

RED1-91-22

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2024 International Energy Conservation Code [RE Project]

Add new text as follows:

RP On-Site Renewable Energy

RP101 SCOPE. These provisions shall ~~apply be applicable for new construction~~ where on-site renewable energy is required.

RP102 GENERAL DEFINITION.

POTENTIAL SOLAR ZONE AREA. The combined area of any steep-sloped roofs oriented between 90 degrees and 300 degrees of true north and any low-sloped roofs where the *annual solar access* is 70 percent or greater.

ANNUAL SOLAR ACCESS. The ratio of annual solar insolation with shade to the annual solar insolation without shade. Shading from obstructions located on the roof or any other part of the building shall not be included in the determination of *annual solar access*. Shading from existing permanent natural or person-made obstructions that are external to the building, including but not limited to trees, hills, and adjacent structures, shall be considered for *annual solar access* calculations.

PHYSICAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT. A contract for the purchase of renewable electricity from a specific renewable electricity generator to a purchaser of renewable electricity.

RP103 ON-SITE RENEWABLE ENERGY

RP103.1 General. ~~The New buildings~~ shall comply with R401.2 and the requirements of this Section. ~~RP103.1 through RP103.6~~

~~RP103.2 One and two family dwellings and townhouses and other R3 Occupancies. Install an on-site renewable energy system with a nameplate DC power rating measured under standard test conditions, of not less than 2kW.~~

Exceptions:

- ~~1. A building with a permanently installed domestic solar water heating system with a solar savings fraction of not less than 0.5.~~
- ~~2. A building in climate zone 4C, 5C or 8.~~
- ~~3. A building where the potential solar zone area is less than 300 square feet (28 m²).~~

~~RP103.3 Group R2 and R4 Occupancies. Buildings containing Group R-2 or R-4 shall install an on-site renewable energy system with a peak rated capacity calculated to be of not less than 0.75 W/ft² multiplied by the gross conditioned floor area.~~

Exceptions:

- ~~1. A building with a permanently installed domestic solar water heating system with a solar savings fraction of not less than 0.5.~~
- ~~2. A building in climate zone 8.~~
- ~~3. A building where the potential solar zone area is less than 300 square feet (28 m²).~~

RP103.1.1 Installed Capacity An on-site renewable energy system shall be installed on, or at the site of, the building with a

peak rated capacity, measured under standard test conditions, in accordance with one of the following:

1. For one- and two- family dwellings, townhouses and other Group R-3 occupancies, the peak rated capacity shall be no less than 2kW.
2. For Group R-2 or R-4 residential buildings, the peak rated capacity shall be no less than 0.75 W/ft² multiplied by the gross conditioned floor area.
3. Where a building includes both commercial occupancies and R-2 or R-4 occupancies required to comply with this Code, the peak capacity shall be no less than 0.75 W/ft² multiplied by the gross conditioned floor area of the Group R-2 and R-4 occupancies.

The capacity of installed on-site renewable energy systems used to comply with this Appendix shall be in addition to the total capacity of installed on-site renewable energy systems used to comply with all other requirements of this Code.

Exceptions:

1. A building with a permanently installed domestic solar water heating system sized with a solar savings fraction of not less than 0.5 based on the total service water heating load of all residential occupancies.
2. One and two family dwellings, townhouses and other Group R-3 Occupancies in climate zone 4C, 5C or 8.
3. Group R-2 or R-4 occupancies in climate zone 8.
4. Buildings where the potential solar zone area is less than 300 square feet (28 m²).
5. Buildings with a physical renewable energy power purchase agreement with a duration of not less than 15 years from a utility or a community renewable energy facility and for not less than 80 percent of the estimated whole-building electric use on an annual basis.
6. Buildings that demonstrate compliance in accordance with Section RP103.1.1.1

RP103.1.1.1 Alternate Capacity Determination. Where compliance is demonstrated in accordance with Section R405 Simulated Building Performance and the proposed design and standard reference design are adjusted in accordance with Items (1) and (2), the required capacity of the installed renewable energy systems shall be permitted to differ.

1. **Proposed Design.** Where applicable, the proposed design shall comply with one of the following:
 - a. Where one or more systems providing on-site renewable energy are included in the construction documents, the systems shall be modeled in the proposed design with a design capacity not greater than the required capacity in accordance with Section RP103.1.1. A combination of on-site renewable energy systems shall be permitted to be included in the proposed design.
 - b. Where no on-site renewable energy systems are specified in the construction documents, no on-site renewable energy systems shall be modeled in the proposed design.
2. **Standard Reference Design.** Where applicable, the standard reference design shall comply with one of the following:
 - a. Where a proposed design includes one or more on-site renewable energy systems the same systems shall be modeled identically in the standard reference design except the total rated capacity of all systems shall be equal to the required capacity in accordance with Section RP103.1.1. Where more than one type of on-site renewable energy system is modeled, the total capacity of each system shall be allocated in the same proportion as in the proposed design.
 - b. Where the proposed design does not include any on-site renewable energy systems, an unshaded photovoltaic system shall be modeled in the standard reference design in accordance with the performance criteria in Table RP103.1.1.1(1).

**TABLE RP103.1.1.1(1)
PERFORMANCE CRITERIA for STANDARD REFERENCE DESIGN PHOTOVOLTAIC SYSTEMS**

<u>Criteria</u>	<u>Design model</u>
<u>Size:</u>	Rated capacity no less than required in accordance with Section RP103.1.1.
<u>Type</u>	Crystalline-0.37%/°C.
<u>Array Type:</u>	Rack mounted array with installed nominal operating cell temperature (INOCT) of 103°F (45°C).

<u>Total System Losses (DC output):</u>	<u>11.3%.</u>
<u>Tilt:</u>	<u>0-degrees (mounted horizontally).</u>
<u>Azimuth:</u>	<u>180 degrees.</u>

RP103.1.24 Renewable energy certificate (REC) documentation. Where RECs are associated with renewable energy power production required by Section RP103.2 or RP103.3, documentation shall comply with Section R404.4 Renewable energy certificate (REC) documentation.

RP103.1.3 ERI With OPP Requirements. Where compliance is demonstrated in accordance with Section 406.5 using the Energy Rating Index With OPP, a project shall comply with the requirements of this Appendix if the *rated proposed design* and confirmed built dwelling are shown to have an ERI less than or equal to the values in Table RP103.1.3.

TABLE RP103.1.3
MAXIMUM ENERGY RATING INDEX INCLUDING OPP

<u>CLIMATE ZONE</u>	<u>ENERGY RATING INDEX WITH OPP</u>
<u>0-1</u>	<u>35</u>
<u>2</u>	<u>34</u>
<u>3</u>	<u>33</u>
<u>4</u>	<u>40</u>
<u>5</u>	<u>43</u>
<u>6</u>	<u>43</u>
<u>7 & 8</u>	<u>46</u>

~~**RP103.5 Total Building Performance.** Where new buildings demonstrate compliance using Section R405 Total Building Performance, the applicable requirements of RP103.2, RP103.3 and RP103.4 shall be met.~~

~~**RP103.6 Energy Rating Index.** Where new buildings demonstrate compliance using Section R406 Energy Rating Index, the applicable requirements of RP103.2, RP103.3 and RP103.4 shall be met.~~

Reason: On-site electricity generation using photovoltaics is a key technology for reducing greenhouse gas emissions associated with Commercial and Residential buildings. According to the most recent assessment by the National Renewable Energy Lab (NREL) the cost of installed photovoltaics in 2020 was 3% lower than in 2019 and 65-70% lower than the cost of similar sized systems in 2010. With the continued drop in cost of installing on-site PV the cost per kilowatt hour of PV generated electricity is at parity with grid purchased electricity in many States throughout the country. This proposal describes requirements for prescriptive solar PV that must be installed at the time of construction. Analysis by PNNL shows that on-site renewable electricity generation is cost effective across all low-rise multifamily buildings and most single family and one or two unit townhouses. The analysis was done using each of the Residential prototypes in each ASHRAE climate zone. The capacity requirements were established by calculating the highest on-site solar PV capacity that limited electricity export back to the grid. The threshold used for determining these capacities was a grid export limit of less than 0.5% of total annual building electricity consumption. A review of the hourly results showed it was unrealistic to set a hard limit of zero overproduction. When calculating cost effectiveness no credit was taken for electricity that was exported back to the grid. The calculation of grid exports was done on an hourly basis. The proposed requirements reduce purchased energy from the electrical grid which will help reduce green house gas emissions and energy costs for building owners.

PVs provide substantial benefits to the consumer and society by helping to reduce GHG emissions associated with electricity generation. PV market growth combined with a cleaner grid will support goals of reduced GHG emissions established across the U.S. and others by federal agencies, as well as many states and local governments.

This public comment is in direct response to the feedback provided by the full Residential Committee that REPI-114

be brought back as an optional Appendix.

Cost Impact: The code change proposal will increase the cost of construction.

PNNL prepared a cost effectiveness analysis of the proposed changes as part of the original REPI-114 submission in October 2021. This original analysis of residential building solar PV cost effectiveness was calculated using the Life Cycle Cost methodology established by Pacific Northwest National Lab for determining National and State cost effectiveness of the 2021 International Energy Conservation Code. The DOE methodology accounts for the benefits of energy-efficient home construction over the life of a typical mortgage, balancing initial costs against longer term energy savings. The Life-Cycle Cost methodology provides a full accounting over a 30-year period of the cost savings, considering energy savings, the initial investment financed through increased mortgage costs, tax impacts, and residual values of energy efficiency measures. The installed cost of solar PV was based on costs reported in the U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020 published by NREL in 2021. Installed costs were scaled based on solar PV capacity from 2kW up to 200kW and applied based on the calculated capacity required for each prototype in each climate zone. The proposed solar PV capacities were shown to be cost effective for R occupancies in each ASHRAE climate zone except for climate zone 8 and for single family residences in all climate zones except 4C, 5C and 8. An updated analysis was provided to the full committee in May 2022 using the IECC Residential cost effectiveness methodology. The results of that analysis by climate zone are provided below. The analysis has not been updated to reflect any change in the national average cost of small-scale renewables or to capture the impact of the Inflation Reduction Act passed in November 2022 that included renewable tax credits through 2032.

Single Family Dwellings	1A	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
PV Capacity (kW)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
PV Generation (kWh)	3,189	3,082	3,480	3,000	3,651	3,458	2,669	3,593	2,304	2,510	3,154	2,355	2,611	2,775	2,444	1,885
PV Cost @ 3.55	\$ 7,100	\$ 7,100	\$ 7,100	\$ 7,100	\$ 7,100	\$ 7,100	\$ 7,100	\$ 7,100	\$ 7,100	\$ 7,100	\$ 7,100	\$ 7,100	\$ 7,100	\$ 7,100	\$ 7,100	\$ 7,100
IECC Cost effectiveness @ \$3.55 per Watt																
3.84% Real w/o SCC	\$2,956	\$2,617	\$3,881	\$2,356	\$4,424	\$3,811	\$1,305	\$4,239	\$146	\$800	\$2,845	\$308	\$1,121	\$1,642	\$591	(\$1,185)
3% Real w/o SCC	\$2,164	\$1,884	\$2,927	\$1,669	\$3,374	\$2,869	\$802	\$3,223	(\$154)	\$386	\$2,073	(\$20)	\$650	\$1,080	\$213	(\$1,251)
7% Real w/o SCC	\$871	\$692	\$1,358	\$555	\$1,645	\$1,321	\$0.30	\$1,547	(\$611)	(\$266)	\$812	(\$525)	(\$97)	\$178	(\$376)	(\$1,312)
3.84% Real w/ SCC	\$4,542	\$4,149	\$5,611	\$3,848	\$6,239	\$5,531	\$2,632	\$6,026	\$1,292	\$2,048	\$4,414	\$1,479	\$2,419	\$3,022	\$1,806	(\$247)
3% Real w/ SCC	\$3,750	\$3,417	\$4,657	\$3,161	\$5,190	\$4,589	\$2,130	\$5,009	\$992	\$1,634	\$3,641	\$1,151	\$1,949	\$2,460	\$1,428	(\$314)
7% Real w/ SCC	\$2,457	\$2,225	\$3,089	\$2,047	\$3,460	\$3,041	\$1,328	\$3,334	\$535	\$982	\$2,381	\$646	\$1,202	\$1,558	\$839	(\$375)
Low-Rise Multifamily																
PV Capacity (kW)	16.22	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2
PV Generation (kWh)	25,921	25,050	28,286	24,388	29,675	28,108	21,699	29,208	18,728	20,403	25,634	19,145	21,221	22,554	19,863	15,322
PV Cost @ 2.26/W	\$ 36,673	\$ 36,673	\$ 36,673	\$ 36,673	\$ 36,673	\$ 36,673	\$ 36,673	\$ 36,673	\$ 36,673	\$ 36,673	\$ 36,673	\$ 36,673	\$ 36,673	\$ 36,673	\$ 36,673	\$ 36,673
IECC Cost effectiveness @ \$2.26 per Watt																
3.84% Real w/o SCC	\$45,279	\$42,513	\$52,789	\$40,410	\$57,201	\$52,224	\$31,871	\$55,717	\$22,436	\$27,755	\$44,367	\$23,760	\$30,353	\$34,586	\$26,040	\$11,619
3% Real w/o SCC	\$35,929	\$33,648	\$42,124	\$31,914	\$45,762	\$41,658	\$24,871	\$44,539	\$17,089	\$21,476	\$35,177	\$18,181	\$23,619	\$27,110	\$20,062	\$8,167
7% Real w/o SCC	\$20,320	\$18,862	\$24,280	\$17,753	\$26,606	\$23,982	\$13,251	\$25,824	\$8,276	\$11,081	\$19,840	\$8,975	\$12,451	\$14,683	\$10,177	\$2,574
3.84% Real w/ SCC	\$58,170	\$54,971	\$66,857	\$52,539	\$71,959	\$66,203	\$42,663	\$70,244	\$31,750	\$37,902	\$57,116	\$33,281	\$40,907	\$45,803	\$35,919	\$19,239
3% Real w/ SCC	\$48,821	\$46,106	\$56,192	\$44,043	\$60,521	\$55,637	\$35,662	\$59,065	\$26,403	\$31,623	\$47,926	\$27,702	\$34,173	\$38,327	\$29,940	\$15,788
7% Real w/ SCC	\$33,212	\$31,320	\$38,348	\$29,883	\$41,364	\$37,961	\$24,043	\$40,350	\$17,591	\$21,228	\$32,589	\$18,496	\$23,005	\$25,900	\$20,056	\$10,194
The installed cost of photovoltaic systems was based on published NREL cost data that was further adjusted to account for streamlined permitting under the NREL SolarApp+ program and to account for differences between retrofit and new construction costs. A cost of \$3.55 per installed watt was used for 2kW array capacity and \$2.26 per installed watt was used for a 16kW array capacity.																

Workgroup Recommendation