Commercial PV Required

Modify the 2021 International Energy Conservation Code as follows:

Add new text as follows:

C405.13On site renewable energy.

Each building site shall have equipment for on-site renewable electricity generation with a nameplate direct current(DC) power rating calculated in accordance with Equation 4-12.

DC Power Rating = REN_{DF} x REN_{AREA}

(Equation 4-12)

where:

REN_{DF} = Renewable Density Factor selected from Table C405.13.1 based on building occupancy.

REN_{AREA} = the sum of gross conditioned floor area for all floors up to the three (3) largest floors

Exceptions to C405.13:

1. Any building in climate zone 8
2. Any building located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily aver- age incident solar radiation less than 3.5 kWh/m2·day (1.1 kBtu/ft2·day).
3. Any building where more than 80% of the roof area is covered by any combination ofequipment other than for on-site renewable energy systems, planters, vegetated space, skylights, or occupied roof deck.
4. Any building where more than 50% of roof area is shaded from direct-beam sunlightby natural objects or by structures that are not part of the building for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.
5. Alterations that do not include additions.

C405.13.1Renewable energy certificate documentation.
Documentation shall be provided to the code official that indicates that renewable energy certificates (RECs) associated with the on-site renewable energy will be retained and retired by or on behalf of the owner or tenant.

Table C405.13.1 On-site renewable electricity density factors

Occupancy	Renewable Density Factor (W/ft^2)
R-1, R-2, R-4, I-1, I-2 and E	0.75
B with IT & phone equip. > 0.5 W/ft^2	0.75
B with IT & phone equip. ≤ 0.5 W/ft^2	0.50
A-2 and M	1.50

S-1 and S-2	0.50
All Other	0.68

For SI: 1 W/ft^2 = 10.76 W/m^2

Revise as follows:

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
On-site Renewable Energy	Where a *system* providing *on-site renewable energy* has been modeled in the *proposed design* the same *system* shall be modeled identically in the *standard reference design* except the rated capacity shall meet the requirements of Section C405.13 Where no system is designed or included in the proposed design, model an unshaded photovoltaic system with the following characteristics: **Size:** Rated capacity per Section C405.13 **Module Type:** Crystalline Silicon Panel with a glass cover, 19.1% nominal efficiency and temperature coefficient of -0.35%/°C, Performance shall be based on a reference temperature of 77°F (25°C) and irradiance of 317 Btu/h·ft^2 (1000 W/m^2). **Array Type**: Rack mounted array with installed nominal operating cell temperature (INOCT) of 103°F (45°C). **Total System Losses** (DC output to AC output): 11.3%. **Tilt**: 0-degrees (mounted horizontally). **Azimuth:**180 degrees.	As proposed

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. The Solar Energy Industries Association 2019 Solar Means Business Report found a 10% increase in on-site commercial solar PV capacity in 2019 compared to 2017 and 2018 driven largely by the reduction in cost. More recently in the SEIA 2021 Q3 Solar Insight Report they reported that new installed commercial solar PV in 2021 has rebounded to pre-COVID levels. The demand for Commercial on-site solar PV continues to grow and has been proven to be an effective technology for reducing the energy cost and greenhouse gas emissions of buildings. This proposal describes requirements for prescriptive solar PV that must be installed at the time of construction. ASHRAE 90.1-2022 will include similar renewable energy requirements and the model code language in this proposal expands those requirements. Analysis by PNNL shows that higher levels of on-site renewable electricity generation is cost effective. The analysis was done for each of the commercial prototypes in each ASHRAE climate zone and calculated the maximum 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 greenhouse gas (GHG) emissions and energy costs for building owners. The potential impact of the requirements varies by building type and climate zone but have the potential to achieve a weighted national average annual emission reduction of 1,780,110 metric tons.

The approach used for this proposal requires that building owners incorporate a modest amount of cost effective on-site solar PV. This approach addresses the management and dispatch challenge faced by Utilities when distributed solar resource export large amounts of unused electricity back into the grid by setting the required capacity to minimize exports. Where solar-PV is required by this proposal, no less than 99.5% of the generated electricity will be used directly by the building. Distributed generation also helps reduce transmission losses and the burden for new transmission infrastructure to centralized renewable resources.

On-site solar PV provides 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.

Potential Impact of Solar Required Measures

Metric	Units	PV Required
Annual Reduced Electric Grid Energy Consumption	MWH	2,164,300
Consumer Annual Purchased Electricity Cost Savings	million $US	$237.9m
Annual Emission Reductions, CO_2	metric tons	1,780,110

Cost Impact:

The code change proposal will increase the cost of construction.

For this analysis the Scalar Method was used to evaluate cost effectiveness. The Scalar Method is used by ASHRAE 90.1 to evaluate cost effectiveness and is being considered by the Commercial IECC Cost Effectiveness WG as the preferred approach for the Commercial IECC.

The Scalar Method is an alternative life-cycle cost approach for individual energy efficiency changes with a defined useful life, taking into account first costs, annual energy cost savings, annual maintenance, taxes, inflation, energy escalation, and financing impacts. The Scalar Method allows a discounted payback threshold (scalar ratio limit) to be calculated based on the measure life. A measure is considered cost effective if the simple payback (scalar ratio) is less than the scalar limit. For this study an average measure life of 32.5 years was established based on data published by the National Renewable Energy Laboratory(NREL) indicating the useful life of installed solar PV is 25-40 years. The table below shows the economic parameters used for the scalar calculations.

Scalar Ratio Method Economic Parameters and Scalar Ratio Limit

Input Economic Variables	Cooling (electricity) SRc
Economic Life – Years	32.5
Down Payment - $	0.00
Energy Escalation Rate - %[a]	2.25
Nominal Discount Rate - %[b]	8.1
Loan Interest Rate - %	5.0
Federal Tax Rate - %[b]	NA[b]
State Tax Rate - %[b]	NA[b]
Heating – Natural Gas Price, $/therm	
Cooling - Electricity Price $/kWh	0.1099
Scalar Ratio Limit	**20.0**

(a) The energy escalation rate used in the scalar calculation for 90.1-2022 includes inflation, so it is a nominal rather than a real escalation rate.

(b) Beginning with addenda for 90.1-2016, SSPC 90.1 eliminated tax analysis from the Scalar Method by using a pre-tax discount rate.

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.

Energy cost savings were based on evaluating the impact of solar PV on hourly electric consumption in each of the PNNL prototype buildings across all of the ASHRAE climate zones. On-site solar PV capacity was constrained by the following:

1. An array occupying no more than 20% of the roof area, and
2. A limit on electricity export back into the grid of no more than 0.5% of the total annual building electricity consumption.

The proposed solar PV capacities are cost effective for the consumer based on established metrics and criteria for determining cost effectiveness for all building types in all climate zones except for climate zone 8.