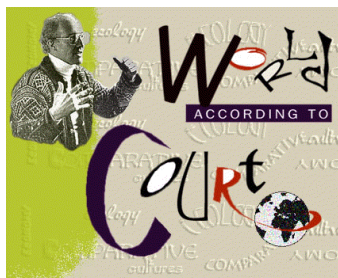


# Corvallis Solar Photovoltaic Capacity



**Court Smith**

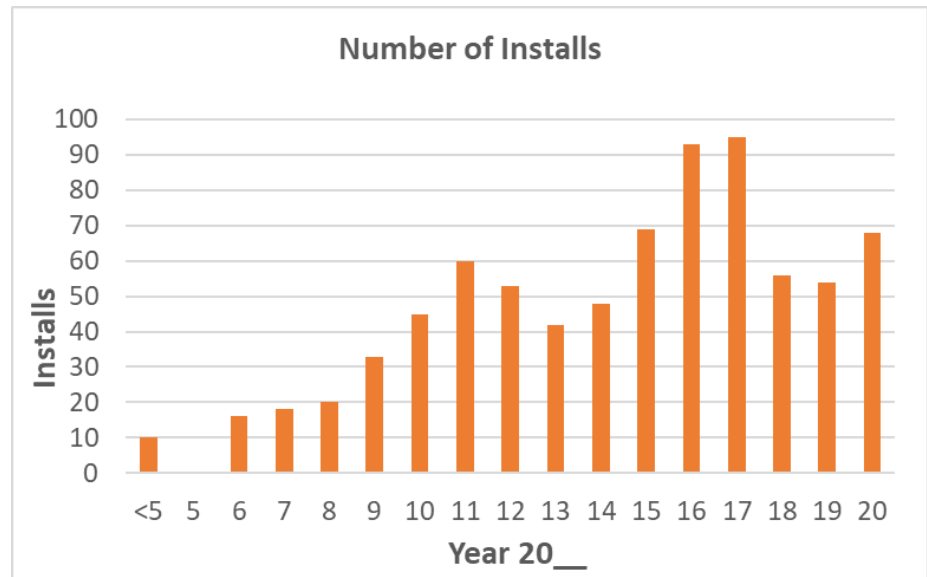


**June 2021**

How much solar capacity does Corvallis have? No person or public entity has an answer. Using Corvallis searchable electronic permit records on installing solar generating capacity, the estimate is 7,758 kilowatts (kW) installed from 1991-2020.

Electronic permit records go back to 1991. Paper permits for solar water heating installations go back to the 1970s. Each solar installation is

like adding an electric company to the grid. The Energy Trust of Oregon and Oregon Department of Energy do not report data at the community level. The graph shows the number of solar installations



added each year from 2006-20. Most of the data come from City of Corvallis, Community Development Department electronic permits. Nearly all the solar was added after 2005. From 1991-2020, there were 780 solar installations. Prior to 2005, which had none, 10 solar permits were recorded.

Solar installations are most often on residences, multifamily, commercial, and public properties. The typical residence in Corvallis uses about 1000 kWh per month. The largest solar installations are publicly owned, commercial, and nonprofits.

The table lists the largest solar installations over 25 kW. The bottom summarizes the estimated total installed solar capacity.

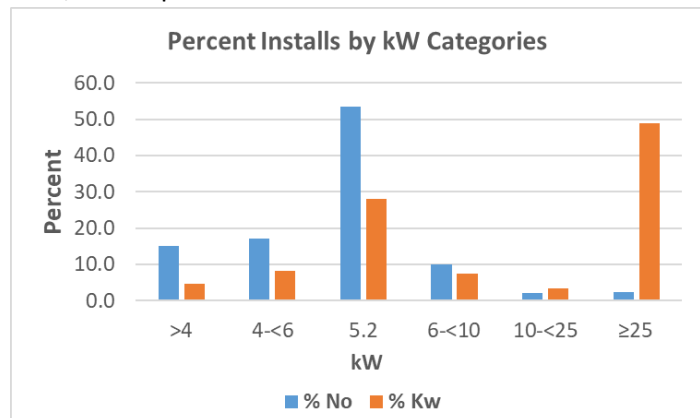
Entity ≥100 kW installed	kW
OSU 35 <sup>th</sup> Street Solar Array	1435
OSU Aquatic Animal Health Lab Solar Array	482
OSU 53 <sup>rd</sup> Street Solar Array	289
Toyota of Corvallis	273
Corvallis Public Works	209
509J Office	150
509J CHS	117
Benton County Research Way Building	110
Corvallis Airport	100
Boys and Girls Club of Corvallis	100
Old Mill Center	100
Cornerstone Associates, Inc.	74
Benton County Fairgrounds	70
Samaritan Village	70
Community Outreach, Adv Energy Sys	67
Community Outreach	52
OSU Student Experience Center	48
Downtown Fire Station	37
<b>Sum of Solar Capacity</b>	<b>kW</b>
<b>Sum Capacity ≥ 25 kW (n=18)</b>	<b>3783</b>
<b>Known Capacity &lt;25 (N=345)</b>	<b>1806</b>
<b>Estimated Unknown Capacity (n=417*5.2)</b>	<b>2168</b>
<b>Grand Total = Sum Cap ≥25 kW + Known Cap &lt;25 kW + Estimated Unknown Cap</b>	<b>7758</b>

The three largest installations are leased on OSU lands in the Corvallis area for a total of 2,206 kW. The City of Corvallis has a total of 360 kW at the Airport, Downtown Fire Station, Fire Station 4 (16 kW), and Public Works. The Corvallis School District at the District Office and Corvallis High School has a total of 267 kW. Benton County has

a total of 200 kW at the Fairgrounds, 4500 SW Research Way, and Benton Health Center (20.3 kW). Toyota of Corvallis is the largest commercial solar installation at 273 kW. The Boys & Girls Club of Corvallis and Old Mill Center each has 100 kW installed on their buildings. Community Outreach, Inc. has 134 kW at three locations on buildings near NW Reiman Avenue.

Most often the 780 installations have building or electrical permits; not all permits have capacity information. Eighteen installations (2.4%) listed in the table have 49.3% the total capacity for solar in Corvallis. They are a complete list of installations over 25 kW. The OSU installations are 28.7% of the installed solar. Of permits listed as “Completed” in the permit summaries, the capacity of solar installed is known for 363 addresses, plus 345 of those rated under 25 kW. Nearly all the missing capacity information is in what the permits list as “1&2 Family,” most often rooftop solar less than 25 kW. For the 345 installations with known data, the range is from 1.2-24 kW; the average is 5.2 kW. Adding the sum for the 363 addresses with known kW to the 417 addresses where the kW rating is unreported times the 5.2 kW average gives the estimate of installed capacity at 7,758 kW. Six of the nine installations 100 kW and over are ground mounted. Of the 18 over 25 kW, 13 are public entities.

The graph (right) shows the installations by kW categories. The blue bars show a normal distribution of installations by category. In actuality, the center bar with the estimated capacity installations would be distributed among the installations from <4 to <25 kW. So, there are two distinctly different populations of installations. One is mainly residential, multifamily, and commercial. The other consists mostly of public entities, nonprofits, and large commercial sites with ground-mounted arrays and large roof areas. Both groups used incentives to install their solar arrays, and few paid the total cost of installation.

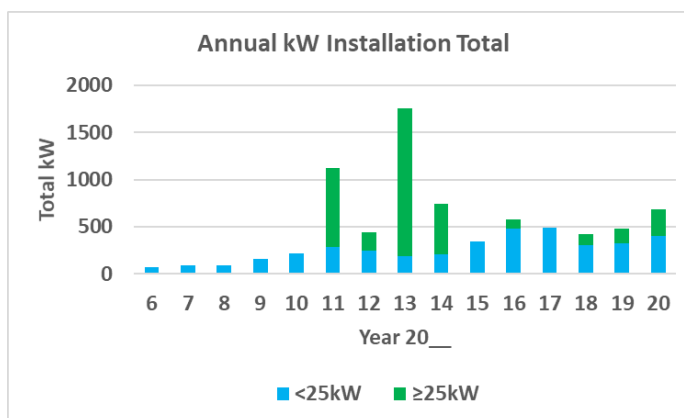


People who reviewed this summary asked several questions. Data to answer these questions come from the City of Corvallis Permitting System, Oregon Department of Energy Tax Credit Data for 2014-17, Energy Trust of Oregon, and other sources.

## Questions

### 1. Why the permit uptick in 2006?

Corvallis had 10 solar permits prior to 2006. From 2006-08 there were an average of 18 permits per year. Concern over the amount of domestic oil production and rising imports were stimulus for passing



the Energy Policy Act of 2005. President Bush noted when signing the bill “...high gas costs” and “...rising dependence on foreign oil” are justifications for residential and commercial tax credits for solar installations. The Tax Relief and Health Care Act of 2006 extended the tax credits. One of the programs in the Great Recession stimulus of 2009 was legislation to use federal tax credits along with state and other programs to increase solar

installations. In 2009, permits jumped to 33 and 45 in 2010 as shown by the red bars of the first graph titled “Number of Installs”.

The graph (above left) shows the number of kW installed annually. The green bars add the >25 kW installations. The big jumps in 2011 and 2013 are OSU installations. The blue bars are the more numerous residential, multifamily, and commercial installations averaging 5.2 kW.

Before 2018, Oregon offered tax credits of up to \$6,000 per residential installation. See 2018 drop in Number of Installs graph on page 2. Subsidies from federal and state tax credits made solar reasonably inexpensive to install. The blue bar in the “Annual kW Installations Total” graph shows under 500 kW installed yearly until 2016 and 2017, when they peaked. After 2017, the larger subsidies were removed. The 2020 jump comes mainly from installations over 25 kW.

Program revisions lowered the benefit after December 31, 2017. Incentive programs continue, but they are not as favorable to residential installations as they were. The Oregon standard residential limit in 2020 is up to \$2,400 per installation meeting Energy Trust of Oregon requirements. Standard business incentives are up to \$20,000. More recently, applications for larger installations have increased, while residential and multifamily installations have remained under the 500 kW per year level.

## 2. Why the steep permit drop in 2017?

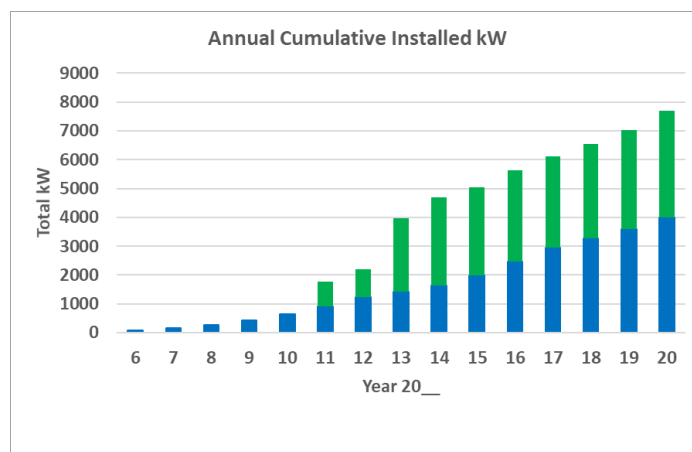
The tax credit incentives declined substantially with the ending of the state’s Residential Energy Tax Credit (RETC) program. The Oregon Department of Energy tabulated payments from the RETC program. These records show that the incentives stimulated 408 Corvallis mailing addresses to participate in the tax credit program. A total of \$7,469,913 was spent on residential solar installations in Corvallis from 2014-17.

Incentives in the form of tax credits funded 32% of installation costs; the average credit was \$5,835 on the average installation cost of \$18,309. The 2014-17 tax credit was over twice the maximum for the Oregon Energy Trust incentive program in 2020. Going forward, better pricing continues solar installations at a slower rate. As of May 2020, EnergySage.com estimates a 5 kW solar panel system installation in the Corvallis area costs an average of \$10,922 to \$14,887.

Residents using these incentives typically report that solar was quite affordable to install. Nearly all public, nonprofit, and commercial large installations had subsidies of some sort on installation or loans. Solar incentives are complex and can include federal, state, municipal, electricity provider, and others who provide tax breaks, loans, and direct subsidies. Information on incentive programs was found at the Energy Trust of Oregon web site. In 2019, the State Legislature passed HB 2618, which “... created a new solar and solar plus storage rebate program at the Oregon Department of Energy. The program issues rebates for solar electric systems and paired solar and solar storage systems for residential customers and low-income service providers in Oregon.”

## 3. What is the pattern of growth in Corvallis solar installations?

This graph (right) shows the annual cumulative installed kW each year from 2006-2020. These data are for the year the permit was requested and in most cases when construction was started. Each bar is the accumulated total of that year, plus all the previous years added together to give the total installed solar capacity at the end of each year, assuming no installations were



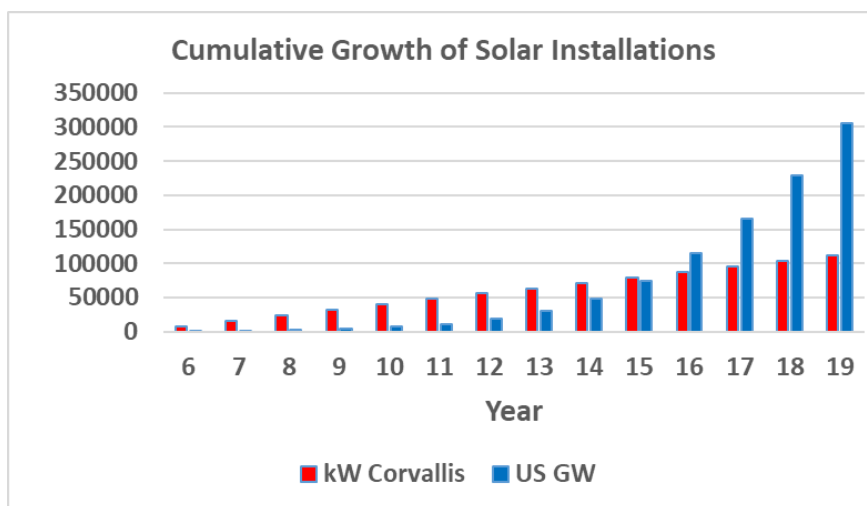


taken out of service. The graph shows continued growth of solar capacity with those installations over 25 kW becoming a larger share of the total.

Many Corvallis homes use natural gas for space and water heating, thus solar installations on these houses do not allow for 100% fossil fuel-free energy use. Pacific Power's electricity has had year-over-year growth averaging 2%, but electricity growth has had a slight decline in recent years. For Pacific Power, the electric use is not precisely known, so the Corvallis franchise fee is used as an estimate. The franchise fee is paid to the City of Corvallis for use of the public right-of-way. In the case of Pacific Power, the franchise fee is based on the amount of electricity sold each month. Since the franchise fee is based on electricity usage, it is a proxy for the amount of electricity consumed. Electricity use is affected by weather and other use factors, for example, greater appliance efficiency and more installed solar could reduce the growth in Pacific Power electricity used.

This graph compares the installed growth from 2006-19 for Corvallis (red bars) and the US (blue bars).

The US graph has an escalating rate of growth. US growth is from less than one GW installed in 2006 to a total of 305 GW added thru 2019. Corvallis has grown from less than a MW to about 7.8 MW. The average growth of installs is 23% year-over-year. Corvallis' growth curve shows relatively consistent growth, while the US's growth is more like an exponential growth curve.



#### 4. What does knowing the installed solar capacity tell us about electricity production?

From a climate perspective, the important measure is the kilowatt hours (kWh) of annual energy production. The amount of electricity generated by solar is the capacity in kW times the average annual energy output in hours. Every installation has a different actual output. The actual output of a solar panel varies with many factors, such as the power rating, efficiency rating, and degradation rate, along with the tilt, shading, weather, and installation location.

In Corvallis, the average annual hours of operation is about 1,150 across all installations. Thus, 7,758 kW of installed solar times 1,150 hours of operation at the rated value gives 8,921,700 kWh per year that is locally generated at the current capacity. This would support 740 all-electric homes using 12,000 kWh per year. For comparison, the OSU Greenhouse Gas Inventory reported that for FY 2019 OSU purchased for its Corvallis campus about seven times more, 63,444,516 kWh.

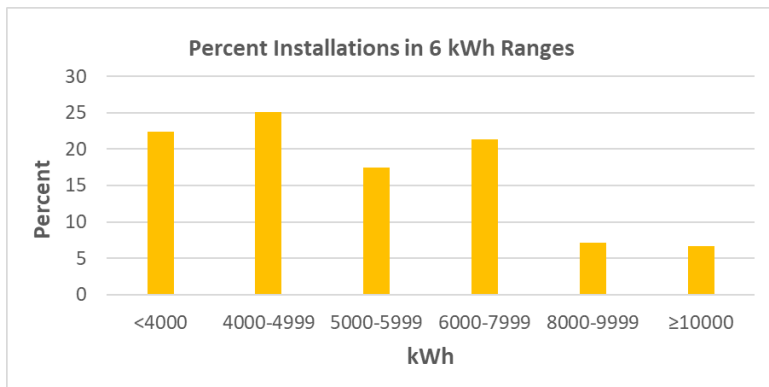
#### 5. What does the capacity of residential solar tell us about addressing climate issues?

A goal of solar installation is to replace electricity generated using fossil fuels with renewable energy. The typical all-electric house uses about 12,000 kWh per year. Assuming 1,150 hours is the average hours at full capacity, this would require a solar installation of 10.4 kW. Comparing this example of an all-electric home with the Percent Installs by Category graph on page 2 shows that 95.5% of the residential and commercial solar capacity in Corvallis is less than 10 kW, which suggests that few of the solar installations are located on all-electric homes. Other sources of energy come into play, principally

fossil fuels for space and water heating. Having an all-electric home depends on people's life style, quality of home insulation, operation of home appliances, and number and kind of appliances used. Three owners of smaller homes have achieved all electric with 3, 4.5, and 5.52 kW installations. But, in general, the smaller the solar capacity, the more likely space and water heating is with natural gas.

The typical 2000 ft<sup>2</sup> house uses 60% of its energy for space and water heating. The rest is in lighting, electric appliances, and electronics. Houses producing less than 12,000 kWh per year are more likely to be offsetting only a portion of their energy use with a solar installation. In many homes with solar installations, the space and/or water heating are with fossil fuels like natural gas, propane, or oil.

Annual household kWh use can be analyzed using RETC program data. The graph shows the kWh distribution for all Corvallis solar installations from 2014-17 in the RETC data for Corvallis (n=408). Notice that nearly half (47%) of the installations are under 5,000 kWh. These are very unlikely to be all-electric homes. The 7% over 10,000 kWh per year have the greatest probability of being all-electric. Thus, if a house is only using solar for lighting, electric appliances, and electronics, it is still emitting greenhouse gases when it burns fossil fuels for heating.



## Methodology

### The Data

The main data were derived from the City of Corvallis Permitting System. First was selection of all the Corvallis Community Development permits mentioning the word "solar". This resulted in the identification of about 2000 permits. The permits were of various types, but nearly all solar installations are required to have a building and electrical permit.

The next step was to sort the permits by address and year. A few addresses had a second or added installation at a later time. Creation of a unique address file required checking anywhere from 1 to over 20 permits for each address and selecting the most data-rich permit (Each address averaged 2.6 permits.). Next, one permit summary was saved with the best description of the installation, hopefully including capacity information. The final piece of information was the status of the permit. Permits were listed most often as "Closed." Those listed as "Completed" and "Finaled" were taken to be closed. Nine permits were labeled "Expired." Expired permits had no impact on the calculation of the total installed kW. Of the installations at 780 unique addresses, 363 permit summaries gave enough information to estimate the kW installed.

The data for estimating the installed capacity came most often in kilowatts (kW). Often the data were in kVA, which is kilo-volt-amperes. This can be converted to watts by multiplying by a power factor 0.8. The kVA data were generally in ranges (<5, 5.1 to 15, and 15.1 to 25). For the three kVA ranges 4, 8, and 16 kW were used, which came from multiplying 5, 10, and 20 by 0.8.

Some records listed the number of solar panels. The typical factor to get watts is assuming that each panel generates 250 watts. Thus, 10 panels times 250 is 2,500 watts or 2.5 kW. Sometimes the square footage is given. For this, ft<sup>2</sup> is multiplied by 15 watts/ft<sup>2</sup>. Sometimes the lineal footage is given. Each

solar panel is about a meter wide, so dividing the linear feet by 3.3 feet gives an estimate of the number of solar panels. Using these various methods, the kW rating for each installation with adequate data was calculated.

A second database was extracted from the Oregon Department of Energy's summary of the RETC program from 2014-17. During this time period, 408 installations with Corvallis mailing addresses received tax credits. These data contain address, cost, rebate, and energy production, but no capacity information.

Finally, photos of installations made around Corvallis show many different types of solar installations. Solar is very space intensive. Most installations over 100 kW are ground mounted. In terms of numbers of installations, the most common is rooftop solar for 1&2 Family residences.

The photo database is used to verify the existence of installations mentioned in the permit data and those who took part in the RETC program. Photos enable checking conversion factors, adding new data on installations, and seeing how solar installations are situated. Solar panels can be counted and checked against actual kW ratings. Some solar owners have been contacted about their experiences with solar.

**Assumptions are:**

The post 1991 electronic permit data are a complete and accurate description of all solar installations in Corvallis.

"Corvallis" can include installations outside the City Limits. OSU's Aquatic Animal Health Laboratory, their 53<sup>rd</sup> Street array, and Benton County's installation at the Fairgrounds are outside the City Limits. RETC data are for Corvallis mailing addresses.

No installation over 25 kW was missed. Although solar installers report an increase in the size of installations, residential installations are typically less than 25 kW because of current requirements of electric companies when they link a solar installation to the grid and limitations on residential roof and ground space.

An average of 5.2 kW for all the permits with unknown size under 25 kW is adequate for estimating the average installation from 2006-20. Choosing a different multiplier would adjust the capacity estimate. From inspection of many electrical permits and observation of solar installations, nearly all of unreported kW's are 1&2 Family. The 2019 Energy Trust of Oregon average solar installation was 7.7 kW. Using this would make the Corvallis capacity estimate 13% higher (8,800 kW). Keep in mind that solar panels degrade at a rate of 0.5 to 1.0% per year. The size of solar installations have increased in recent years. Collecting and analyzing these data is complex, and the assumption is that number of errors made working with the data do not significantly affect the results.

The 5.2 kW average for estimating permits would lead to a low solar capacity estimate only if every solar installation is working to rated capacity. If installations are not operating as designed or if any have been removed, disconnected, or are not working properly, the 5.2 kW estimate would be high. Because solar panels have been improving, older panels are less productive than the newer ones. Further, the current maintenance and operation of solar installations is not known, and this could lower the effective kW production.