Renewable Energy System Sizing Parameters and Processes

I. Sizing Parameters for Systems at Existing Properties

Qualified Projects must not exceed 25kW AC as measured by the Inverter Nameplate Capacity of the Qualified System's inverter. More than one Qualified Project may be located at a single one-to-four family property, however the total nameplate AC capacity for all qualified systems may not exceed 25 kW. Co-located or paired energy storage system capacity does not count towards the 25 kW AC cap of Residential Renewable Energy Solutions.

Expected annual production from each photovoltaic ("PV") system will be provided at application by the customer's installer. For projects at existing homes, the Electric Distribution Companies ("EDCs") will review whether the expected production exceeds the highest 12-month aggregate consumption from the previous 60 months to ensure the project is sized to meet historic load. The EDCs will allow sizing up to 5% beyond this 12-month aggregate consumption before accounting for other allowances like EVs and Heat Pumps (as outlined here). This is to prevent projects being rejected for minor and unintentional sizing exceedance.

In scenarios where less than 12 months of historical electric usage is available for the premise with its current occupant as the Customer of Record (i.e., an existing home that was purchased and the Customer of Record has resided there for 8 months), the system may be sized up to a maximum of 9 kW AC[1] nameplate capacity without consideration of the limited available electric usage. Such systems may exceed 9 kW AC by an amount consistent with any planned future electrification measures.

II. Sizing Parameters for Systems at New Construction Residences

Expected annual production from each system will be provided at application by the customer's installer. For projects at new construction homes, systems may be sized up to 9 kW AC without including an energy model with the application. If the system is sized larger than 9 kW AC, the installer will submit with the application a copy of an energy model for the proposed property estimating the design day load or annual kWh consumption at the site. Acceptable models[2] include, but are not limited to, the following:

- REM/Rate
- EkoTrope
- WUFI Passive
- EQuest

[1] The average system size for the 2020-2021 period in the Connecticut Green Bank's RSIP program was 9.04 kW AC. Data source: https://www.gosolarct.com/wp-content/uploads/2022/01/RSIP-Web-Report-1-13-2022.csv. This sizing may be re-evaluated annually by the EDCs based on the previous 2 years' average installed system size.

[2] Models were selected based on their ability to produce either 1) design day load for heating, which were then used in the Conservation & Load Management Program Savings Documentation equation to determine annual kWh, or 2) annual energy usage kWh for heating

- REVIT
- Manual J

Solar installers may petition the EDCs to allow acceptance of alternative energy models not listed above. Proposed alternative models must be models that have been created by, used by and/or recommended by the Department of Energy and/or ASHRAE.

Real-world verification of site energy consumption projections would require a full 12 months of consumption data. The EDCs do not intend to require load to materialize at the site before allowing system interconnection and tariff agreement execution as this would present an unreasonable barrier to new construction PV system development in Connecticut.

III. Sizing Parameters for Multi Family Affordable Housing

Projects may be sized to cover the load of the entire multi-family affordable housing property, including the load of each individual unit and common space meter, with a cap of 25kW per unit and common space meter. Projects located at such multifamily dwellings shall be sized so as not to exceed the load of the premises and shall only qualify if: "(I) Each of the dwelling units receives an appropriate share of the benefits from the generation project, and (II) no greater than an appropriate share of the benefits from the generation project is used to offset common area usage.

EDCs and EOE reserve the right to inspect tenant lists to confirm properties meet income eligibility and may choose to audit tenant data for those properties identified as eligible under the second and third tier of the property eligibility process outlined in Section II.A.3 of Docket No, 21-08-02.

Exceptions to this sizing rule are allowed for fuel-switching and the addition of electric vehicles (EVs), as approved in the First Interim Decision, dated October 6, 2021, and described in Attachment 14 of the joint EDC compliance filing in the instant proceeding dated December 1, 2021

IV. Additional Sizing Allowances for Electric Vehicles

The EDCs propose to have a fixed, standard kWh allowance for projects seeking to size systems above existing (or projected) annual kWh in order to accommodate up to two electric vehicles ("EV") for 1-4 unit residential properties, or one EV per unit for multi-family affordable housing properties. During the application process, the installer can indicate that the customer is seeking to increase the size of their project to accommodate a specified number of EVs.

According to Connecticut Department of Transportation ("CTDOT") data the average EV consumption is 0.3 kWh per mile and the average daily vehicle miles traveled ("VMT") is 30 miles.[3] This equates to 9 kWh of EV electricity consumption per day per EV. Extrapolating daily usage for a year equates to 3,285 kWh consumption per EV and 6,570 kWh per annum for two EVs. The EDCs propose to use these values, in addition to the customer's existing (or projected) load when determining the maximum allowable PV system size.

Given these values use simplified averages, the EDCs will allow customers to petition for exceptions to the 0.3 kWh per mile limit in the event they are purchasing an EV with a kWh per mile greater than .3. In the event an exception is requested, the EDCs may request supporting documentation such as proof of vehicle purchase or clearly demonstrable intent to purchase a vehicle with a kWh per mile greater than 0.3.

V. Additional Sizing Allowances for Electrification of Heating for 1-4 Unit Residential Properties

The EDCs propose to have a fixed, standard kWh allowance for projects that seek to size their PV projects in order to accommodate future load for the following technologies:

- Whole-home air-source heat pumps ("ASHP")
- Whole-home ground-source heat pumps ("GSHP")

In calculating the PV system oversizing for electric heat pumps, the EDCs utilized the Conservation and Load Management Program Savings Document ("PSD") and projections from the U.S. Energy Information Administration (EIA) Appendix A – Technology Forecast Updates – Residential and Commercial Building Technologies. According to this Technology Forecast the typical residential Air Source Heat Pump ("ASHP") has a capacity of 3 tons and an HSPF of 8.6.[4] Using this capacity and HSPF, the typical annual heating consumption of an ASHP is 3,608 kWh (see ASHP equation below), which will be used as the fixed standard kWh allowance for ASHPs.

Using the same average heat pump capacity of 3 tons and the typical Ground Source Heat Pump ("GSHP") Coefficient of Performance ("COP") of 3.7[5], the typical annual heating consumption of a GSHP is 2,458 kWh (see GSHP equation below). The EDCs propose to use this value as the fixed standard kWh allowance for GSHP. The EDCs propose to use these heat pump allowance values, in addition to the customer's existing (or projected) load plus the EV allowance (if applicable) when determining the maximum allowable PV system size.

Given these values use simplified averages, the EDCs will allow customers to petition for exceptions to these limits in the event they are installing heat pumps larger than three tons. In the event an exception is requested, the homeowner will be required to submit a Manual J heat load calculation that provides a

[3] https://portal.ct.gov/-/media/DOT/documents/dpolicy/2020FastFacts-onlineFINAL.pdf- page 21
4 https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/appendix-a.pdf - page 29
5 https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/appendix-a.pdf - page 33

customer specific design day load to estimate the annual heat pump heating energy consumption for the home based on the equations below.

The following equations illustrate how the above values were calculated (see Table 1 for reference table):

Air Source Heat Pump[6]

Heating:

$$AkWh_H = Cap_H \times 12{,}000 \times \left(\frac{1}{HSPF}\right) \times EFLH_H \times \frac{1}{1000}$$

$$AkWh_H = 3 \times 12{,}000 \times \left(\frac{1}{8.6}\right) \times 862 \times \frac{1}{1000}$$

$$\boldsymbol{AkWh_H = 3{,}608\ kWh}$$

Ground Source Heat Pump[7]

Heating:

$$AkWh_H = Cap_H \times 12{,}000 \times \left(\frac{1}{COP}\right) \times EFLH_H \times \frac{1}{3{,}412}$$

$$AkWh_H = 3 \times 12{,}000 \times \left(\frac{1}{3.7}\right) \times 862 \times \frac{1}{3{,}412}$$

$$\boldsymbol{AkWh_H = 2{,}458\ kWh}$$

VI. Additional Sizing Allowances for Electrification of Heating for Multi-Family Affordable Housing Properties

Given the wide range in architecture and unit sizing in multifamily buildings, the EDCs propose a square footage-based allowance for air source heat pumps and ground source heat pumps.

[6] Connecticut's 2021 Program Savings Document: 18th Edition, Filed on March 1, 2021 – page 153
[7] Connecticut's 2021 Program Savings Document: 18th Edition, Filed on March 1, 2021 – page 156

The standard allowance for air source heat pumps assumes a building Energy Use Intensity ("EUI") of 59.6 kBtu/sf[8] and that 25% of the EUI is used for heating.[9] This results in an EUI of 14.9 kBtu/sf for space heating. Assuming the space is heated by fossil fuels and an 90% efficiency factor, the required EUI for space heating is 13.4 kBtu/sf. With a standard heat pump efficiency of 8.6 Btu/Wh[10] the resulting standard allowance for air source heat pumps in multifamily buildings is 1.6kWh/sf. Using the same inputs and a Coefficient of Performance ("COP") of 3.7 for ground source heat pumps,[11] the resulting standard allowance is 1.1kWh/sf.

RRES multifamily affordable housing participants may choose to use these standard allowances to oversize their solar PV system for future electrification or submit a building load analysis (Manual J or solar developers may petition the EDCs to allow acceptance of alternative energy models) summarizing the modeled annual kWh consumption if the specific measures planned deviate significantly from the standard allowances.

The following equations illustrate how the above values were calculated (see Table 1 for reference table):

Air Source Heat Pump:

Heating:

$$AkWh_{H/sf} = EUI_{MF} \times EUI_{\%HMF} \times AFUE \times \left(\frac{1}{HSPF}\right)$$

$$AkWh_{H/sf} = 59.6 \times 0.25 \times 0.9 \times \left(\frac{1}{8.6}\right)$$

$$\boldsymbol{AkWh_{H/sf} = 1.6\ kWh/sf}$$

Ground Source Heat Pump:

Heating:

$$AkWh_{H/sf} = EUI_{MF} \times EUI_{\%HMF} \times AFUE \times \left(\frac{1}{COP}\right) \times \left(\frac{1}{3{,}412}\right) \times 1000$$

$$AkWh_{H/sf} = 59.6 \times 0.25 \times 0.9 \times \left(\frac{1}{3.7}\right) \times \left(\frac{1}{3{,}412}\right) \times 1000$$

$$\boldsymbol{AkWh_{H/sf} = 1.1\ kWh/sf}$$

[8] https://www.energystar.gov/buildings/benchmark/understand_metrics/what_eui
[9] Use of energy in homes - U.S. Energy Information Administration (EIA) available at: https://www.eia.gov/energyexplained/use-of-energy/homes.php
[10] https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/appendix-a.pdf - page 29
[11] https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/appendix-a.pdf - page 33

Table 1: Variables for above equations defined with Reference

Variable	Value	Units	Description	Reference
AFUE	90	%	Annual Fuel Utilization Factor	EIA – Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, April 2018, U.S. Energy Information Administration, Updated Buildings Sector Appliance and Equipment Costs and Efficiencies, pg. 15
$AkWh_H$		kWh/ year	Annual energy consumption for heating only	
$AkWh_{H/sf}$		kWh/sf	Annual energy consumption for heating per square foot of building area	
Cap_H	3	Tons	Installed Heating Capacity	EIA - Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, April 2018, U.S. Energy Information Administration, Updated Buildings Sector Appliance and Equipment Costs and Efficiencies, pg. 29
$EFLH_H$	862	Hours	Heating equivalent full-load hours	CT 2021 PSD filed March 1, 2021, Measure 4.2.2, pg. 151
EUI_{MF}	59.6	kBTU/sf	Energy Use Intensity for Multifamily Housing	Energy Star – Median EUIs in the United States, property type multifamily housing. For details on how these national energy use intensities are calculated, see Portfolio Manager Technical Reference: U.S. National Energy Use Intensity
$EUI_{\%HMF}$	25	%	Percentage of Energy Use Intensity for Heating Multifamily	EIA – End-use consumption shares by type of US homes, apartments 5+ units
HSPF	8.6	BTU/ watt-hr	Heating season performance factor representing typical new model Air Source Heat Pump	EIA - Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, April 2018, U.S. Energy Information Administration,

				Updated Buildings Sector Appliance and Equipment Costs and Efficiencies, pg. 29
COP	3.7		Coefficient Of Performance for a typical new model Ground Source Heat Pump	EIA - Technology Forecast Updates – Residential and Commercial Building Technologies – Reference Case, April 2018, U.S. Energy Information Administration, Updated Buildings Sector Appliance and Equipment Costs and Efficiencies, pg. 33
	12,000	BTU/ Ton	Conversion Factor for BTU to Ton	
	3,412	kWh/ BTU	Conversion factor for kWh to BTU	
	1,000	Watts/ kW	Conversion Factor for Watts to kilo-Watts	