Statement of

Martha G. VanGeem, PE, LEED Accredited Professional
Principal Engineer, Building Science and Sustainability
CTLGroup

Before the Committee on Science and Technology
U.S House of Representatives

Options and Opportunities for Onsite Renewable Energy Integration – Renewable Ready

Field Hearing in Chicago, IL
November 15, 2010

Thank you for this opportunity to testify before you today. I will be speaking to you on the subject of "renewable ready." I will discuss the genesis of renewable-ready requirements of *ANSI/ASHRAE/USGBC/IES Standard 189.1-2009, Standard for the Design of High Performance Green Buildings*, as well as its advantages and disadvantages.

I have been a member of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and Standards Project Committee (SPC)[1] 189.1 (the committee responsible for drafting the language in the standard) since its inception in 2006. I have been a member of ASHRAE since 1984 and have been involved in standards project committee work at ASHRAE since 1987. However, today I am speaking for myself and not for ASHRAE nor the SPC 189.1.

Renewable ready – What does this mean?

"Renewable ready" in *ASHRAE 189.1-2009* requires that the building site include provision for future installation of renewable energy systems. Specifically, the language from *ASHRAE 189.1-2009* states:

> **7.3.2 On-Site Renewable Energy Systems.** Building projects shall provide for the future installation of on-site renewable energy systems with a minimum rating of 3.7 W/ft^2 or 13 Btu/h·ft^2 (40 W/m^2) multiplied by the total roof area in ft^2 (m^2). Building projects design shall show allocated space and pathways for installation of on-site renewable energy systems and associated infrastructure.
>
> **Exception:** Building projects that have an annual daily average incident solar radiation available to a flat plate collector oriented due south at an angle from horizontal equal to the latitude of the collector location

[1] The SPC became a Standing Standards Project Committee (SSPC) after the standard was published in early 2010. I was a member of SPC 189.1 and am now a member of SSPC 189.1.

> less than 4.0 kWh/m^2·day, accounting for existing buildings, permanent infrastructure that is not part of the building project, topography, or trees, are not required to provide for future on-site renewable energy systems.
> © ANSI/ASHRAE/USGBC/IES Standard 189.1-2009, *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings*, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (www.ashrae.org).

The intent of this provision is to assure that the building design includes a plan to accommodate future installations of common renewable energy systems such as photovoltaic, solar thermal, or wind. By definition in *ASHRAE 189.1-2009*, on-site renewable energy systems also include geothermal energy but not the energy associated with ground-source heat pumps. The requirement is for the building design documents to indicate the space, pathways, conduit, and piping for the planned future renewable energy system.

Why a requirement for renewable ready and not a renewable energy requirement?

The Compromise. The renewable ready requirements were appealing to the committee because renewable energy is expensive and therefore less cost effective when compared to other energy-saving measures required by the standard. While cost-effectiveness was not a criteria for requirements in the standard, the future usability of the standard is somewhat dependent on practicality and economics. The committee members and the participating public[2] had a spectrum of views on this issue – from mandating that a portion of energy from all buildings be renewable to not having a mandatory requirement due to the cost of these systems. The renewable-ready requirements were included as a compromise position.

The basis of this compromise position was that once a building is constructed, the future installation of such systems could be prohibitively expensive even if the costs of the systems themselves decrease. Installation of these systems as a retrofit in an existing building is more expensive if the initial building design did not account for additional structural loads or did not provide readily available space for the renewable system and its pathways, conduit, and piping. Accounting for structural loads and providing space for these systems in initial building design reduces the cost compared to adding them to the building in the future. In addition, the capital costs of renewable systems are expected to decline as their use increases. Costs are anticipated to decrease due to production on a larger scale and technological improvements that are gained from mass scale production.

Mandatory provisions versus a rating system. In addition, the structure of the standard, with mandatory, prescriptive, and performance requirements, lent itself to the renewable-ready requirement compared to a rating system such as LEED-NC©.

[2] The committee before publication had up to 34 members with some being added and removed at various times. The meetings of the committee were open to the public. Four public review drafts of the standard received over 2800 comments from interested parties.

ASHRAE 189.1-2009 is written in mandatory language[3] so that the requirements are clear and it can be adopted by building codes and used in design specifications. *ASHRAE 189.1-2009* is currently a jurisdictional compliance option of the *International Green Construction Code (IgCC)*™, which is a model code under development by the International Code Council (ICC)[4]. As a document in mandatory language, *ASHRAE 189.1-2009* differs significantly from the LEED© [5] family of point-based rating systems wherein one or more points are achieved for implementing a measure. In point-based rating systems, any particular measure generally does not need to be implemented. Historically, the least expensive measures are implemented and more expensive measures are ignored.

Conversely, codes or standards written in mandatory language generally have two paths. All projects must comply with either (1) all mandatory plus all prescriptive requirements (the prescriptive path), or (2) all mandatory plus all performance requirements (the performance path). The prescriptive path generally offers a simpler method of compliance with little or no calculations whereas the performance path often involves complex calculations.

In a rating system, it is straightforward to have a point that requires on-site renewable energy requirements. The user of the rating system can then decide whether or not to implement on-site renewable energy; it is the user's choice.

In a standard written in mandatory language, such as *ASHRAE 189.1-2009*, the implications are different than in a rating system. If on-site renewable energy is in the mandatory section of the standard, it is then required for *all* buildings complying with the standard and is not a choice. *ASHRAE 189.1-2009* has a requirement in the prescriptive section 7.4.1.1 for on-site renewable energy systems (with an exception for shaded buildings) but no such requirement in the mandatory or performance sections.

Previous unpublished versions. The 189.1 committee through ASHRAE released four drafts for public review. The 2nd public review draft included a mandatory requirement for on-site renewable energy power systems:

> **7.3.2 On-site Renewable Energy Power Systems.** Building projects shall contain on-site renewable energy power systems with an electrical rating not less than 1.0% of the service overcurrent protection device rating. The rating of the on-site renewable energy power system shall be the nameplate rating in kVA (dc).

[3] It is not a guide or guideline, which often contain advice, considerations, or background information. ASHRAE will soon publish a user's manual for ASHRAE 189.1-2009 with this type of guidance.
[4] www.iccsafe.org
[5] www.usgbc.org

Exceptions to 7.3.2:
(a) Building projects with an on-site solar water heating system that provides 100% of the domestic hot water needs or has a peak capacity equivalent to not less than 2.5% of the service overcurrent protection device rating for the building project. The system shall be certified in accordance with SRCC OG-100.

(b) Building projects that demonstrate compliance using the Performance Option in 7.5 and provide any combination of energy cost and CO_2e savings achieving a minimum of 10.0% total.

This required that (1) approximately 1% of the energy use of the building be renewable, (2) as an exception, approximately 2.5% of the energy use be solar-thermal (at the solar-thermal peak) or solar-thermal provide all of the hot water needs, or (3) as an exception, the building had to save additional energy. In response to comments from the public reviews and a change in some of the members of the committee, the committee changed the language to the current language in the 2009 standard, previously cited.

Although it must be recognized that each member of a committee votes yes or no for a particular reason that is generally not documented, the issues with the mandatory language from the 2nd public review were threefold.

First, to many on the committee, the requirement for on-site renewable energy was a severe cost burden. These members expressed opinions that each dollar that could be invested in on-site renewable could be invested in other energy-saving measures that were much more cost-effective. Those in favor of mandatory renewable energy requirements expressed opinions that mandatory on-site renewable energy requirements were in place in some European countries and that the way to drive down costs of renewable energy is to mandate it. Once mandated, costs would come down due to volume efficiencies and technological gains as demand increased. Furthermore, in order to meet the goal of net-zero energy buildings, on-site renewable energy will be necessary. Therefore, requiring a small amount now will cause designers to start incorporating on-site renewable energy systems and experience will be gained.

Second, the alternative requirement for 2.5% solar-thermal in the first exception seemed like a large amount for some buildings. Also, the requirement for 100% of the hot water demand seemed problematic for times when and locations where the solar-thermal has traditionally been required to have conventional back-up hot water.

Third, the alternate requirement for increased energy savings in the second exception meant that a whole building energy analysis would need to be performed. Without this provision, the standard allowed a prescriptive path that did not require a whole building energy analysis. These analyses generally cost at least $30,000 and often considerably more. It also seemed burdensome to require these analyses for building projects that did not have adequate access to solar or wind resources – the most common sources of renewable energy.

As a result, the committee developed the renewable-ready text in the mandatory section as a less-expensive, compromise position. Since the prescriptive section has requirements for on-site renewable energy (with an exception for shaded buildings), the only way to avoid using on-site renewable energy generation when using *ASHRAE 189.1-2009* is to use the more complicated energy performance path.

More on what renewable ready requires

The phrase "renewable ready" does not occur in the mandatory requirements in section 7.3.2 of *ASHRAE 189.1-2009*. To meet the mandatory requirement, provided above, the building design drawings must show allocated space, pathways, and associated infrastructure for generating electricity or solar-thermal of 3.7 W/ft^2, as a minimum rating, multiplied by the roof area.

Whereas the 2nd public review draft considered approximately 1% generation of energy from on-site renewables as sufficient, the requirement in *ASHRAE 189.1-2009* is based on how many photovoltaic arrays could reasonably be placed on a roof. This was calculated by assuming that photovoltaic arrays generate approximately 8 to 10 W/ft^2, and that slightly less than 50% of the roof area is available for photovoltaic arrays, assuming the other 50% of the roof space is for pathways and mechanical equipment. Although the calculation is based on photovoltaic arrays on a roof, the renewable energy source can be placed anywhere on the site. For a one-story building, the 3.7 W/ft^2 requirement can be 30% or more of the energy use of the building. For some one-story buildings, the renewable-ready requirement is three times more than that required in the prescriptive path. ASHRAE is currently in the process of changing the renewable-ready requirement so that it does not exceed the requirement in the prescriptive path in section 7.4.1.1 of *ASHRAE 189.1-2009*.

Although the requirement was calculated based on photovoltaic arrays on the roof, other methods of meeting the renewable-ready requirement include provisions for:

- Photovoltaic arrays within fenestration and on opaque walls, although these systems are generally not as efficient as optimally oriented systems on a roof
- Arrays on racks above parking or on window shades
- Solar thermal hot water systems located on roofs or elsewhere on the site
- Wind turbines designed for use on roofs or on the ground

The renewable-ready design for photovoltaic arrays, solar thermal hot water systems, and wind turbines must account for the additional structural loads of these systems. Solar-thermal systems require the design of associated tank(s) and piping between the collectors and the tanks. Wind turbines on roofs require the structural design of the building accommodate the appropriate loads and serviceability requirements, including lateral loads, torsion, and vibration.

Pathways from the energy source to the electrical panel (or to the point of hot water use for solar-thermal) are required. For photovoltaic arrays, this requires identifying pathways for the conduits from the arrays to the inverter, and then from the inverter to the electrical panel. Shading of one portion of an array can lead to significant losses in power generation from other arrays when they are connected in series. Therefore, shade is an important consideration when designing a photovoltaic system.

Exception to the renewable-ready requirement

Recognizing that some buildings projects do not have sufficient access to solar resources, an exception was added for buildings located in areas without specified amounts of annual solar energy and for buildings shaded by other buildings or structures, hills or mountains (topography), or trees. Specifically, it exempts building projects that have an annual daily average incident solar radiation, measured a specific way, of less than 4.0 $kWh/m^2 \cdot day$. This exempts portions of western Oregon and Washington, the upper Midwest, and New England, as shown below.

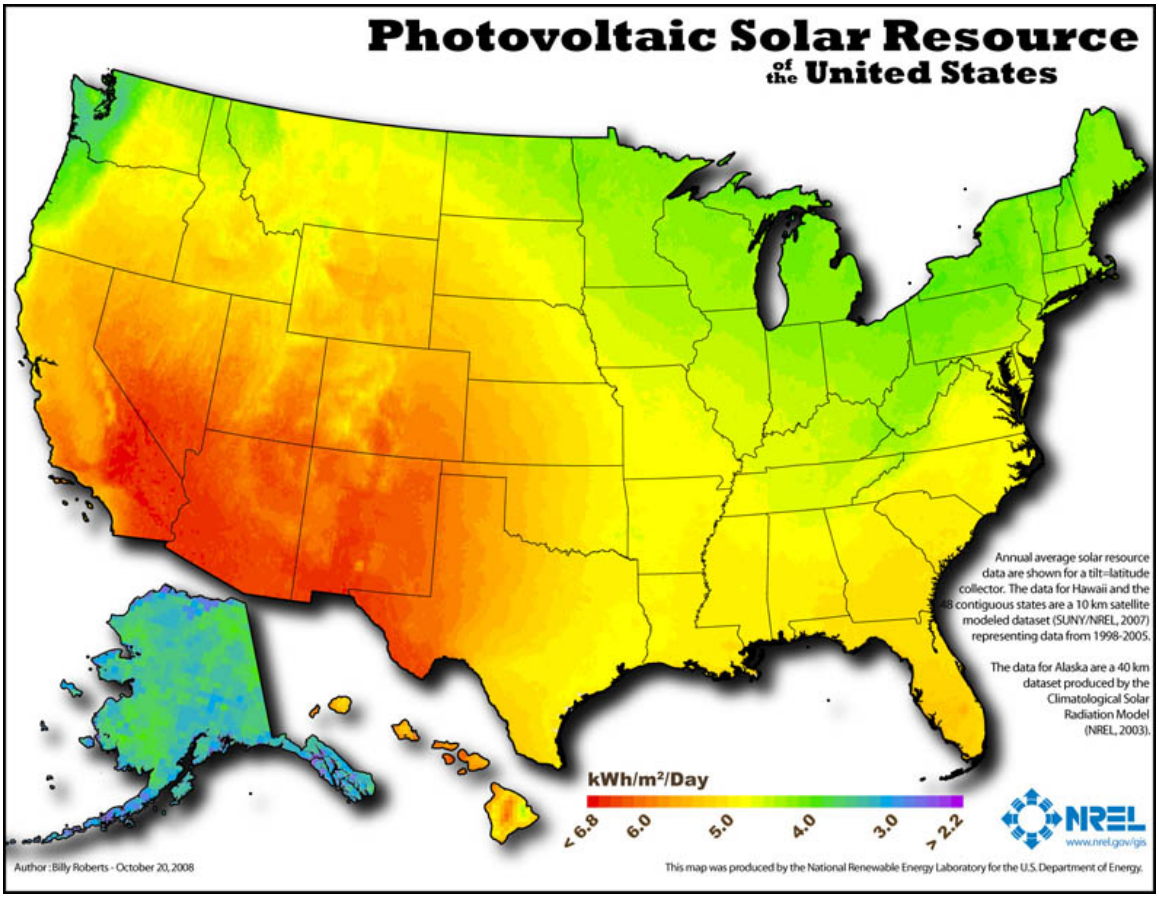
Additional advantages and disadvantages

In addition to the advantages and disadvantages of renewable-ready previously discussed, it is challenging to design for a renewable energy system before that system is chosen. The renewable-ready requirement will encourage the least expensive “renewable ready” pathways and infrastructure and not necessarily the renewable energy method that is most appropriate or cost effective for that building. Another disadvantage is that the term “associated infrastructure” in the standard is not specifically defined. It is not clear how much detail needs to be included in the design or on the design drawings.

Renewable ready can be viewed as an interim solution. The 189.1 committee made a determination on how far they could reach with a green building standard given the current state of renewable energy technologies – their costs, designer awareness, existing laws, and financial incentives. To meet the longer term objective of on-site energy generation, the U.S. government could support greater research in photovoltaic cells that can be applied/installed as the surface for all building materials, with the possible exception of vision glazing. The country's goal should be that the entire sunlit surface of all future buildings should be converting sunlight and daylight in general to power (e.g. electricity) or thermal energy (e.g. domestic water heating or swimming pool heating).

The U.S. government could also require that all new federal buildings, as well as substantial remodels to existing buildings, have on-site renewable energy power generation. This percentage could be steadily increasing over time.

In summary, the renewable-ready option in ASHRAE Standard 189.1-2009 is a compromise between cost-effectiveness and the ultimate goal of having on-site renewable energy in all buildings.



Source: www.nrel.gov/gis/solar.html