Distributed Solar Energy Potential of I-1631

Prepared for: **Solar Installers of Washington**

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Summary

Washington's solar energy generation has experienced consistent growth over the past decade, resulting in 116 million kilowatt-hours (kWh) of production by 2017. To date nearly all of the solar generating capacity installed in the state is distributed on customer homes and businesses, with little deployment of larger utility-scale solar farms that serve the wholesale electricity market. Growth in solar energy generating capacity has been accelerated by a decrease in solar equipment costs combined with federal and state incentives. Although costs of solar equipment and installation costs are expected to continue to decline, the expiration of federal and state incentives threaten the continued growth of the solar industry in Washington.

A new state-based incentive program, as envisioned in the Protect Washington Act, could accelerate solar energy production and solar jobs in Washington. By directing 10-20% of projected carbon fee revenues from the Clean Air Clean Energy Fund (CACE) to solar incentives, the solar industry is expected to install the equivalent of over 400,000 typical rooftop systems across the state by 2050.[1] At mid-century, the total solar electricity generation from these solar electric systems would account for 5% of statewide electricity consumption in the commercial sector and 10% in the residential sector.[2]

Industry growth could add well over 3,000 jobs beyond the 3,400 existing today.[3] The grid electricity generation avoided as a result means that by 2050, new solar incentives deployed under the CACE could reduce global greenhouse gas emissions by up to 32 million metric tons of carbon dioxide equivalent.

Clean Air Clean Energy Washington

Clean Air Clean Energy (CACE) is a fund that would be created under the Protect Washington Act. The Initiative would disburse about 70% of the pollution fees collected under the Act to various clean air and clean energy programs launched under the CACE. In our analysis we imagine between 10% and 20% of CACE funding being made available to solar PV incentives.

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[1] Assuming an average rooftop system size of 10 kilowatts. For reference, residential systems are defined in Washington statute as less than or equal to 12 kilowatts nameplate rating.

[2] This analysis does not include expected growth of utility-scale solar and that sector's additional contribution to serving Washington's electricity demand by 2050.

[3] The Solar Foundation, "2017 National Solar Jobs Census" (The Solar Foundation, January 2018).

This would represent between $56 and $112 million in solar funding after the first year of fee collections, slowly increasing to between $170 million and $340 million per year after the pollution fee has reached its maximum value.

Imagining What's Possible

Though we want to be creative about what is possible to do with the new funding available from the CACE, for the purpose of this analysis, we ground our imagination in program designs that have demonstrated their effectiveness at deploying solar electric systems. So, we assumed that solar funding from CACE would be distributed among incentive programs that extend existing mechanisms for the single-family residential, commercial, and community solar sectors. In the **single-family residential** sector we replicate the Solar Jobs Act production incentive at 2018 levels, offering 16¢ per kilowatt-hour of production (16¢/kWh) for a period of eight years following installation.[4] In the **commercial** sector we also replicate the Solar Jobs Act, offering 6¢/kWh for eight years. Finally, we model continued funding under the **community solar** model at 16¢/kWh but capped at a maximum outlay of $5,000 per participant. We distribute the available CACE funding so that 50% is consumed by the residential incentive, and 25% each by the commercial and community solar incentives.

With this distribution of incentives, the low funding scenario (10% of CACE funds) can support 60 MW of new capacity in just the first year. In the high funding scenario (20% of CACE funds), this becomes 120 MW. Solar still supplies a relatively small fraction of Washington's electricity consumption -- about 0.27% of Washington's residential sector electricity consumption in 2017, and just 0.05% in the commercial sector. Over the past few years, Washington's solar industry has been adding 15 to 25 MW (megawatts) of capacity per year.[5] Although this is a healthy rate of growth, it is far short of the deployment levels needed to meet demand that can be created using CACE funds. Indeed, even in the low funding scenario, annual growth will jump four- to five-fold over historic industry trends.

Washington's solar industry will need some time to grow its installation capacity to meet the task. We studied industry growth rates around the country and discovered that the maximum reasonable assumption for *sustained* industry growth would be about a 50% increase in installation capacity per year. That limitation created the more realistic projections of what can be done with CACE funds shown in Figure 1.

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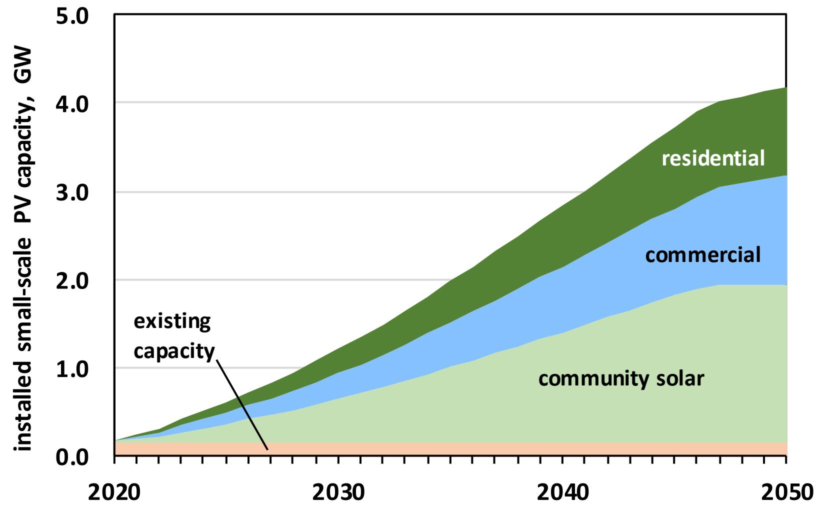
[4] The Solar Jobs Act offers lower levels of funding in years after 2018. We choose to emulate the 2018 rate because (1) the higher incentive has a proven history of success in the past; (2) as a continuation of the status quo it is the most straightforward choice and (3) requiring a high incentive for solar uptake makes our projection of solar PV market penetration conservative.

[5] "Electricity Data Browser - Net Generation for Residential," accessed May 16, 2018, https://www.eia.gov/electricity/data/browser/#/topic/0?agg=2,0,1&fuel=0002&geo=000000000001&sec=004&linechart=ELEC.GEN.DPV-WA-8.A&columnchart=ELEC.GEN.DPV-WA-8.A&map=ELEC.GEN.DPV-WA-8.A&freq=A&ctype=linechart&ltype=pin&rtype=s&pin=&rse=0&maptype=0.



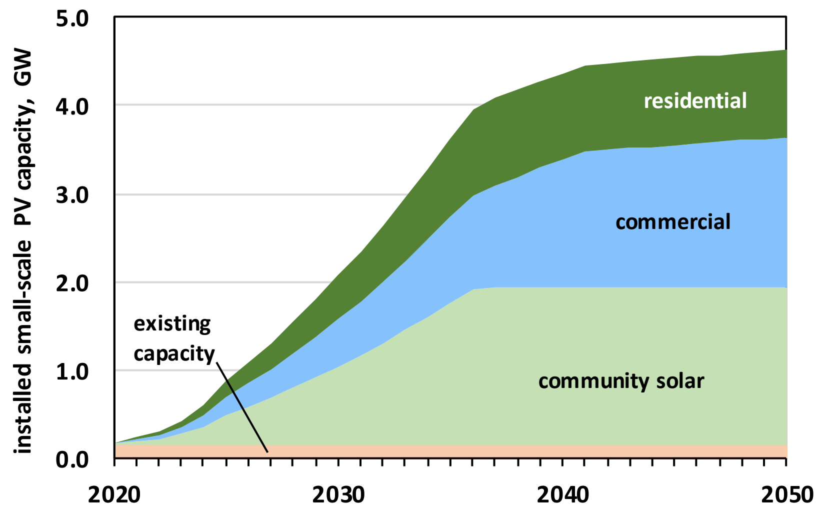


Figure 1 – Total small-scale solar PV installed in Washington assuming 10% of CACE funding is applied to incentive programs (above) or 20% of CACE funding (below). In both cases, the commercial sector shows more growth in out years because the underlying forecast of commercial sector growth (from the Washington State energy forecast) is more aggressive than the forecast of residential sector growth.

Solar capacity growth *accelerates* in our analysis during the first three to five years of the CACE, reaching a sustained growth rate of about 170 MW installed per year during the years of greatest growth under the low funding scenario, or 330 MW per year under the high funding scenario.

Even in the low funding scenario, the solar market eventually saturates at the levels we set in our analysis: 10% of residential electricity consumption statewide and 5% of commercial electricity consumption.

Economic and Environmental Benefits

Directing CACE funding to reduce carbon emissions in the electricity sector through greater solar deployment will also increase economic activity and job creation. The high funding scenario can create nearly 2,900 new solar jobs in Washington State by 2025, a number that will increase until the peak growth rate is achieved in 2036, at which point CACE funds will have created 3,700 active solar jobs. Even under the low funding scenario, we will see 1,100 new solar jobs by 2025. In the low funding scenario, the industry grows more slowly and installation activity does not peak until 2046, with just shy of 2,000 CACE-induced jobs statewide (Table 1).

	CACE-induced solar jobs		
	in 2025	peak	peak year
low funding scenario	1,106	1,974	2046
high funding scenario	2,872	3,739	2036

Table 1 – New solar jobs induced by funding from the CACE.

The environmental benefit of solar photovoltaic systems is their ability to displace grid-supplied electricity. Grid-supplied electricity is generated with a combination of renewable and fossil fuels. Fossil fuels emit greenhouse gases (GHGs) when combusted. The mix of fuels generating grid-supplied electricity varies around the country. The U.S. EPA offers an analysis of grid-supplied electricity emissions rates disaggregated by region – Washington lies in the region known as the Northwest Power Pool. We compute the environmental benefit of CACE-funded solar photovoltaic installations according to the avoidance of electricity generated at the U.S. EPA's Northwest Power Pool emission rate.[6]

Solar photovoltaic systems have proven to be low-maintenance devices with long lifetimes. The electricity-generating panels typically last for thirty years or more. Hence, the electricity displacement caused by PV installed in a given year is persistent, and each year the rate of GHG displacement increases as more installations are added (Table 2).

	2025			2035			2050		
	annual solar generation TWh	annual avoided GHGs $mmtCO_2e$	cumulative avoided GHGs $mmtCO_2e$	annual solar generation TWh	annual avoided GHGs $mmtCO_2e$	cumulative avoided GHGs $mmtCO_2e$	annual solar generation TWh	annual avoided GHGs $mmtCO_2e$	cumulative avoided GHGs $mmtCO_2e$
low funding scenario	0.72	0.21	0.79	2.33	0.69	5.35	4.91	1.46	22.68
high funding scenario	1.02	0.30	0.92	4.24	1.26	8.81	5.44	1.62	31.98

Table 2 – GHG reductions associated with CACE-funded solar installations. TWh means terawatt-hours (billion kilowatt-hours). $mmtCO_2e$ means million metric tons of carbon dioxide equivalent.

By 2050, when the first panels installed in 2020 with CACE funding reach age thirty, the entire fleet of new PV installations will be avoiding nearly 1.5 million metric tons of GHGs each year. They will have displaced a cumulative 23 to 32 million metric tons of carbon dioxide equivalent since program inception, depending on the level of CACE funding chosen.

[6] U.S. EPA, "EGRID Summary Tables 2016," February 15, 2018, https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid.

Methodology and Assumptions

Summary of Approach

We simulated voter approval and promulgation of Initiative 1631 as written, using a straightforward, transparent econometric model built in Microsoft Excel. The model also utilizes results generated exogenously in the Washington State Department of Ecology's Carbon Tax Assessment Model (CTAM). Our simulation includes five components:

1. **Cash Flow** estimates I-1631 related revenue available to the solar industry;
2. **Induced Demand** converts cash flow to anticipated demand for new solar installations;
3. **Growth Rate Cap** limits the rate at which solar installations in Washington State can increase;
4. **Market Penetration Cap** limits the gross deployment of solar installations in Washington State; and
5. **Impacts Analysis** applies the results of the other four components to estimate GHG reductions, costs, marginal abatement cost, and jobs growth.

Cash Flow

We modeled cash flow utilizing CTAM version 3.3. I-1631 applies a progressively increasing pollution fee beginning at $15.00 per metric ton of carbon dioxide equivalent ($15.00/tCO$_2$e) as of January 1, 2020 and increasing $2.00/tCO$_2$e each year thereafter.[7] We modeled escalation to cease after the January 1, 2035 increment under the conservative assumption that Washington State's GHG reduction targets would be met in 2035.

As the pollution fee increases from 2020 to 2035, fuel consumption will decrease relative to a business-as-usual case representing Washington's economy without the fee. CTAM uses price elasticities of fuel consumption to account for this decrease, and the corresponding decrease in anticipated revenue. With this depression of revenue accounted for, we find that gross revenue generation from the carbon fee grows from about $1.2 billion in 2020 to $3.1 billion in 2035, growing more slowly thereafter to a final value of $3.4 billion in 2050.

In late August of 2018, the Washington State Office of Financial Management (OFM) issued an I-1631 fiscal note that forecast revenue during the first four fiscal years the initiative would be in force.[8] OFM's revenue forecast during this period is about 73% of ours, for unknown reasons.[9] In order to supply a conservative estimate of I-1631 revenue we scaled our forecast

[7] "Initiative Measure No. 1631" (n.d.).

[8] Office of Financial Management, "I-1631 Fiscal Impact Statements Revised.Pdf," August 24, 2018, https://www.ofm.wa.gov/sites/default/files/public/budget/ballot/2018/I-1631_Fiscal_Impact_Statement-082418.pdf.

[9] Potential revenue described in the OFM document comes through three channels: Direct collection by the Department of Revenue (Table 1 in the fiscal note); avoided collections due to investor owned utility credits; and

by 73%, thus preserving the *shape* of CTAM's forecast but shifting it downward to meet OFM's estimates in the early years.

Of course, only a fraction of I-1631's gross revenue will be available to the solar industry. Solar industry incentives would be delivered through the CACE, which disburses 70% of the gross revenue. I-1631 allows for the loss of some revenue to "reasonable administrative costs." We adopted the same losses tabulated by OFM: about $2.9 million per year for administration of the fee in general, and $3.4 million per year for CACE program administration.[10] The model results reported here assume the direction of 10% to 20% of the CACE funds, after these losses, to the solar industry. Sample values for the amounts generated this way appear in Table 3.

	CACE fraction	mm$ available to solar industry 2020	2035	2050
low funding scenario	10%	56	158	171
high funding scenario	20%	112	316	342

Table 3 – funding available to the solar industry under two theoretical funding levels. The three years are examples taken from the full sequence of 31 years 2020 through 2050 modeled.

Induced Demand

Available cash is converted to demand for solar installations following the financial structures promulgated in existing, successful solar programs. The CACE solar industry funding (per Table 3) is applied as follows:

program type	fraction of funding received	incentive	sunset or cap	Made in WA bonus	computed subsidy of capacity
Residential	50%	16 ¢/kWh	8 yr	5 ¢/kWh	1,739 $/kW
Commercial	25%	6 ¢/kWh	8 yr	5 ¢/kWh	799 $/kW
Community Solar	25%	16 ¢/kWh	5,000 $/paricip	5 ¢/kWh	500 $/kW

Table 4 – program types modeled to forecast induced demand.[11]

The figures presented in this paper assume that half of installed panels are made in Washington. Each program type is converted into a gross subsidy per installed kilowatt under

avoided collections due to consumer owned utility credits (Table 4 in the fiscal note). We imputed the avoided collections due to investor owned utility credits by multiplying revenue to the Public Service Revolving Account (Table 2 data row 5) by 100.

[10] Pollution fee administration is estimated by summing costs assigned to the Governor's Office, Department of Revenue, Dept. of Health and OSPI. CACE administration is estimated by summing costs assigned to the Dept. of Commerce, Utilities and Transportation Commission and Washington State University Energy Program. Each of the two annual administrative costs given in this report is the average of the relevant Fiscal Year 2022 sum and the relevant Fiscal Year 2023 sum.

[11] The Solar Jobs Act, on which the model policies are based, includes both an 8-year sunset *and* a cap of 50% of project cost. To keep computations and discussion simple, we modeled theses as an 8-year sunset only, without the cap.

the assumption that 75% of installations occur in western Washington, producing 1,100 kWh per kilowatt installed, and 25% in eastern Washington producing 1,400 kWh per kilowatt installed. Induced demand in kilowatts is computed for each program type by dividing the subsidy of capacity (in $/kW) into the available portion of CACE funds (measured in dollars). That is, there is an underlying assumption that if the subsidy is available the market will expand to consume it.

In the case of Community Solar, we assume 10 kW installed per participant, and at this rate the $5,000/participant incentive cap is reached within 2 to 2½ years after each participant's installation.

Growth Rate Cap

Solar still makes up a relatively small fraction of Washington's electricity production. In 2017, Washington's residential sector consumed 35.6 billion kWh of electricity[12] of which about .097 billion kWh, or 0.27%, was solar.[13] In the commercial sector, solar provided just .05% of 35.4 billion kWh of electricity. Over the past few years, Washington's solar industry has been adding 15 to 25 MW (megawatts) of capacity per year. Though this is a healthy rate of growth, it is far short of what will be needed to respond to the demand that can be created using CACE funds.

At the upper tier of funding, $112 million in CACE funding could support 120 MW of new capacity in just the first year, approaching eight times what the industry is accustomed to installing annually. The industry will require some time to support this level of solar deployment. The Solar Foundation's annual *Solar Jobs Census* offers growth rates for the number of solar installation jobs in each state. Around the union, the three highest, two-year sustained growth rates in 2015-2017 were for Minnesota (94%/yr), Maine (31%/yr) and Idaho (27%/yr).[14] The average of these is, conveniently, 50%/yr. Speaking from experience, Washington industry experts found this to be a reasonable estimate of the maximum sustainable industry growth rate in Washington. For reference, a federal forecast of national growth in solar installation jobs forecasts 7.4% average annual growth from 2016 through 2026.[15]

Solar capacity growth accelerates in our analysis during the first five to six years of the CACE, reaching a sustained growth rate of about 170 to 330 MW installed per year during the years of greatest growth.

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[12] Keibun Mori, Greg Nothstein, and Roel Hammerschlag, *Carbon Tax Analysis Model (CTAM)*, version 3.3b, Microsoft Excel (Olympia, WA: Washington State Department of Commerce, 2018), http://www.commerce.wa.gov/Programs/Energy/Office/Topics/Pages/Carbon-Tax.aspx.

[13] "Electricity Data Browser - Net Generation for Residential."

[14] The Solar Foundation, "Solar Jobs Census 2017," 2018, http://www.solarstates.org.

[15] "Fastest Growing Occupations : Occupational Outlook Handbook: : U.S. Bureau of Labor Statistics," April 13, 2018, https://www.bls.gov/ooh/fastest-growing.htm.

Market Penetration Cap

The *Induced Demand* component of the model will generate solar demand to meet any amount of subsidy offered. Of course, there are real, physical, and behavioral limits on Washington's electricity market that cannot be ignored. Once a forecast of demand has been created with the preceding three methodology steps, we cap solar penetration into the electricity market. CTAM contains forecasts of Washington's residential and commercial electricity markets (measured in total energy consumed). In our analysis we cap total market penetration at 10% of electric generation in the residential market, and 5% in the commercial market. These caps were based on our review of literature describing maximum penetration of intermittent renewable generation into the electricity market, with a focus on keeping grid integration costs and consumer rate shifts to *de minimis* levels.[16,17,18,19]

Impacts Analysis

The previous four model components output an anticipated trajectory of solar installations measured in MW. The final step is to compute the induced jobs and greenhouse gas reductions.

Jobs growth estimates are computed at the rate of 11.0 jobs per installed megawatt, a value taken directly from the Solar Foundation's *2017 National Solar Jobs Census*.[20]

Greenhouse gas reductions associated with all installed solar are equal to avoided emissions of grid electricity displaced by the solar electricity. In our model all displaced electricity is assigned the most recent available (2016) U.S. EPA eGRID emission factor for the Northwest Power Pool, 655.4 lbCO_2e/MWh.[21] Since electricity displacement is measured in units of energy (MWh) rather than capacity (MW), we needed to assume an average generation rate for installed capacity; this value is 1,175 kWh/kW, the weighted average of typical eastern and western Washington capacity factors 1,400 kWh/kW and 1,100 kWh/kW respectively.[22]

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[16] Austin Brown et al., "Estimating Renewable Energy Economic Potential in the United States: Methodology and Initial Results," *Renewable Energy*, 2016, 154.

[17] A Hoke et al., "Maximum Photovoltaic Penetration Levels on Typical Distribution Feeders: Preprint," n.d., 16.

[18] Pieter Gagnon et al., "Rooftop Solar Photovoltaic Technical Potential in the United States. A Detailed Assessment," January 1, 2016, http://www.osti.gov/servlets/purl/1236153/.

[19] Galen Barbose, "Putting the Potential Rate Impacts of Distributed Solar into Context," January 2017, 51.

[20] The Solar Foundation, "2017 National Solar Jobs Census."

[21] U.S. EPA, "EGRID Summary Tables 2016."

[22] Jeremy Smithson to Roel Hammerschlag, "Re: Peak Sun Hours," May 23, 2018.