.337.2268
Date:	January 7, 2019

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☒ **Public Document**

Xcel Energy | Information Request No. 13

Docket No.: E999/CI-15-115
Response To: MN Solar Energy Industries Association
Requestor: David Shaffer
Date Received: December 14, 2018

Question:
Please provide NSP's current best available five-year forecast of annual peak load (in MW) on its system, consistent with the historical monthly system peaks listed in FERC Form 1, page 401b, column d. For example, we understand the Northern States Power (Minnesota) peak in 2017 was 7,371 MW (July 17, 2017, hour 1800).

Response:

We note that the NSP (Minnesota) peak in 2017 of 7,371 MW on July 17, 2017 at hour 1800 is a NSP-MN Company coincident peak. NSP's current five-year forecast of the NSP-MN Company coincident peak is:

2019 7,175 MW
2020 7,188 MW
2021 7,210 MW
2022 7,260 MW
2023 7,284 MW

Preparer: Kent Holcomb
Title: Associate Quantitative Risk Analyst
Department: Sales Energy & Demand Forecast
Telephone: 303-294-2607
Date: January 7, 2019

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Xcel Energy		Information Request No. 18
Docket No.:	E002/M-13-867	
Response To:	Minnesota Solar Energy Industries Association	
Requestor:	David Shaffer	
Date Received:	July 3, 2019	

Question:
If not provided in the workpapers, please provide the calculations used to convert the $80 per kW Effective Avoided Distribution Cost into a Value of Solar Distribution Component of 0.33 cents per kWh.

Response:
Please see Attachment B to Information Response 16 that shows the conversion of the $160 system distribution cost per kW into the 0.33 cents per kWh. Applying the 50% Deferral Reduction Factor to $160 system distribution cost per kW yields an $80 Effective Avoided Distribution cost per kW as is calculated on page 6 of the Company's May 1st compliance filing. Applying the $80 Effective Avoided Distribution cost per kW to the 2018 VOS yields an avoided distribution cost of 0.16 cents per kWh. Please see Attachment A, for the calculation of Avoided Distribution Cost Component based on the $80 Effective Avoid Distribution Cost per kW.

Preparer:	Nick Paluck
Title:	Rate Consultant
Department:	Regulatory Analysis
Telephone:	(612) 330-2905
Date:	July 15, 2019

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Note: Table 1, 2 and 16 were not included as they are not required for the VOS calculation. Table 7 (Losses to be considered) are included in Fig. ES-1

Figure ES-1. VOS Calculation Table: economic value, load match, loss savings and distributed PV value

CURRENT POSITION *25 Year Levelized Values*	**Economic Value ($/kWh)**	**Load Match (No Losses) (%)**	**Distributed Loss Savings (%)**	**Distributed PV Value ($/kWh)**
Avoided Fuel Cost	$0.0262		9.8%	$0.0288
Avoided Plant O&M - Fixed	$0.0023	48.6%	11.0%	$0.0013
Avoided Plant O&M - Variable	$0.0030		9.8%	$0.0033
Avoided Generation Capacity Cost	$0.0440	48.6%	11.0%	$0.0237
Avoided Reserve Capacity Cost	$0.0036	48.6%	11.0%	$0.0019
Avoided Transmission Capacity Cost	$0.0338	48.6%	11.0%	$0.0182
Avoided Distribution Capacity Cost	$0.0026	55.2%	12.6%	$0.0016
Avoided Environmental Cost	$0.0316		9.8%	$0.0348
Avoided Voltage Control Cost				
Solar Integration Cost				
TOTAL				**$0.1136**

Figure ES-2. 1st-Year VOS Rate calculation

Year	Discount Factor	Escalation Factor	**VOS Levelized**	Disc.	**VOS Inflation Adj. ($/kWh)**	Disc
2018	1.000	1.000	$0.114	$0.114	$0.0922	0.092
2019	0.942	1.023	$0.114	$0.107	$0.0943	0.089
2020	0.887	1.046	$0.114	$0.101	$0.0965	0.086
2021	0.835	1.070	$0.114	$0.095	$0.0986	0.082
2022	0.787	1.094	$0.114	$0.089	$0.1009	0.079
2023	0.741	1.119	$0.114	$0.084	$0.1032	0.076
2024	0.698	1.144	$0.114	$0.079	$0.1055	0.074
2025	0.698	1.170	$0.114	$0.079	$0.1079	0.075
2026	0.698	1.197	$0.114	$0.079	$0.1104	0.077
2027	0.583	1.224	$0.114	$0.066	$0.1129	0.066
2028	0.549	1.252	$0.114	$0.062	$0.1154	0.063
2029	0.517	1.280	$0.114	$0.059	$0.1181	0.061
2030	0.487	1.309	$0.114	$0.055	$0.1207	0.059
2031	0.459	1.339	$0.114	$0.052	$0.1235	0.057
2032	0.432	1.369	$0.114	$0.049	$0.1263	0.055
2033	0.407	1.400	$0.114	$0.046	$0.1291	0.053
2034	0.407	1.432	$0.114	$0.046	$0.1321	0.054
2035	0.361	1.465	$0.114	$0.041	$0.1351	0.049
2036	0.340	1.498	$0.114	$0.039	$0.1381	0.047
2037	0.320	1.532	$0.114	$0.036	$0.1413	0.045
2038	0.301	1.567	$0.114	$0.034	$0.1445	0.044
2039	0.284	1.602	$0.114	$0.032	$0.1478	0.042
2040	0.267	1.639	$0.114	$0.030	$0.1511	0.040
2041	0.252	1.676	$0.114	$0.029	$0.1545	0.039
2042	0.237	1.714	$0.114	$0.027	$0.1581	0.037
				$1.532		$1.540

Table 3. Fixed Assumptions to be used for the VOS calculations

Fuel Prices					
Guaranteed NG Fuel Prices			**Environmental Externalities**		
2018	$3.035	$/mmBtu	Environmental Discount Rate	5.34%	per year
2019	$2.855	$/mmBtu	Environmental Costs	separate table	
2020	$2.835	$/mmBtu			
2021	$2.859	$/mmBtu	**Economic Assumptions**		
2022	$2.892	$/mmBtu	General Escalation Rate	2.27%	per year
2023	$2.945	$/mmBtu			
2024	$3.010	$/mmBtu	**Treasury Yields**		
2025	$3.085	$/mmBtu	1 Year	1.14%	
2026	$3.164	$/mmBtu	2 Year	1.31%	
2027	$3.246	$/mmBtu	3 Year	1.50%	
2028	$3.331	$/mmBtu	5 Year	1.84%	
2029	$3.420	$/mmBtu	7 Year	2.10%	
			10 Year	2.29%	
Fuel Price Escalation	2.27%		20 Year	2.65%	
			30 Year	2.90%	
PV Assumptions					
PV Degradation Rate	0.50%				
PV Life	25				

Table 4. Environmental costs by year.

Year	Analysis Year	CO2 Cost $/mmBtu	PM 2.5 Cost $/mmBtu	CO Cost $/mmBtu	NOx Cost $/mmBtu	Pb Cost $/mmBtu	SO2 Cost $/mmBtu	Total Cost $/mmBtu
2018	0	$2.488	$0.020	$0.000	$0.268	$0.000	$0.003	$2.779
2019	1	$2.622	$0.020	$0.000	$0.274	$0.000	$0.003	$2.919
2020	2	$2.760	$0.020	$0.000	$0.280	$0.000	$0.003	$3.064
2021	3	$2.876	$0.021	$0.000	$0.287	$0.000	$0.004	$3.188
2022	4	$2.997	$0.021	$0.000	$0.293	$0.000	$0.004	$3.315
2023	5	$3.121	$0.022	$0.000	$0.300	$0.000	$0.004	$3.446
2024	6	$3.249	$0.022	$0.000	$0.307	$0.000	$0.004	$3.582
2025	7	$3.382	$0.023	$0.000	$0.314	$0.000	$0.004	$3.722
2026	8	$3.519	$0.023	$0.000	$0.321	$0.000	$0.004	$3.867
2027	9	$3.660	$0.024	$0.000	$0.328	$0.000	$0.004	$4.016
2028	10	$3.806	$0.024	$0.000	$0.335	$0.000	$0.004	$4.170
2029	11	$3.957	$0.025	$0.000	$0.343	$0.000	$0.004	$4.329
2030	12	$4.113	$0.026	$0.000	$0.351	$0.000	$0.004	$4.493
2031	13	$4.290	$0.026	$0.000	$0.359	$0.000	$0.004	$4.680
2032	14	$4.473	$0.027	$0.000	$0.367	$0.000	$0.005	$4.872
2033	15	$4.663	$0.027	$0.000	$0.375	$0.000	$0.005	$5.070
2034	16	$4.859	$0.028	$0.000	$0.384	$0.000	$0.005	$5.275
2035	17	$5.061	$0.029	$0.000	$0.393	$0.000	$0.005	$5.487
2036	18	$5.270	$0.029	$0.000	$0.401	$0.000	$0.005	$5.706
2037	19	$5.486	$0.030	$0.000	$0.411	$0.000	$0.005	$5.932
2038	20	$5.709	$0.031	$0.000	$0.420	$0.000	$0.005	$6.165
2039	21	$5.939	$0.031	$0.000	$0.429	$0.000	$0.005	$6.405
2040	22	$6.177	$0.032	$0.000	$0.439	$0.000	$0.005	$6.654
2041	23	$6.401	$0.033	$0.000	$0.449	$0.000	$0.006	$6.889
2042	24	$6.633	$0.033	$0.000	$0.459	$0.000	$0.006	$7.132

Table 5. VOS Data table -- required format showing assumptions used in the VOS calculation.

	Input Data	Units
Economic Factors		
Start Year for VOS applicability	2018	
Discount Rate (WACC)	6.18%	per year
Load Match Analysis		
ELCC (no loss)	48.6%	% of rating
PLR (no loss)	55.2%	% of rating
Loss Savings - Energy	9.8%	% of PV output
Loss Savings - PLR	12.6%	% of PV output
Loss Savings - ELCC	11.0%	% of PV output
PV Energy		
First year annual energy	1,452	kWh per kW-AC
Transmission		
Capacity-related transmission capital cost	$48.67	$ per kW
Power Generation		
Peaking CT, simple cycle		
Installed Cost	$631	$/kW
Heat Rate	9,942	BTU/kWh
Intermediate CCGT		
Installed Cost	$971	$/kW
Heat Rate	6,822	BTU/kWh

	Input Data	Units
Power Generation - Continued		
Other		
Solar weighted Heat Rate	7,482	BTU per kWh
Fuel Price Overhead	$0.029	$ per MMBtu
Generation life	35	years
Heat Rate degradation	0.10%	pear year
O&M cost (first year) - Fixed	$2.65	per kW-yr
O&M cost (first year) - Variable	$0.002	$ per kWh
O&M cost escalation rate	2.64%	per year
Reserve planning margin	8.1%	
Years until new Generation is needed	0	
Distribution		
Capacity-related distribution capital costs -System	$80	$ per kW
Capacity-related distribution capital costs - Mpls	N/A	$ per kW
Capacity-related distribution capital costs - Mtka	N/A	$ per kW
Capacity-related distribution capital costs -Edina	N/A	$ per kW
Capacity-related distribution capital costs - SE	N/A	$ per kW
Capacity-related distribution capital costs -MG	N/A	$ per kW
Capacity-related distribution capital costs - Newport	N/A	$ per kW
Capacity-related distribution capital costs - St. Paul	N/A	$ per kW
Capacity-related distribution capital costs - NW	N/A	$ per kW
Capacity-related distribution capital costs - WBL	N/A	$ per kW
Distribution capital cost escalation	2.64%	per year
Peak Load (Weather Normalized)	6,809	MW
Peak Load Growth	0.27%	per year

Table 6. Azimuth and Tilt Angles

	Array KW	% of Total	Azimuth	Tilt	
1	715	1.2%	80	25	
2	1,058	3.0%	138	26	
3	1,065	3.7%	169	26	
4	4,944	7.5%	180	16	
5	1,147	8.4%	180	24	
6	4,832	20.8%	180	27	
7	4,053	15.6%	180	30	
8	1,729	7.4%	180	35	
9	552	2.6%	180	41	
10	1,843	19.4%	180	46	
11	656	3.2%	187	27	
12	387	1.8%	198	28	
13	862	3.2%	212	24	
14	521	1.3%	240	26	
15	481	1.0%	272	25	
TOTAL	**24,844**	**100%**	**180.2**	**30.3**	**Weighted Average**

Table 8. Economic Value of Avoided Fuel Costs.

Year	Guaranteed NG Price	Burner Tip NG Price	Heat Rate	Prices Utility	Prices VOS	p.u. PV Production	Costs Utility	Costs VOS	Discount Factor	Disc. Costs Utility	Disc. Costs VOS
	$/mmBtu	$/mmBtu	mmBtu/MWh	$/kWh	$/kWh	(kWh)	($)	($)	(risk free)	($)	($)
2018	$3.03	$3.06	7,482	$0.023	$0.0262	1,452	$33	$38	1.000	$33	$38
2019	$2.85	$2.88	7,489	$0.022	$0.0262	1,444	$31	$38	0.989	$31	$37
2020	$2.84	$2.87	7,497	$0.021	$0.0262	1,437	$31	$38	0.974	$30	$37
2021	$2.86	$2.89	7,504	$0.022	$0.0262	1,430	$31	$38	0.956	$30	$36
2022	$2.89	$2.92	7,512	$0.022	$0.0262	1,423	$31	$37	0.936	$29	$35
2023	$2.94	$2.98	7,519	$0.022	$0.0262	1,416	$32	$37	0.913	$29	$34
2024	$3.01	$3.04	7,527	$0.023	$0.0262	1,409	$32	$37	0.889	$29	$33
2025	$3.09	$3.12	7,535	$0.024	$0.0262	1,402	$33	$37	0.864	$28	$32
2026	$3.16	$3.20	7,542	$0.024	$0.0262	1,395	$34	$37	0.842	$28	$31
2027	$3.25	$3.28	7,550	$0.025	$0.0262	1,388	$34	$36	0.820	$28	$30
2028	$3.33	$3.37	7,557	$0.025	$0.0262	1,381	$35	$36	0.797	$28	$29
2029	$3.42	$3.46	7,565	$0.026	$0.0262	1,374	$36	$36	0.776	$28	$28
2030	$3.50	$3.54	7,572	$0.027	$0.0262	1,367	$37	$36	0.756	$28	$27
2031	$3.58	$3.62	7,580	$0.027	$0.0262	1,360	$37	$36	0.735	$27	$26
2032	$3.66	$3.70	7,587	$0.028	$0.0262	1,353	$38	$36	0.714	$27	$25
2033	$3.74	$3.78	7,595	$0.029	$0.0262	1,347	$39	$35	0.693	$27	$24
2034	$3.83	$3.87	7,603	$0.029	$0.0262	1,340	$39	$35	0.673	$27	$24
2035	$3.91	$3.96	7,610	$0.030	$0.0262	1,333	$40	$35	0.653	$26	$23
2036	$4.00	$4.04	7,618	$0.031	$0.0262	1,326	$41	$35	0.632	$26	$22
2037	$4.09	$4.14	7,625	$0.032	$0.0262	1,320	$42	$35	0.612	$25	$21
2038	$4.19	$4.23	7,633	$0.032	$0.0262	1,313	$42	$34	0.593	$25	$20
2039	$4.28	$4.33	7,641	$0.033	$0.0262	1,307	$43	$34	0.574	$25	$20
2040	$4.38	$4.42	7,648	$0.034	$0.0262	1,300	$44	$34	0.556	$24	$19
2041	$4.48	$4.53	7,656	$0.035	$0.0262	1,294	$45	$34	0.539	$24	$18
2042	$4.58	$4.63	7,664	$0.035	$0.0262	1,287	$46	$34	0.521	$24	$18

Validation: Present Value	$687	$687

Table 9. Economic value of avoided plant O&M - fixed

				Prices			Costs			Disc. Costs	
Year	**O&M Fixed**	**Utility Capacity**	**PV Capacity**	**Utility**	**VOS**	**p.u. PV Production**	**Utility**	**VOS**	**Discount Factor**	**Utility**	**VOS**
	$/kW	per unit		$/kWh	$/kWh	(kWh)	($)	($)		($)	($)
2018	$2.65	1.00	1.00	$0.0018	$0.0023	1,452	$2.65	$3.40	1.000	$2.65	$3.40
2019	$2.72	0.999	0.995	$0.0019	$0.0023	1,444	$2.71	$3.38	0.942	$2.55	$3.19
2020	$2.79	0.998	0.990	$0.0019	$0.0023	1,437	$2.77	$3.37	0.887	$2.46	$2.99
2021	$2.87	0.997	0.985	$0.0020	$0.0023	1,430	$2.83	$3.35	0.835	$2.37	$2.80
2022	$2.94	0.996	0.980	$0.0021	$0.0023	1,423	$2.89	$3.33	0.787	$2.28	$2.62
2023	$3.02	0.995	0.975	$0.0021	$0.0023	1,416	$2.96	$3.32	0.741	$2.19	$2.46
2024	$3.02	0.994	0.970	$0.0021	$0.0023	1,409	$2.95	$3.30	0.698	$2.06	$2.30
2025	$3.02	0.993	0.966	$0.0021	$0.0023	1,402	$2.94	$3.28	0.698	$2.05	$2.29
2026	$3.26	0.992	0.961	$0.0023	$0.0023	1,395	$3.16	$3.27	0.698	$2.21	$2.28
2027	$3.35	0.991	0.956	$0.0024	$0.0023	1,388	$3.23	$3.25	0.583	$1.88	$1.90
2028	$3.44	0.990	0.951	$0.0025	$0.0023	1,381	$3.30	$3.24	0.549	$1.81	$1.78
2029	$3.53	0.989	0.946	$0.0025	$0.0023	1,374	$3.38	$3.22	0.517	$1.75	$1.66
2030	$3.62	0.988	0.942	$0.0026	$0.0023	1,367	$3.45	$3.20	0.487	$1.68	$1.56
2031	$3.72	0.987	0.937	$0.0027	$0.0023	1,360	$3.53	$3.19	0.459	$1.62	$1.46
2032	$3.82	0.986	0.932	$0.0028	$0.0023	1,353	$3.61	$3.17	0.432	$1.56	$1.37
2033	$3.82	0.985	0.928	$0.0028	$0.0023	1,347	$3.59	$3.16	0.407	$1.46	$1.28
2034	$4.02	0.984	0.923	$0.0030	$0.0023	1,340	$3.77	$3.14	0.407	$1.53	$1.28
2035	$4.13	0.983	0.918	$0.0030	$0.0023	1,333	$3.85	$3.12	0.361	$1.39	$1.13
2036	$4.24	0.982	0.914	$0.0031	$0.0023	1,326	$3.94	$3.11	0.340	$1.34	$1.06
2037	$4.35	0.981	0.909	$0.0032	$0.0023	1,320	$4.03	$3.09	0.320	$1.29	$0.99
2038	$4.46	0.980	0.905	$0.0033	$0.0023	1,313	$4.12	$3.08	0.301	$1.24	$0.93
2039	$4.58	0.979	0.900	$0.0034	$0.0023	1,307	$4.21	$3.06	0.284	$1.20	$0.87
2040	$4.70	0.978	0.896	$0.0035	$0.0023	1,300	$4.30	$3.05	0.267	$1.15	$0.81
2041	$4.83	0.977	0.891	$0.0036	$0.0023	1,294	$4.40	$3.03	0.252	$1.11	$0.76
2042	$4.95	0.976	0.887	$0.0038	$0.0023	1,287	$4.50	$3.02	0.237	$1.07	$0.72
					$0.0023						
							Validation: Present Value			**$44**	**$44**

Table 10. Economic value of avoided plant O&M - variable

	Prices			Costs			Disc. Costs	
Year	Utility	VOS	p.u. PV Production	Utility	VOS	Discount Factor	Utility	VOS
	$/kWh	$/kWh	(kWh)	($)	($)	(risk free)	($)	($)
2018	$0.002	$0.0030	1,452	$3	$4	1.000	$3	$4
2019	$0.002	$0.0030	1,444	$3	$4	0.942	$3	$4
2020	$0.002	$0.0030	1,437	$4	$4	0.887	$3	$4
2021	$0.003	$0.0030	1,430	$4	$4	0.835	$3	$4
2022	$0.003	$0.0030	1,423	$4	$4	0.787	$3	$3
2023	$0.003	$0.0030	1,416	$4	$4	0.741	$3	$3
2024	$0.003	$0.0030	1,409	$4	$4	0.698	$3	$3
2025	$0.003	$0.0030	1,402	$4	$4	0.657	$3	$3
2026	$0.003	$0.0030	1,395	$4	$4	0.619	$2	$3
2027	$0.003	$0.0030	1,388	$4	$4	0.583	$2	$2
2028	$0.003	$0.0030	1,381	$4	$4	0.549	$2	$2
2029	$0.003	$0.0030	1,374	$4	$4	0.517	$2	$2
2030	$0.003	$0.0030	1,367	$4	$4	0.487	$2	$2
2031	$0.003	$0.0030	1,360	$4	$4	0.459	$2	$2
2032	$0.003	$0.0030	1,353	$5	$4	0.432	$2	$2
2033	$0.003	$0.0030	1,347	$5	$4	0.407	$2	$2
2034	$0.004	$0.0030	1,340	$5	$4	0.383	$2	$2
2035	$0.004	$0.0030	1,333	$5	$4	0.361	$2	$1
2036	$0.004	$0.0030	1,326	$5	$4	0.340	$2	$1
2037	$0.004	$0.0030	1,320	$5	$4	0.320	$2	$1
2038	$0.004	$0.0030	1,313	$5	$4	0.301	$2	$1
2039	$0.004	$0.0030	1,307	$5	$4	0.284	$1	$1
2040	$0.004	$0.0030	1,300	$5	$4	0.267	$1	$1
2041	$0.004	$0.0030	1,294	$5	$4	0.252	$1	$1
2042	$0.004	$0.0030	1,287	$6	$4	0.237	$1	$1

Validation: Present Value	**$55**	**$55**

Table 11. Economic value of avoided generation capacity cost.

				Prices			Costs			Disc. Costs	
Year	**Capacity Cost**	**Utility Capacity**	**PV Capacity**	**Utility**	**VOS**	**PV Production**	**Utility**	**VOS**	**Discount Factor**	**Utility**	**VOS**
	$/kW-yr	pu.	kW	$/kWh	$/kWh	(kWh)	($)	($)		($)	($)
2018	$63	1.00	1.00	$0.044	$0.0440	1,452	$63	$64	1.000	$63	$64
2019	$63	0.999	0.995	$0.044	$0.0440	1,444	$63	$64	0.942	$59	$60
2020	$63	0.998	0.990	$0.044	$0.0440	1,437	$63	$63	0.887	$56	$56
2021	$63	0.997	0.985	$0.044	$0.0440	1,430	$63	$63	0.835	$52	$53
2022	$63	0.996	0.980	$0.044	$0.0440	1,423	$62	$63	0.787	$49	$49
2023	$63	0.995	0.975	$0.044	$0.0440	1,416	$62	$62	0.741	$46	$46
2024	$63	0.994	0.970	$0.044	$0.0440	1,409	$62	$62	0.698	$43	$43
2025	$63	0.993	0.966	$0.044	$0.0440	1,402	$62	$62	0.657	$40	$41
2026	$63	0.992	0.961	$0.044	$0.0440	1,395	$61	$61	0.619	$38	$38
2027	$63	0.991	0.956	$0.044	$0.0440	1,388	$61	$61	0.583	$36	$36
2028	$63	0.990	0.951	$0.044	$0.0440	1,381	$61	$61	0.549	$33	$33
2029	$63	0.989	0.946	$0.044	$0.0440	1,374	$61	$60	0.517	$31	$31
2030	$63	0.988	0.942	$0.044	$0.0440	1,367	$60	$60	0.487	$29	$29
2031	$63	0.987	0.937	$0.044	$0.0440	1,360	$60	$60	0.459	$28	$27
2032	$63	0.986	0.932	$0.044	$0.0440	1,353	$60	$60	0.432	$26	$26
2033	$63	0.985	0.928	$0.044	$0.0440	1,347	$60	$59	0.407	$24	$24
2034	$63	0.984	0.923	$0.044	$0.0440	1,340	$59	$59	0.383	$23	$23
2035	$63	0.983	0.918	$0.044	$0.0440	1,333	$59	$59	0.361	$21	$21
2036	$63	0.982	0.914	$0.044	$0.0440	1,326	$59	$58	0.340	$20	$20
2037	$63	0.981	0.909	$0.044	$0.0440	1,320	$59	$58	0.320	$19	$19
2038	$63	0.980	0.905	$0.045	$0.0440	1,313	$58	$58	0.301	$18	$17
2039	$63	0.979	0.900	$0.045	$0.0440	1,307	$58	$58	0.284	$17	$16
2040	$63	0.978	0.896	$0.045	$0.0440	1,300	$58	$57	0.267	$15	$15
2041	$63	0.977	0.891	$0.045	$0.0440	1,294	$58	$57	0.252	$15	$14
2042	$63	0.976	0.887	$0.045	$0.0440	1,287	$58	$57	0.237	$14	$13
					$0.0440						
							Validation: Present Value			$815	$815

Table 12. Economic value of avoided reserve capacity cost.

					Prices			Costs			Disc. Costs	
Year	Capacity Cost	Reserve Margin	Utility Capacity	PV Capacity	Utility	VOS	PV Production	Utility	VOS	Discount Factor	Utility	VOS
	$/kW-yr	%	pu.	kW	$/kWh	$/kWh	(kWh)	($)	($)		($)	($)
2018	$63	8.1%	1.00	1.00	$0.004	$0.0036	1,452	$5	$5	1.000	$5	$5
2019	$63	8.1%	0.999	0.995	$0.004	$0.0036	1,444	$5	$5	0.942	$5	$5
2020	$63	8.1%	0.998	0.990	$0.004	$0.0036	1,437	$5	$5	0.887	$5	$5
2021	$63	8.1%	0.997	0.985	$0.004	$0.0036	1,430	$5	$5	0.835	$4	$4
2022	$63	8.1%	0.996	0.980	$0.004	$0.0036	1,423	$5	$5	0.787	$4	$4
2023	$63	8.1%	0.995	0.975	$0.004	$0.0036	1,416	$5	$5	0.741	$4	$4
2024	$63	8.1%	0.994	0.970	$0.004	$0.0036	1,409	$5	$5	0.698	$3	$4
2025	$63	8.1%	0.993	0.966	$0.004	$0.0036	1,402	$5	$5	0.657	$3	$3
2026	$63	8.1%	0.992	0.961	$0.004	$0.0036	1,395	$5	$5	0.619	$3	$3
2027	$63	8.1%	0.991	0.956	$0.004	$0.0036	1,388	$5	$5	0.583	$3	$3
2028	$63	8.1%	0.990	0.951	$0.004	$0.0036	1,381	$5	$5	0.549	$3	$3
2029	$63	8.1%	0.989	0.946	$0.004	$0.0036	1,374	$5	$5	0.517	$3	$3
2030	$63	8.1%	0.988	0.942	$0.004	$0.0036	1,367	$5	$5	0.487	$2	$2
2031	$63	8.1%	0.987	0.937	$0.004	$0.0036	1,360	$5	$5	0.459	$2	$2
2032	$63	8.1%	0.986	0.932	$0.004	$0.0036	1,353	$5	$5	0.432	$2	$2
2033	$63	8.1%	0.985	0.928	$0.004	$0.0036	1,347	$5	$5	0.407	$2	$2
2034	$63	8.1%	0.984	0.923	$0.004	$0.0036	1,340	$5	$5	0.383	$2	$2
2035	$63	8.1%	0.983	0.918	$0.004	$0.0036	1,333	$5	$5	0.361	$2	$2
2036	$63	8.1%	0.982	0.914	$0.004	$0.0036	1,326	$5	$5	0.340	$2	$2
2037	$63	8.1%	0.981	0.909	$0.004	$0.0036	1,320	$5	$5	0.320	$2	$2
2038	$63	8.1%	0.980	0.905	$0.004	$0.0036	1,313	$5	$5	0.301	$1	$1
2039	$63	8.1%	0.979	0.900	$0.004	$0.0036	1,307	$5	$5	0.284	$1	$1
2040	$63	8.1%	0.978	0.896	$0.004	$0.0036	1,300	$5	$5	0.267	$1	$1
2041	$63	8.1%	0.977	0.891	$0.004	$0.0036	1,294	$5	$5	0.252	$1	$1
2042	$63	8.1%	0.976	0.887	$0.004	$0.0036	1,287	$5	$5	0.237	$1	$1
						$0.0036						
								Validation: Present Value			$66	$66

Table 13. Economic value of avoided transmission capacity cost.

				Prices			Costs			Disc. Costs	
Year	**Capacity Cost**	**Utility Capacity**	**PV Capacity**	**Utility**	**VOS**	**PV Production**	**Utility**	**VOS**	**Discount Factor**	**Utility**	**VOS**
	$/kW-yr	pu.	kW	$/kWh	$/kWh	(kWh)	($)	($)		($)	($)
2018	$49	1.00	1.00	$0.034	$0.0338	1,452	$49	$49	1.000	$49	$49
2019	$49	0.999	0.995	$0.034	$0.0338	1,444	$48	$49	0.942	$46	$46
2020	$49	0.998	0.990	$0.034	$0.0338	1,437	$48	$49	0.887	$43	$43
2021	$49	0.997	0.985	$0.034	$0.0338	1,430	$48	$48	0.835	$40	$40
2022	$49	0.996	0.980	$0.034	$0.0338	1,423	$48	$48	0.787	$38	$38
2023	$49	0.995	0.975	$0.034	$0.0338	1,416	$48	$48	0.741	$35	$35
2024	$49	0.994	0.970	$0.034	$0.0338	1,409	$48	$48	0.698	$33	$33
2025	$49	0.993	0.966	$0.034	$0.0338	1,402	$47	$47	0.657	$31	$31
2026	$49	0.992	0.961	$0.034	$0.0338	1,395	$47	$47	0.619	$29	$29
2027	$49	0.991	0.956	$0.034	$0.0338	1,388	$47	$47	0.583	$27	$27
2028	$49	0.990	0.951	$0.034	$0.0338	1,381	$47	$47	0.549	$26	$26
2029	$49	0.989	0.946	$0.034	$0.0338	1,374	$47	$46	0.517	$24	$24
2030	$49	0.988	0.942	$0.034	$0.0338	1,367	$46	$46	0.487	$23	$23
2031	$49	0.987	0.937	$0.034	$0.0338	1,360	$46	$46	0.459	$21	$21
2032	$49	0.986	0.932	$0.034	$0.0338	1,353	$46	$46	0.432	$20	$20
2033	$49	0.985	0.928	$0.034	$0.0338	1,347	$46	$46	0.407	$19	$19
2034	$49	0.984	0.923	$0.034	$0.0338	1,340	$46	$45	0.383	$17	$17
2035	$49	0.983	0.918	$0.034	$0.0338	1,333	$45	$45	0.361	$16	$16
2036	$49	0.982	0.914	$0.034	$0.0338	1,326	$45	$45	0.340	$15	$15
2037	$49	0.981	0.909	$0.034	$0.0338	1,320	$45	$45	0.320	$14	$14
2038	$49	0.980	0.905	$0.034	$0.0338	1,313	$45	$44	0.301	$14	$13
2039	$49	0.979	0.900	$0.034	$0.0338	1,307	$45	$44	0.284	$13	$13
2040	$49	0.978	0.896	$0.034	$0.0338	1,300	$45	$44	0.267	$12	$12
2041	$49	0.977	0.891	$0.034	$0.0338	1,294	$44	$44	0.252	$11	$11
2042	$49	0.976	0.887	$0.034	$0.0338	1,287	$44	$44	0.237	$10	$10
					$0.0338						
							Validation: Present Value			$627	$627

Table 14. Determination of deferrable distribution costs.

Year	Distribution Project Costs	% Capacity Related	Capacity Related		
	$	%	$		
2016	165,929,956	9.6%	15,936,132		
2015	134,867,264	12.1%	16,309,114		
2014	129,899,465	16.3%	21,147,768		
2013	142,118,822	20.3%	28,825,462		
2012	109,286,058	20.8%	22,683,879		
2011	100,102,075	7.5%	7,502,291		
2010	98,267,667	11.0%	10,823,959		
2009	82,821,606	10.6%	8,749,417		
2008	100,420,422	29.5%	29,595,797		
2007	83,835,204	8.5%	7,134,725		
TOTAL 10-YEAR PERIOD	1,147,548,539		168,708,544		

Table 15. Economic value of avoided distribution capacity cost.

		Conventional Distribution Planning				Deferred Distribution Planning			
Year	**Distribution Cost**	**New Dist. Capacity**	**Capital Cost**	**Disc Capital Cost**	**Amortized**	**Def. Dist. Capacity**	**Def. Capital Cost**	**Disc Capital Cost**	**Amortized**
	$/kW-yr	(MW)	($M)	($M)	$M/yr	(MW)	($M)	($M)	$M/yr
2018	$80	50	$4	$4	$6				$5
2019	$82	50	$4	$4	$6	50	$4.1	$3.9	$5
2020	$84	50	$4	$4	$6	50	$4.2	$3.7	$5
2021	$87	50	$4	$4	$6	50	$4.3	$3.6	$5
2022	$89	51	$4	$4	$6	50	$4.5	$3.5	$5
2023	$91	51	$5	$3	$6	51	$4.6	$3.4	$5
2024	$94	51	$5	$3	$6	51	$4.7	$3.3	$5
2025	$96	51	$5	$3	$6	51	$4.9	$3.2	$5
2026	$99	51	$5	$3	$6	51	$5.0	$3.1	$5
2027	$101	51	$5	$3	$6	51	$5.2	$3.0	$5
2028	$104	51	$5	$3	$6	51	$5.3	$2.9	$5
2029	$107	52	$5	$3	$6	51	$5.5	$2.8	$5
2030	$109	52	$6	$3	$6	52	$5.6	$2.7	$5
2031	$112	52	$6	$3	$6	52	$5.8	$2.7	$5
2032	$115	52	$6	$3	$6	52	$6.0	$2.6	$5
2033	$118	52	$6	$3	$6	52	$6.1	$2.5	$5
2034	$121	52	$6	$2	$6	52	$6.3	$2.4	$5
2035	$125	52	$7	$2	$6	52	$6.5	$2.3	$5
2036	$128	52	$7	$2	$6	52	$6.7	$2.3	$5
2037	$131	53	$7	$2	$6	52	$6.9	$2.2	$5
2038	$135	53	$7	$2	$6	53	$7.1	$2.1	$5
2039	$138	53	$7	$2	$6	53	$7.3	$2.1	$5
2040	$142	53	$8	$2	$6	53	$7.5	$2.0	$5
2041	$146	53	$8	$2	$6	53	$7.7	$1.9	$5
2042	$150	53	$8	$2	$6	53	$8.0	$1.9	$5
2039	$153					53	$8.2	$1.8	
				$71				$68	

Continued - Table 15. Economic value of avoided distribution capacity cost. *EXAMPLE*

Prices			Costs			Disc. Costs	
Utility	VOS	PV Production	Utility	VOS	Discount Factor	Utility	VOS
$/kWh	$/kWh	(kWh)	($)	($)		($)	($)
$0.00258	$0.0026	1,452	$4	$4	1.000	$4	$4
$0.00258	$0.0026	1,444	$4	$4	0.942	$4	$4
$0.00259	$0.0026	1,437	$4	$4	0.887	$3	$3
$0.00260	$0.0026	1,430	$4	$4	0.835	$3	$3
$0.00260	$0.0026	1,423	$4	$4	0.787	$3	$3
$0.00261	$0.0026	1,416	$4	$4	0.741	$3	$3
$0.00261	$0.0026	1,409	$4	$4	0.698	$3	$3
$0.00262	$0.0026	1,402	$4	$4	0.657	$2	$2
$0.00263	$0.0026	1,395	$4	$4	0.619	$2	$2
$0.00263	$0.0026	1,388	$4	$4	0.583	$2	$2
$0.00264	$0.0026	1,381	$4	$4	0.549	$2	$2
$0.00264	$0.0026	1,374	$4	$4	0.517	$2	$2
$0.00265	$0.0026	1,367	$4	$4	0.487	$2	$2
$0.00266	$0.0026	1,360	$4	$4	0.459	$2	$2
$0.00266	$0.0026	1,353	$4	$4	0.432	$2	$2
$0.00267	$0.0026	1,347	$4	$4	0.407	$1	$1
$0.00267	$0.0026	1,340	$4	$4	0.383	$1	$1
$0.00268	$0.0026	1,333	$4	$4	0.361	$1	$1
$0.00269	$0.0026	1,326	$4	$3	0.340	$1	$1
$0.00269	$0.0026	1,320	$4	$3	0.320	$1	$1
$0.00270	$0.0026	1,313	$4	$3	0.301	$1	$1
$0.00271	$0.0026	1,307	$4	$3	0.284	$1	$1
$0.00271	$0.0026	1,300	$4	$3	0.267	$1	$1
$0.00272	$0.0026	1,294	$4	$3	0.252	$1	$1
$0.00272	$0.0026	1,287	$4	$3	0.237	$1	$1
					-		
	$0.0026		**Validation: Present Value**			$49	$49

Table 17. Economic value of avoided environmental costs

Environmental Discount Rate 5.34%

			Prices			Costs			Disc. Costs	
Year	Env. Cost	Solar Weighted Heat Rate	Utility	VOS	p.u. PV Production	Utility	VOS	Discount Factor	Utility	VOS
	$/mmBtu	mmBtu/MWh	$/kWh	$/kWh	(kWh)	($)	($)	(risk free)	($)	($)
2018	$2.78	7,482	$0.021	$0.0316	1,452	$30	$46	1.000	$30	$46
2019	$2.92	7,489	$0.022	$0.0316	1,444	$32	$46	0.949	$30	$43
2020	$3.06	7,497	$0.023	$0.0316	1,437	$33	$45	0.901	$30	$41
2021	$3.19	7,504	$0.024	$0.0316	1,430	$34	$45	0.856	$29	$39
2022	$3.31	7,512	$0.025	$0.0316	1,423	$35	$45	0.812	$29	$37
2023	$3.45	7,519	$0.026	$0.0316	1,416	$37	$45	0.771	$28	$35
2024	$3.58	7,527	$0.027	$0.0316	1,409	$38	$45	0.732	$28	$33
2025	$3.72	7,535	$0.028	$0.0316	1,402	$39	$44	0.695	$27	$31
2026	$3.87	7,542	$0.029	$0.0316	1,395	$41	$44	0.660	$27	$29
2027	$4.02	7,550	$0.030	$0.0316	1,388	$42	$44	0.626	$26	$27
2028	$4.17	7,557	$0.032	$0.0316	1,381	$44	$44	0.594	$26	$26
2029	$4.33	7,565	$0.033	$0.0316	1,374	$45	$43	0.564	$25	$25
2030	$4.49	7,572	$0.034	$0.0316	1,367	$47	$43	0.536	$25	$23
2031	$4.68	7,580	$0.035	$0.0316	1,360	$48	$43	0.509	$25	$22
2032	$4.87	7,587	$0.037	$0.0316	1,353	$50	$43	0.483	$24	$21
2033	$5.07	7,595	$0.039	$0.0316	1,347	$52	$43	0.458	$24	$20
2034	$5.28	7,603	$0.040	$0.0316	1,340	$54	$42	0.435	$23	$18
2035	$5.49	7,610	$0.042	$0.0316	1,333	$56	$42	0.413	$23	$17
2036	$5.71	7,618	$0.043	$0.0316	1,326	$58	$42	0.392	$23	$16
2037	$5.93	7,625	$0.045	$0.0316	1,320	$60	$42	0.372	$22	$16
2038	$6.16	7,633	$0.047	$0.0316	1,313	$62	$42	0.353	$22	$15
2039	$6.41	7,641	$0.049	$0.0316	1,307	$64	$41	0.336	$21	$14
2040	$6.65	7,648	$0.051	$0.0316	1,300	$66	$41	0.319	$21	$13
2041	$6.89	7,656	$0.053	$0.0316	1,294	$68	$41	0.302	$21	$12
2042	$7.13	7,664	$0.055	$0.0316	1,287	$70	$41	0.287	$20	$12

Validation: Present Value	$630	$630

Table 18. Calculation of inflation-adjusted VOS

Year	Discount Factor	PV Production	Escallation Factor	VOS Levelized	Disc.	**VOS Inflation Adj. ($/kWh)**	Disc
2018	1.000	1452	1.000	$0.114	$165	$0.0922	133.883
2019	0.942	1444	1.023	$0.114	$155	$0.0943	128.308
2020	0.887	1437	1.046	$0.114	$145	$0.0965	122.965
2021	0.835	1430	1.070	$0.114	$136	$0.0986	117.845
2022	0.787	1423	1.094	$0.114	$127	$0.1009	112.938
2023	0.741	1416	1.119	$0.114	$119	$0.1032	108.235
2024	0.698	1409	1.144	$0.114	$112	$0.1055	103.728
2025	0.698	1402	1.170	$0.114	$111	$0.1079	105.552
2026	0.698	1395	1.197	$0.114	$111	$0.1104	107.408
2027	0.583	1388	1.224	$0.114	$92	$0.1129	91.302
2028	0.549	1381	1.252	$0.114	$86	$0.1154	87.500
2029	0.517	1374	1.280	$0.114	$81	$0.1181	83.857
2030	0.487	1367	1.309	$0.114	$76	$0.1207	80.365
2031	0.459	1360	1.339	$0.114	$71	$0.1235	77.019
2032	0.432	1353	1.369	$0.114	$66	$0.1263	73.812
2033	0.407	1347	1.400	$0.114	$62	$0.1291	70.738
2034	0.407	1340	1.432	$0.114	$62	$0.1321	71.982
2035	0.361	1333	1.465	$0.114	$55	$0.1351	64.970
2036	0.340	1326	1.498	$0.114	$51	$0.1381	62.264
2037	0.320	1320	1.532	$0.114	$48	$0.1413	59.672
2038	0.301	1313	1.567	$0.114	$45	$0.1445	57.187
2039	0.284	1307	1.602	$0.114	$42	$0.1478	54.806
2040	0.267	1300	1.639	$0.114	$39	$0.1511	52.523
2041	0.252	1294	1.676	$0.114	$37	$0.1545	50.336
2042	0.237	1287	1.714	$0.114	$35	$0.1581	48.240
					$2,127		$2,127

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Xcel Energy — Information Request No. 18

Docket No.:	E002/M-13-867
Response To:	Minnesota Solar Energy Industries Association
Requestor:	David Shaffer
Date Received:	July 3, 2019

Question:
If not provided in the workpapers, please provide the calculations used to convert the $80 per kW Effective Avoided Distribution Cost into a Value of Solar Distribution Component of 0.33 cents per kWh.

Response:
Please see Attachment B to Information Response 16 that shows the conversion of the $160 system distribution cost per kW into the 0.33 cents per kWh. Applying the 50% Deferral Reduction Factor to $160 system distribution cost per kW yields an $80 Effective Avoided Distribution cost per kW as is calculated on page 6 of the Company's May 1st compliance filing. Applying the $80 Effective Avoided Distribution cost per kW to the 2018 VOS yields an avoided distribution cost of 0.16 cents per kWh. Please see Attachment A, for the calculation of Avoided Distribution Cost Component based on the $80 Effective Avoid Distribution Cost per kW.

Preparer:	Nick Paluck
Title:	Rate Consultant
Department:	Regulatory Analysis
Telephone:	(612) 330-2905
Date:	July 15, 2019

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Note: Table 1, 2 and 16 were not included as they are not required for the VOS calculation. Table 7 (Losses to be considered) are included in Fig. ES-1

Figure ES-1. VOS Calculation Table: economic value, load match, loss savings and distributed PV value

CURRENT POSITION *25 Year Levelized Values*	**Economic Value ($/kWh)**	**Load Match (No Losses) (%)**	**Distributed Loss Savings (%)**	**Distributed PV Value ($/kWh)**
Avoided Fuel Cost	$0.0262		9.8%	$0.0288
Avoided Plant O&M - Fixed	$0.0023	48.6%	11.0%	$0.0013
Avoided Plant O&M - Variable	$0.0030		9.8%	$0.0033
Avoided Generation Capacity Cost	$0.0440	48.6%	11.0%	$0.0237
Avoided Reserve Capacity Cost	$0.0036	48.6%	11.0%	$0.0019
Avoided Transmission Capacity Cost	$0.0338	48.6%	11.0%	$0.0182
Avoided Distribution Capacity Cost	$0.0026	55.2%	12.6%	$0.0016
Avoided Environmental Cost	$0.0316		9.8%	$0.0348
Avoided Voltage Control Cost				
Solar Integration Cost				
TOTAL				**$0.1136**

Figure ES-2. 1st-Year VOS Rate calculation

Year	Discount Factor	Escalation Factor	**VOS Levelized**	Disc.	**VOS Inflation Adj. ($/kWh)**	Disc
2018	1.000	1.000	$0.114	$0.114	$0.0922	0.092
2019	0.942	1.023	$0.114	$0.107	$0.0943	0.089
2020	0.887	1.046	$0.114	$0.101	$0.0965	0.086
2021	0.835	1.070	$0.114	$0.095	$0.0986	0.082
2022	0.787	1.094	$0.114	$0.089	$0.1009	0.079
2023	0.741	1.119	$0.114	$0.084	$0.1032	0.076
2024	0.698	1.144	$0.114	$0.079	$0.1055	0.074
2025	0.698	1.170	$0.114	$0.079	$0.1079	0.075
2026	0.698	1.197	$0.114	$0.079	$0.1104	0.077
2027	0.583	1.224	$0.114	$0.066	$0.1129	0.066
2028	0.549	1.252	$0.114	$0.062	$0.1154	0.063
2029	0.517	1.280	$0.114	$0.059	$0.1181	0.061
2030	0.487	1.309	$0.114	$0.055	$0.1207	0.059
2031	0.459	1.339	$0.114	$0.052	$0.1235	0.057
2032	0.432	1.369	$0.114	$0.049	$0.1263	0.055
2033	0.407	1.400	$0.114	$0.046	$0.1291	0.053
2034	0.407	1.432	$0.114	$0.046	$0.1321	0.054
2035	0.361	1.465	$0.114	$0.041	$0.1351	0.049
2036	0.340	1.498	$0.114	$0.039	$0.1381	0.047
2037	0.320	1.532	$0.114	$0.036	$0.1413	0.045
2038	0.301	1.567	$0.114	$0.034	$0.1445	0.044
2039	0.284	1.602	$0.114	$0.032	$0.1478	0.042
2040	0.267	1.639	$0.114	$0.030	$0.1511	0.040
2041	0.252	1.676	$0.114	$0.029	$0.1545	0.039
2042	0.237	1.714	$0.114	$0.027	$0.1581	0.037
				$1.532		$1.540

Table 3. Fixed Assumptions to be used for the VOS calculations

Fuel Prices

Guaranteed NG Fuel Prices		
2018	$3.035	$/mmBtu
2019	$2.855	$/mmBtu
2020	$2.835	$/mmBtu
2021	$2.859	$/mmBtu
2022	$2.892	$/mmBtu
2023	$2.945	$/mmBtu
2024	$3.010	$/mmBtu
2025	$3.085	$/mmBtu
2026	$3.164	$/mmBtu
2027	$3.246	$/mmBtu
2028	$3.331	$/mmBtu
2029	$3.420	$/mmBtu

Fuel Price Escalation	2.27%

PV Assumptions

PV Degradation Rate	0.50%
PV Life	25

Environmental Externalities

Environmental Discount Rate	5.34%	per year
Environmental Costs	separate table	

Economic Assumptions

General Escalation Rate	2.27%	per year

Treasury Yields

1 Year	1.14%
2 Year	1.31%
3 Year	1.50%
5 Year	1.84%
7 Year	2.10%
10 Year	2.29%
20 Year	2.65%
30 Year	2.90%

Table 4. Environmental costs by year.

Year	Analysis Year	CO2 Cost $/mmBtu	PM 2.5 Cost $/mmBtu	CO Cost $/mmBtu	NOx Cost $/mmBtu	Pb Cost $/mmBtu	SO2 Cost $/mmBtu	Total Cost $/mmBtu
2018	0	$2.488	$0.020	$0.000	$0.268	$0.000	$0.003	$2.779
2019	1	$2.622	$0.020	$0.000	$0.274	$0.000	$0.003	$2.919
2020	2	$2.760	$0.020	$0.000	$0.280	$0.000	$0.003	$3.064
2021	3	$2.876	$0.021	$0.000	$0.287	$0.000	$0.004	$3.188
2022	4	$2.997	$0.021	$0.000	$0.293	$0.000	$0.004	$3.315
2023	5	$3.121	$0.022	$0.000	$0.300	$0.000	$0.004	$3.446
2024	6	$3.249	$0.022	$0.000	$0.307	$0.000	$0.004	$3.582
2025	7	$3.382	$0.023	$0.000	$0.314	$0.000	$0.004	$3.722
2026	8	$3.519	$0.023	$0.000	$0.321	$0.000	$0.004	$3.867
2027	9	$3.660	$0.024	$0.000	$0.328	$0.000	$0.004	$4.016
2028	10	$3.806	$0.024	$0.000	$0.335	$0.000	$0.004	$4.170
2029	11	$3.957	$0.025	$0.000	$0.343	$0.000	$0.004	$4.329
2030	12	$4.113	$0.026	$0.000	$0.351	$0.000	$0.004	$4.493
2031	13	$4.290	$0.026	$0.000	$0.359	$0.000	$0.004	$4.680
2032	14	$4.473	$0.027	$0.000	$0.367	$0.000	$0.005	$4.872
2033	15	$4.663	$0.027	$0.000	$0.375	$0.000	$0.005	$5.070
2034	16	$4.859	$0.028	$0.000	$0.384	$0.000	$0.005	$5.275
2035	17	$5.061	$0.029	$0.000	$0.393	$0.000	$0.005	$5.487
2036	18	$5.270	$0.029	$0.000	$0.401	$0.000	$0.005	$5.706
2037	19	$5.486	$0.030	$0.000	$0.411	$0.000	$0.005	$5.932
2038	20	$5.709	$0.031	$0.000	$0.420	$0.000	$0.005	$6.165
2039	21	$5.939	$0.031	$0.000	$0.429	$0.000	$0.005	$6.405
2040	22	$6.177	$0.032	$0.000	$0.439	$0.000	$0.005	$6.654
2041	23	$6.401	$0.033	$0.000	$0.449	$0.000	$0.006	$6.889
2042	24	$6.633	$0.033	$0.000	$0.459	$0.000	$0.006	$7.132

Table 5. VOS Data table -- required format showing assumptions used in the VOS calculation.

	Input Data	Units
Economic Factors		
Start Year for VOS applicability	2018	
Discount Rate (WACC)	6.18%	per year
Load Match Analysis		
ELCC (no loss)	48.6%	% of rating
PLR (no loss)	55.2%	% of rating
Loss Savings - Energy	9.8%	% of PV output
Loss Savings - PLR	12.6%	% of PV output
Loss Savings - ELCC	11.0%	% of PV output
PV Energy		
First year annual energy	1,452	kWh per kW-AC
Transmission		
Capacity-related transmission capital cost	$48.67	$ per kW
Power Generation		
Peaking CT, simple cycle		
Installed Cost	$631	$/kW
Heat Rate	9,942	BTU/kWh
Intermediate CCGT		
Installed Cost	$971	$/kW
Heat Rate	6,822	BTU/kWh

	Input Data	Units
Power Generation - Continued		
Other		
Solar weighted Heat Rate	7,482	BTU per kWh
Fuel Price Overhead	$0.029	$ per MMBtu
Generation life	35	years
Heat Rate degradation	0.10%	pear year
O&M cost (first year) - Fixed	$2.65	per kW-yr
O&M cost (first year) - Variable	$0.002	$ per kWh
O&M cost escalation rate	2.64%	per year
Reserve planning margin	8.1%	
Years until new Generation is needed	0	
Distribution		
Capacity-related distribution capital costs -System	$80	$ per kW
Capacity-related distribution capital costs - Mpls	N/A	$ per kW
Capacity-related distribution capital costs - Mtka	N/A	$ per kW
Capacity-related distribution capital costs -Edina	N/A	$ per kW
Capacity-related distribution capital costs - SE	N/A	$ per kW
Capacity-related distribution capital costs -MG	N/A	$ per kW
Capacity-related distribution capital costs - Newport	N/A	$ per kW
Capacity-related distribution capital costs - St. Paul	N/A	$ per kW
Capacity-related distribution capital costs - NW	N/A	$ per kW
Capacity-related distribution capital costs - WBL	N/A	$ per kW
Distribution capital cost escalation	2.64%	per year
Peak Load (Weather Normalized)	6,809	MW
Peak Load Growth	0.27%	per year

Table 6. Azimuth and Tilt Angles

	Array KW	% of Total	Azimuth	Tilt	
1	715	1.2%	80	25	
2	1,058	3.0%	138	26	
3	1,065	3.7%	169	26	
4	4,944	7.5%	180	16	
5	1,147	8.4%	180	24	
6	4,832	20.8%	180	27	
7	4,053	15.6%	180	30	
8	1,729	7.4%	180	35	
9	552	2.6%	180	41	
10	1,843	19.4%	180	46	
11	656	3.2%	187	27	
12	387	1.8%	198	28	
13	862	3.2%	212	24	
14	521	1.3%	240	26	
15	481	1.0%	272	25	
TOTAL	**24,844**	**100%**	**180.2**	**30.3**	**Weighted Average**

Table 8. Economic Value of Avoided Fuel Costs.

Year	Guaranteed NG Price	Burner Tip NG Price	Heat Rate	Prices		p.u. PV Production	Costs		Discount Factor	Disc. Costs	
				Utility	VOS		Utility	VOS		Utility	VOS
	$/mmBtu	$/mmBtu	mmBtu/MWh	$/kWh	$/kWh	(kWh)	($)	($)	(risk free)	($)	($)
2018	$3.03	$3.06	7,482	$0.023	$0.0262	1,452	$33	$38	1.000	$33	$38
2019	$2.85	$2.88	7,489	$0.022	$0.0262	1,444	$31	$38	0.989	$31	$37
2020	$2.84	$2.87	7,497	$0.021	$0.0262	1,437	$31	$38	0.974	$30	$37
2021	$2.86	$2.89	7,504	$0.022	$0.0262	1,430	$31	$38	0.956	$30	$36
2022	$2.89	$2.92	7,512	$0.022	$0.0262	1,423	$31	$37	0.936	$29	$35
2023	$2.94	$2.98	7,519	$0.022	$0.0262	1,416	$32	$37	0.913	$29	$34
2024	$3.01	$3.04	7,527	$0.023	$0.0262	1,409	$32	$37	0.889	$29	$33
2025	$3.09	$3.12	7,535	$0.024	$0.0262	1,402	$33	$37	0.864	$28	$32
2026	$3.16	$3.20	7,542	$0.024	$0.0262	1,395	$34	$37	0.842	$28	$31
2027	$3.25	$3.28	7,550	$0.025	$0.0262	1,388	$34	$36	0.820	$28	$30
2028	$3.33	$3.37	7,557	$0.025	$0.0262	1,381	$35	$36	0.797	$28	$29
2029	$3.42	$3.46	7,565	$0.026	$0.0262	1,374	$36	$36	0.776	$28	$28
2030	$3.50	$3.54	7,572	$0.027	$0.0262	1,367	$37	$36	0.756	$28	$27
2031	$3.58	$3.62	7,580	$0.027	$0.0262	1,360	$37	$36	0.735	$27	$26
2032	$3.66	$3.70	7,587	$0.028	$0.0262	1,353	$38	$36	0.714	$27	$25
2033	$3.74	$3.78	7,595	$0.029	$0.0262	1,347	$39	$35	0.693	$27	$24
2034	$3.83	$3.87	7,603	$0.029	$0.0262	1,340	$39	$35	0.673	$27	$24
2035	$3.91	$3.96	7,610	$0.030	$0.0262	1,333	$40	$35	0.653	$26	$23
2036	$4.00	$4.04	7,618	$0.031	$0.0262	1,326	$41	$35	0.632	$26	$22
2037	$4.09	$4.14	7,625	$0.032	$0.0262	1,320	$42	$35	0.612	$25	$21
2038	$4.19	$4.23	7,633	$0.032	$0.0262	1,313	$42	$34	0.593	$25	$20
2039	$4.28	$4.33	7,641	$0.033	$0.0262	1,307	$43	$34	0.574	$25	$20
2040	$4.38	$4.42	7,648	$0.034	$0.0262	1,300	$44	$34	0.556	$24	$19
2041	$4.48	$4.53	7,656	$0.035	$0.0262	1,294	$45	$34	0.539	$24	$18
2042	$4.58	$4.63	7,664	$0.035	$0.0262	1,287	$46	$34	0.521	$24	$18

Validation: Present Value	$687	$687

Table 9. Economic value of avoided plant O&M - fixed

Year	O&M Fixed	Utility Capacity	PV Capacity	Prices: Utility	Prices: VOS	p.u. PV Production	Costs: Utility	Costs: VOS	Discount Factor	Disc. Costs: Utility	Disc. Costs: VOS
	$/kW	per unit		$/kWh	$/kWh	(kWh)	($)	($)		($)	($)
2018	$2.65	1.00	1.00	$0.0018	$0.0023	1,452	$2.65	$3.40	1.000	$2.65	$3.40
2019	$2.72	0.999	0.995	$0.0019	$0.0023	1,444	$2.71	$3.38	0.942	$2.55	$3.19
2020	$2.79	0.998	0.990	$0.0019	$0.0023	1,437	$2.77	$3.37	0.887	$2.46	$2.99
2021	$2.87	0.997	0.985	$0.0020	$0.0023	1,430	$2.83	$3.35	0.835	$2.37	$2.80
2022	$2.94	0.996	0.980	$0.0021	$0.0023	1,423	$2.89	$3.33	0.787	$2.28	$2.62
2023	$3.02	0.995	0.975	$0.0021	$0.0023	1,416	$2.96	$3.32	0.741	$2.19	$2.46
2024	$3.02	0.994	0.970	$0.0021	$0.0023	1,409	$2.95	$3.30	0.698	$2.06	$2.30
2025	$3.02	0.993	0.966	$0.0021	$0.0023	1,402	$2.94	$3.28	0.698	$2.05	$2.29
2026	$3.26	0.992	0.961	$0.0023	$0.0023	1,395	$3.16	$3.27	0.698	$2.21	$2.28
2027	$3.35	0.991	0.956	$0.0024	$0.0023	1,388	$3.23	$3.25	0.583	$1.88	$1.90
2028	$3.44	0.990	0.951	$0.0025	$0.0023	1,381	$3.30	$3.24	0.549	$1.81	$1.78
2029	$3.53	0.989	0.946	$0.0025	$0.0023	1,374	$3.38	$3.22	0.517	$1.75	$1.66
2030	$3.62	0.988	0.942	$0.0026	$0.0023	1,367	$3.45	$3.20	0.487	$1.68	$1.56
2031	$3.72	0.987	0.937	$0.0027	$0.0023	1,360	$3.53	$3.19	0.459	$1.62	$1.46
2032	$3.82	0.986	0.932	$0.0028	$0.0023	1,353	$3.61	$3.17	0.432	$1.56	$1.37
2033	$3.82	0.985	0.928	$0.0028	$0.0023	1,347	$3.59	$3.16	0.407	$1.46	$1.28
2034	$4.02	0.984	0.923	$0.0030	$0.0023	1,340	$3.77	$3.14	0.407	$1.53	$1.28
2035	$4.13	0.983	0.918	$0.0030	$0.0023	1,333	$3.85	$3.12	0.361	$1.39	$1.13
2036	$4.24	0.982	0.914	$0.0031	$0.0023	1,326	$3.94	$3.11	0.340	$1.34	$1.06
2037	$4.35	0.981	0.909	$0.0032	$0.0023	1,320	$4.03	$3.09	0.320	$1.29	$0.99
2038	$4.46	0.980	0.905	$0.0033	$0.0023	1,313	$4.12	$3.08	0.301	$1.24	$0.93
2039	$4.58	0.979	0.900	$0.0034	$0.0023	1,307	$4.21	$3.06	0.284	$1.20	$0.87
2040	$4.70	0.978	0.896	$0.0035	$0.0023	1,300	$4.30	$3.05	0.267	$1.15	$0.81
2041	$4.83	0.977	0.891	$0.0036	$0.0023	1,294	$4.40	$3.03	0.252	$1.11	$0.76
2042	$4.95	0.976	0.887	$0.0038	$0.0023	1,287	$4.50	$3.02	0.237	$1.07	$0.72
					$0.0023						
							Validation: Present Value			**$44**	**$44**

Table 10. Economic value of avoided plant O&M - variable

	Prices			Costs			Disc. Costs	
Year	Utility	VOS	p.u. PV Production	Utility	VOS	Discount Factor	Utility	VOS
	$/kWh	$/kWh	(kWh)	($)	($)	(risk free)	($)	($)
2018	$0.002	$0.0030	1,452	$3	$4	1.000	$3	$4
2019	$0.002	$0.0030	1,444	$3	$4	0.942	$3	$4
2020	$0.002	$0.0030	1,437	$4	$4	0.887	$3	$4
2021	$0.003	$0.0030	1,430	$4	$4	0.835	$3	$4
2022	$0.003	$0.0030	1,423	$4	$4	0.787	$3	$3
2023	$0.003	$0.0030	1,416	$4	$4	0.741	$3	$3
2024	$0.003	$0.0030	1,409	$4	$4	0.698	$3	$3
2025	$0.003	$0.0030	1,402	$4	$4	0.657	$3	$3
2026	$0.003	$0.0030	1,395	$4	$4	0.619	$2	$3
2027	$0.003	$0.0030	1,388	$4	$4	0.583	$2	$2
2028	$0.003	$0.0030	1,381	$4	$4	0.549	$2	$2
2029	$0.003	$0.0030	1,374	$4	$4	0.517	$2	$2
2030	$0.003	$0.0030	1,367	$4	$4	0.487	$2	$2
2031	$0.003	$0.0030	1,360	$4	$4	0.459	$2	$2
2032	$0.003	$0.0030	1,353	$5	$4	0.432	$2	$2
2033	$0.003	$0.0030	1,347	$5	$4	0.407	$2	$2
2034	$0.004	$0.0030	1,340	$5	$4	0.383	$2	$2
2035	$0.004	$0.0030	1,333	$5	$4	0.361	$2	$1
2036	$0.004	$0.0030	1,326	$5	$4	0.340	$2	$1
2037	$0.004	$0.0030	1,320	$5	$4	0.320	$2	$1
2038	$0.004	$0.0030	1,313	$5	$4	0.301	$2	$1
2039	$0.004	$0.0030	1,307	$5	$4	0.284	$1	$1
2040	$0.004	$0.0030	1,300	$5	$4	0.267	$1	$1
2041	$0.004	$0.0030	1,294	$5	$4	0.252	$1	$1
2042	$0.004	$0.0030	1,287	$6	$4	0.237	$1	$1

Validation: Present Value	$55	$55

Table 11. Economic value of avoided generation capacity cost.

				Prices			Costs			Disc. Costs	
Year	**Capacity Cost**	**Utility Capacity**	**PV Capacity**	**Utility**	**VOS**	**PV Production**	**Utility**	**VOS**	**Discount Factor**	**Utility**	**VOS**
	$/kW-yr	pu.	kW	$/kWh	$/kWh	(kWh)	($)	($)		($)	($)
2018	$63	1.00	1.00	$0.044	$0.0440	1,452	$63	$64	1.000	$63	$64
2019	$63	0.999	0.995	$0.044	$0.0440	1,444	$63	$64	0.942	$59	$60
2020	$63	0.998	0.990	$0.044	$0.0440	1,437	$63	$63	0.887	$56	$56
2021	$63	0.997	0.985	$0.044	$0.0440	1,430	$63	$63	0.835	$52	$53
2022	$63	0.996	0.980	$0.044	$0.0440	1,423	$62	$63	0.787	$49	$49
2023	$63	0.995	0.975	$0.044	$0.0440	1,416	$62	$62	0.741	$46	$46
2024	$63	0.994	0.970	$0.044	$0.0440	1,409	$62	$62	0.698	$43	$43
2025	$63	0.993	0.966	$0.044	$0.0440	1,402	$62	$62	0.657	$40	$41
2026	$63	0.992	0.961	$0.044	$0.0440	1,395	$61	$61	0.619	$38	$38
2027	$63	0.991	0.956	$0.044	$0.0440	1,388	$61	$61	0.583	$36	$36
2028	$63	0.990	0.951	$0.044	$0.0440	1,381	$61	$61	0.549	$33	$33
2029	$63	0.989	0.946	$0.044	$0.0440	1,374	$61	$60	0.517	$31	$31
2030	$63	0.988	0.942	$0.044	$0.0440	1,367	$60	$60	0.487	$29	$29
2031	$63	0.987	0.937	$0.044	$0.0440	1,360	$60	$60	0.459	$28	$27
2032	$63	0.986	0.932	$0.044	$0.0440	1,353	$60	$60	0.432	$26	$26
2033	$63	0.985	0.928	$0.044	$0.0440	1,347	$60	$59	0.407	$24	$24
2034	$63	0.984	0.923	$0.044	$0.0440	1,340	$59	$59	0.383	$23	$23
2035	$63	0.983	0.918	$0.044	$0.0440	1,333	$59	$59	0.361	$21	$21
2036	$63	0.982	0.914	$0.044	$0.0440	1,326	$59	$58	0.340	$20	$20
2037	$63	0.981	0.909	$0.044	$0.0440	1,320	$59	$58	0.320	$19	$19
2038	$63	0.980	0.905	$0.045	$0.0440	1,313	$58	$58	0.301	$18	$17
2039	$63	0.979	0.900	$0.045	$0.0440	1,307	$58	$58	0.284	$17	$16
2040	$63	0.978	0.896	$0.045	$0.0440	1,300	$58	$57	0.267	$15	$15
2041	$63	0.977	0.891	$0.045	$0.0440	1,294	$58	$57	0.252	$15	$14
2042	$63	0.976	0.887	$0.045	$0.0440	1,287	$58	$57	0.237	$14	$13
					$0.0440						
							Validation: Present Value			$815	$815

Table 12. Economic value of avoided reserve capacity cost.

					Prices			Costs			Disc. Costs	
Year	Capacity Cost	Reserve Margin	Utility Capacity	PV Capacity	Utility	VOS	PV Production	Utility	VOS	Discount Factor	Utility	VOS
	$/kW-yr	%	pu.	kW	$/kWh	$/kWh	(kWh)	($)	($)		($)	($)
2018	$63	8.1%	1.00	1.00	$0.004	$0.0036	1,452	$5	$5	1.000	$5	$5
2019	$63	8.1%	0.999	0.995	$0.004	$0.0036	1,444	$5	$5	0.942	$5	$5
2020	$63	8.1%	0.998	0.990	$0.004	$0.0036	1,437	$5	$5	0.887	$5	$5
2021	$63	8.1%	0.997	0.985	$0.004	$0.0036	1,430	$5	$5	0.835	$4	$4
2022	$63	8.1%	0.996	0.980	$0.004	$0.0036	1,423	$5	$5	0.787	$4	$4
2023	$63	8.1%	0.995	0.975	$0.004	$0.0036	1,416	$5	$5	0.741	$4	$4
2024	$63	8.1%	0.994	0.970	$0.004	$0.0036	1,409	$5	$5	0.698	$3	$4
2025	$63	8.1%	0.993	0.966	$0.004	$0.0036	1,402	$5	$5	0.657	$3	$3
2026	$63	8.1%	0.992	0.961	$0.004	$0.0036	1,395	$5	$5	0.619	$3	$3
2027	$63	8.1%	0.991	0.956	$0.004	$0.0036	1,388	$5	$5	0.583	$3	$3
2028	$63	8.1%	0.990	0.951	$0.004	$0.0036	1,381	$5	$5	0.549	$3	$3
2029	$63	8.1%	0.989	0.946	$0.004	$0.0036	1,374	$5	$5	0.517	$3	$3
2030	$63	8.1%	0.988	0.942	$0.004	$0.0036	1,367	$5	$5	0.487	$2	$2
2031	$63	8.1%	0.987	0.937	$0.004	$0.0036	1,360	$5	$5	0.459	$2	$2
2032	$63	8.1%	0.986	0.932	$0.004	$0.0036	1,353	$5	$5	0.432	$2	$2
2033	$63	8.1%	0.985	0.928	$0.004	$0.0036	1,347	$5	$5	0.407	$2	$2
2034	$63	8.1%	0.984	0.923	$0.004	$0.0036	1,340	$5	$5	0.383	$2	$2
2035	$63	8.1%	0.983	0.918	$0.004	$0.0036	1,333	$5	$5	0.361	$2	$2
2036	$63	8.1%	0.982	0.914	$0.004	$0.0036	1,326	$5	$5	0.340	$2	$2
2037	$63	8.1%	0.981	0.909	$0.004	$0.0036	1,320	$5	$5	0.320	$2	$2
2038	$63	8.1%	0.980	0.905	$0.004	$0.0036	1,313	$5	$5	0.301	$1	$1
2039	$63	8.1%	0.979	0.900	$0.004	$0.0036	1,307	$5	$5	0.284	$1	$1
2040	$63	8.1%	0.978	0.896	$0.004	$0.0036	1,300	$5	$5	0.267	$1	$1
2041	$63	8.1%	0.977	0.891	$0.004	$0.0036	1,294	$5	$5	0.252	$1	$1
2042	$63	8.1%	0.976	0.887	$0.004	$0.0036	1,287	$5	$5	0.237	$1	$1
						$0.0036						
								Validation: Present Value			$66	$66

Table 13. Economic value of avoided transmission capacity cost.

				Prices			Costs			Disc. Costs	
Year	**Capacity Cost**	**Utility Capacity**	**PV Capacity**	**Utility**	**VOS**	**PV Production**	**Utility**	**VOS**	**Discount Factor**	**Utility**	**VOS**
	$/kW-yr	pu.	kW	$/kWh	$/kWh	(kWh)	($)	($)		($)	($)
2018	$49	1.00	1.00	$0.034	$0.0338	1,452	$49	$49	1.000	$49	$49
2019	$49	0.999	0.995	$0.034	$0.0338	1,444	$48	$49	0.942	$46	$46
2020	$49	0.998	0.990	$0.034	$0.0338	1,437	$48	$49	0.887	$43	$43
2021	$49	0.997	0.985	$0.034	$0.0338	1,430	$48	$48	0.835	$40	$40
2022	$49	0.996	0.980	$0.034	$0.0338	1,423	$48	$48	0.787	$38	$38
2023	$49	0.995	0.975	$0.034	$0.0338	1,416	$48	$48	0.741	$35	$35
2024	$49	0.994	0.970	$0.034	$0.0338	1,409	$48	$48	0.698	$33	$33
2025	$49	0.993	0.966	$0.034	$0.0338	1,402	$47	$47	0.657	$31	$31
2026	$49	0.992	0.961	$0.034	$0.0338	1,395	$47	$47	0.619	$29	$29
2027	$49	0.991	0.956	$0.034	$0.0338	1,388	$47	$47	0.583	$27	$27
2028	$49	0.990	0.951	$0.034	$0.0338	1,381	$47	$47	0.549	$26	$26
2029	$49	0.989	0.946	$0.034	$0.0338	1,374	$47	$46	0.517	$24	$24
2030	$49	0.988	0.942	$0.034	$0.0338	1,367	$46	$46	0.487	$23	$23
2031	$49	0.987	0.937	$0.034	$0.0338	1,360	$46	$46	0.459	$21	$21
2032	$49	0.986	0.932	$0.034	$0.0338	1,353	$46	$46	0.432	$20	$20
2033	$49	0.985	0.928	$0.034	$0.0338	1,347	$46	$46	0.407	$19	$19
2034	$49	0.984	0.923	$0.034	$0.0338	1,340	$46	$45	0.383	$17	$17
2035	$49	0.983	0.918	$0.034	$0.0338	1,333	$45	$45	0.361	$16	$16
2036	$49	0.982	0.914	$0.034	$0.0338	1,326	$45	$45	0.340	$15	$15
2037	$49	0.981	0.909	$0.034	$0.0338	1,320	$45	$45	0.320	$14	$14
2038	$49	0.980	0.905	$0.034	$0.0338	1,313	$45	$44	0.301	$14	$13
2039	$49	0.979	0.900	$0.034	$0.0338	1,307	$45	$44	0.284	$13	$13
2040	$49	0.978	0.896	$0.034	$0.0338	1,300	$45	$44	0.267	$12	$12
2041	$49	0.977	0.891	$0.034	$0.0338	1,294	$44	$44	0.252	$11	$11
2042	$49	0.976	0.887	$0.034	$0.0338	1,287	$44	$44	0.237	$10	$10
					$0.0338						
							Validation: Present Value			$627	$627

Table 14. Determination of deferrable distribution costs.

Year	Distribution Project Costs	% Capacity Related	Capacity Related		
	$	%	$		
2016	165,929,956	9.6%	15,936,132		
2015	134,867,264	12.1%	16,309,114		
2014	129,899,465	16.3%	21,147,768		
2013	142,118,822	20.3%	28,825,462		
2012	109,286,058	20.8%	22,683,879		
2011	100,102,075	7.5%	7,502,291		
2010	98,267,667	11.0%	10,823,959		
2009	82,821,606	10.6%	8,749,417		
2008	100,420,422	29.5%	29,595,797		
2007	83,835,204	8.5%	7,134,725		
TOTAL 10-YEAR PERIOD	1,147,548,539		168,708,544		

Table 15. Economic value of avoided distribution capacity cost.

		Conventional Distribution Planning				Deferred Distribution Planning			
Year	**Distribution Cost**	**New Dist. Capacity**	**Capital Cost**	**Disc Capital Cost**	**Amortized**	**Def. Dist. Capacity**	**Def. Capital Cost**	**Disc Capital Cost**	**Amortized**
	$/kW-yr	(MW)	($M)	($M)	$M/yr	(MW)	($M)	($M)	$M/yr
2018	$80	50	$4	$4	$6				$5
2019	$82	50	$4	$4	$6	50	$4.1	$3.9	$5
2020	$84	50	$4	$4	$6	50	$4.2	$3.7	$5
2021	$87	50	$4	$4	$6	50	$4.3	$3.6	$5
2022	$89	51	$4	$4	$6	50	$4.5	$3.5	$5
2023	$91	51	$5	$3	$6	51	$4.6	$3.4	$5
2024	$94	51	$5	$3	$6	51	$4.7	$3.3	$5
2025	$96	51	$5	$3	$6	51	$4.9	$3.2	$5
2026	$99	51	$5	$3	$6	51	$5.0	$3.1	$5
2027	$101	51	$5	$3	$6	51	$5.2	$3.0	$5
2028	$104	51	$5	$3	$6	51	$5.3	$2.9	$5
2029	$107	52	$5	$3	$6	51	$5.5	$2.8	$5
2030	$109	52	$6	$3	$6	52	$5.6	$2.7	$5
2031	$112	52	$6	$3	$6	52	$5.8	$2.7	$5
2032	$115	52	$6	$3	$6	52	$6.0	$2.6	$5
2033	$118	52	$6	$3	$6	52	$6.1	$2.5	$5
2034	$121	52	$6	$2	$6	52	$6.3	$2.4	$5
2035	$125	52	$7	$2	$6	52	$6.5	$2.3	$5
2036	$128	52	$7	$2	$6	52	$6.7	$2.3	$5
2037	$131	53	$7	$2	$6	52	$6.9	$2.2	$5
2038	$135	53	$7	$2	$6	53	$7.1	$2.1	$5
2039	$138	53	$7	$2	$6	53	$7.3	$2.1	$5
2040	$142	53	$8	$2	$6	53	$7.5	$2.0	$5
2041	$146	53	$8	$2	$6	53	$7.7	$1.9	$5
2042	$150	53	$8	$2	$6	53	$8.0	$1.9	$5
2039	$153					53	$8.2	$1.8	
				$71				$68	

Continued - Table 15. Economic value of avoided distribution capacity cost. *EXAMPLE*

Prices			Costs			Disc. Costs	
Utility	VOS	PV Production	Utility	VOS	Discount Factor	Utility	VOS
$/kWh	$/kWh	(kWh)	($)	($)		($)	($)
$0.00258	$0.0026	1,452	$4	$4	1.000	$4	$4
$0.00258	$0.0026	1,444	$4	$4	0.942	$4	$4
$0.00259	$0.0026	1,437	$4	$4	0.887	$3	$3
$0.00260	$0.0026	1,430	$4	$4	0.835	$3	$3
$0.00260	$0.0026	1,423	$4	$4	0.787	$3	$3
$0.00261	$0.0026	1,416	$4	$4	0.741	$3	$3
$0.00261	$0.0026	1,409	$4	$4	0.698	$3	$3
$0.00262	$0.0026	1,402	$4	$4	0.657	$2	$2
$0.00263	$0.0026	1,395	$4	$4	0.619	$2	$2
$0.00263	$0.0026	1,388	$4	$4	0.583	$2	$2
$0.00264	$0.0026	1,381	$4	$4	0.549	$2	$2
$0.00264	$0.0026	1,374	$4	$4	0.517	$2	$2
$0.00265	$0.0026	1,367	$4	$4	0.487	$2	$2
$0.00266	$0.0026	1,360	$4	$4	0.459	$2	$2
$0.00266	$0.0026	1,353	$4	$4	0.432	$2	$2
$0.00267	$0.0026	1,347	$4	$4	0.407	$1	$1
$0.00267	$0.0026	1,340	$4	$4	0.383	$1	$1
$0.00268	$0.0026	1,333	$4	$4	0.361	$1	$1
$0.00269	$0.0026	1,326	$4	$3	0.340	$1	$1
$0.00269	$0.0026	1,320	$4	$3	0.320	$1	$1
$0.00270	$0.0026	1,313	$4	$3	0.301	$1	$1
$0.00271	$0.0026	1,307	$4	$3	0.284	$1	$1
$0.00271	$0.0026	1,300	$4	$3	0.267	$1	$1
$0.00272	$0.0026	1,294	$4	$3	0.252	$1	$1
$0.00272	$0.0026	1,287	$4	$3	0.237	$1	$1
					-		
	$0.0026		**Validation: Present Value**			$49	$49

Table 17. Economic value of avoided environmental costs

Environmental Discount Rate 5.34%

			Prices			Costs			Disc. Costs	
Year	Env. Cost	Solar Weighted Heat Rate	Utility	VOS	p.u. PV Production	Utility	VOS	Discount Factor	Utility	VOS
	$/mmBtu	mmBtu/MWh	$/kWh	$/kWh	(kWh)	($)	($)	(risk free)	($)	($)
2018	$2.78	7,482	$0.021	$0.0316	1,452	$30	$46	1.000	$30	$46
2019	$2.92	7,489	$0.022	$0.0316	1,444	$32	$46	0.949	$30	$43
2020	$3.06	7,497	$0.023	$0.0316	1,437	$33	$45	0.901	$30	$41
2021	$3.19	7,504	$0.024	$0.0316	1,430	$34	$45	0.856	$29	$39
2022	$3.31	7,512	$0.025	$0.0316	1,423	$35	$45	0.812	$29	$37
2023	$3.45	7,519	$0.026	$0.0316	1,416	$37	$45	0.771	$28	$35
2024	$3.58	7,527	$0.027	$0.0316	1,409	$38	$45	0.732	$28	$33
2025	$3.72	7,535	$0.028	$0.0316	1,402	$39	$44	0.695	$27	$31
2026	$3.87	7,542	$0.029	$0.0316	1,395	$41	$44	0.660	$27	$29
2027	$4.02	7,550	$0.030	$0.0316	1,388	$42	$44	0.626	$26	$27
2028	$4.17	7,557	$0.032	$0.0316	1,381	$44	$44	0.594	$26	$26
2029	$4.33	7,565	$0.033	$0.0316	1,374	$45	$43	0.564	$25	$25
2030	$4.49	7,572	$0.034	$0.0316	1,367	$47	$43	0.536	$25	$23
2031	$4.68	7,580	$0.035	$0.0316	1,360	$48	$43	0.509	$25	$22
2032	$4.87	7,587	$0.037	$0.0316	1,353	$50	$43	0.483	$24	$21
2033	$5.07	7,595	$0.039	$0.0316	1,347	$52	$43	0.458	$24	$20
2034	$5.28	7,603	$0.040	$0.0316	1,340	$54	$42	0.435	$23	$18
2035	$5.49	7,610	$0.042	$0.0316	1,333	$56	$42	0.413	$23	$17
2036	$5.71	7,618	$0.043	$0.0316	1,326	$58	$42	0.392	$23	$16
2037	$5.93	7,625	$0.045	$0.0316	1,320	$60	$42	0.372	$22	$16
2038	$6.16	7,633	$0.047	$0.0316	1,313	$62	$42	0.353	$22	$15
2039	$6.41	7,641	$0.049	$0.0316	1,307	$64	$41	0.336	$21	$14
2040	$6.65	7,648	$0.051	$0.0316	1,300	$66	$41	0.319	$21	$13
2041	$6.89	7,656	$0.053	$0.0316	1,294	$68	$41	0.302	$21	$12
2042	$7.13	7,664	$0.055	$0.0316	1,287	$70	$41	0.287	$20	$12

Validation: Present Value **$630** **$630**

Table 18. Calculation of inflation-adjusted VOS

Year	Discount Factor	PV Production	Escallation Factor	VOS Levelized	Disc.	**VOS Inflation Adj. ($/kWh)**	Disc
2018	1.000	1452	1.000	$0.114	$165	$0.0922	133.883
2019	0.942	1444	1.023	$0.114	$155	$0.0943	128.308
2020	0.887	1437	1.046	$0.114	$145	$0.0965	122.965
2021	0.835	1430	1.070	$0.114	$136	$0.0986	117.845
2022	0.787	1423	1.094	$0.114	$127	$0.1009	112.938
2023	0.741	1416	1.119	$0.114	$119	$0.1032	108.235
2024	0.698	1409	1.144	$0.114	$112	$0.1055	103.728
2025	0.698	1402	1.170	$0.114	$111	$0.1079	105.552
2026	0.698	1395	1.197	$0.114	$111	$0.1104	107.408
2027	0.583	1388	1.224	$0.114	$92	$0.1129	91.302
2028	0.549	1381	1.252	$0.114	$86	$0.1154	87.500
2029	0.517	1374	1.280	$0.114	$81	$0.1181	83.857
2030	0.487	1367	1.309	$0.114	$76	$0.1207	80.365
2031	0.459	1360	1.339	$0.114	$71	$0.1235	77.019
2032	0.432	1353	1.369	$0.114	$66	$0.1263	73.812
2033	0.407	1347	1.400	$0.114	$62	$0.1291	70.738
2034	0.407	1340	1.432	$0.114	$62	$0.1321	71.982
2035	0.361	1333	1.465	$0.114	$55	$0.1351	64.970
2036	0.340	1326	1.498	$0.114	$51	$0.1381	62.264
2037	0.320	1320	1.532	$0.114	$48	$0.1413	59.672
2038	0.301	1313	1.567	$0.114	$45	$0.1445	57.187
2039	0.284	1307	1.602	$0.114	$42	$0.1478	54.806
2040	0.267	1300	1.639	$0.114	$39	$0.1511	52.523
2041	0.252	1294	1.676	$0.114	$37	$0.1545	50.336
2042	0.237	1287	1.714	$0.114	$35	$0.1581	48.240
					$2,127		$2,127