



CITY OF CAMBRIDGE
COMMUNITY DEVELOPMENT DEPARTMENT

BRIAN MURPHY
Assistant City Manager for
Community Development

To: Planning Board
From: CDD Staff
Date: August 16, 2013
Re: **Connolly, et al. Zoning Petition (“Net Zero” Greenhouse Gas Emissions)**

Summary of Proposal

The proposal would add new requirements to Articles 19.000 (Project Review) and 22.000 (Sustainable Design and Development) of the Zoning Ordinance. In summary, projects requiring a Project Review Special Permit (Section 19.20) would need to submit a Net Zero Emission Narrative and a Greenhouse Mitigation Plan in order to meet the following standard upon approval by the Planning Board:

All new construction or changes in use requiring Project Review Special Permits shall be required to report their energy usage in daily operation on a quarterly basis and purchase Massachusetts Class I Renewable Energy Credits (RECs) for any portion of such usage that is generated by non-renewable sources (net-zero).

The Greenhouse Gas Mitigation Plan could include the following measures:

- Design features meant to increase the energy efficiency of the building
- On-site renewable energy systems to supply energy for the building
- Purchase of off-site renewable energy
- Purchase of Massachusetts Class I RECs to account for the balance between on-site energy consumption (by tenants as well as owners) and on-site energy generation

Analysis

The proposed zoning aims to mitigate greenhouse gas emissions from new Cambridge buildings by encouraging increased energy efficiency and the use of on-site renewable energy systems. While the intent is consistent with Cambridge’s sustainability goals, there are many issues to consider in evaluating this specific proposal. In this memo, we have assembled the following information and commentary:

1. **Net Zero Buildings** – What this means and how it relates to Cambridge
2. **RECs** – How these are defined and used to support renewable energy
3. **Green Power** – How renewable energy can be purchased by consumers
4. **Sustainability Considerations** – How the proposal relates to broader City goals
5. **Zoning Issues** – Compliance, administration and enforcement of the requirements
6. **Potential Outcomes** – What the effects on new development might be

1. Net Zero Buildings

What is a “Net Zero Building”?

Conventionally, “net zero” is a term that refers to energy usage within a building. The terms “net zero energy building,” “zero net energy building” and “zero energy building” are used interchangeably. Although an exact definition is not provided in the proposed zoning, the Massachusetts Executive Office of Energy and Environmental Affairs web site provides the following definition¹:

A zero net energy building (ZNEB) is one that is optimally efficient, and over the course of a year, generates energy onsite, using clean renewable resources, in a quantity equal to or greater than the total amount of energy consumed onsite.

Although building energy is a significant component of greenhouse gas emissions, there is a conceptual difference between net zero energy and net zero greenhouse gas emissions or “carbon neutral” development. The text of the proposed zoning refers to “Greenhouse Gas Mitigation” strategies but appears to cite only energy efficiency and renewable energy strategies.

How is Net Zero Energy achieved?

The way that a building achieves a net zero energy goal is by balancing the energy consumed on the site with energy generated on the site.

- Reduced Energy Consumption: The building is designed and operated to consume as little energy as possible, making use of energy-efficiency practices such as insulation, daylighting, passive heating and cooling, heat recovery systems, maximally efficient mechanical systems and appliances, and geothermal heating and cooling (which consumes some energy but less than a conventional HVAC system). There are also factors aside from efficient design that influence energy consumption, including the local climate, the exact orientation of the site and of the building within the site, the type of building, plug loads and the usage habits of the building’s inhabitants.
- On-Site Energy Generation: The building or site includes systems that produce energy in a renewable way, most typically with solar photovoltaic (PV) cells, but in some cases solar heating or wind energy systems. Some types of on-site energy might be considered renewable but not necessarily carbon-neutral, including generators fueled by biomass or refuse, or fuel cells using natural gas. While these types of systems may contribute to a net zero energy goal, they might have other environmental impacts.

Net zero energy is most typically applied as a performance goal, and is unlike the LEED system, EnergyStar or other design rating that has specific criteria and an independent certification process. There is no accepted nationwide certification program for net zero energy buildings (although some organizations and jurisdictions are beginning to develop such programs), and no single definitive listing

¹ www.mass.gov/eea/energy-utilities-clean-tech/energy-efficiency/zero-net-energy-bldgs

of net zero energy projects. However, there are several different resources that catalogue net zero energy projects based on self-reporting, with different organizations focusing on different criteria.

A review of available resources shows that the number of net zero energy buildings in the United States is small, on the order of dozens. One resource, the U.S. Department of Energy's Zero Energy Buildings (ZEB) Database, lists only ten buildings, most of which are 5,000 square feet or less with some in the range of 10,000 to 20,000 square feet. Another resource, the German web site "EnOB" (Research for Energy Optimized Buildings), shows a map of international net zero energy buildings including approximately 37 net zero energy buildings in the United States, some of which are noted as being in the construction or conceptual stage².

We have reviewed information from various sources and have made the following general characterizations. As an appendix, we provide some additional information about projects that are 45,000 square feet or more and are described as net zero energy.

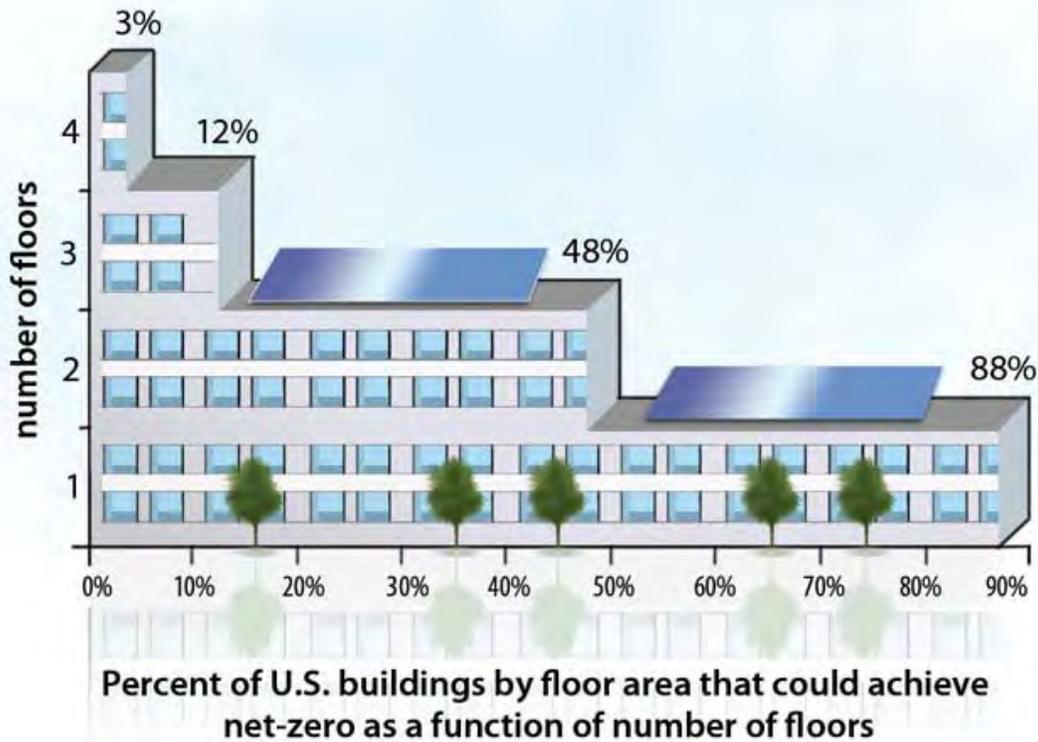
- Most net zero buildings to date rely heavily on the use of photovoltaic (PV) panels to generate electricity and geothermal systems to increase heating/cooling efficiency. This means that net zero energy projects are best suited for sites that are spread out horizontally to accommodate large areas of rooftop PV panels.
- Net zero projects are more achievable in temperate regions such as the western United States, where there are less intensive heating and cooling needs and more sunshine to support the use of solar PV. However, some scattered projects are found in the Northeast, the Midwest and the South.
- The types of buildings that have been able to achieve net zero energy tend to be those with lower energy demands, such as schools, residences, recreation centers and some office buildings. Net zero buildings also tend to be low-rise, which reduces energy needs for elevators, pumps and mechanical systems. Most of the projects tended to be small in size (less than 50,000 square feet), and those that are larger tend to use unusual energy sources such as nearby landfill gas or biomass systems.
- Net zero energy measures can add significantly to upfront construction costs. A review of available research by the New Buildings Institute³, citing a study by the Cascadia Green Building Council, indicates that energy efficiency measures can result in cost premiums of 5-15% while solar PV can add another 5-15% (p. 27) for commercial (mainly office) buildings. While some incremental costs can be minimized in smaller buildings, "In larger buildings, the costs of moving to advanced types of HVAC increased costs more significantly" (p. 31).
- Net zero energy improvements "pay back" their costs over time through reduced needs to purchase energy from utilities. However, in many commercial buildings, these energy savings may not be factored into project costs because ongoing energy costs are typically passed along to tenants.
- Many of the buildings that are characterized as net zero energy have institutional or public sector owners rather than commercial owners. There are a variety of reasons why institutional owners are

² www.enob.info/en/net-zero-energy-buildings/map

³ www.naseo.org/data/sites/1/documents/publications/Getting-to-Zero-Report.pdf

more likely to pursue this goal, including the ability to realize long-term cost savings (as noted above), more ability to control energy use, and harmonization with the goals of the institution.

A 2007 report from the National Renewable Energy Laboratory⁴ assesses the technical potential for achieving net zero energy buildings in the commercial sector. The assessment is based on energy efficiency and solar photovoltaic technologies the authors expect to be available by 2025. On this basis, the report finds that 80% of projects with one story will be able to reach net zero status; for two stories 48%; for 3 stories 12%; and for 4 stories 3%. Above 3 stories it is extremely difficult for a project to achieve net zero energy with technologies expected to be available in 2025 according to the NREL study. The study also found that laboratories rank last out of 17 building types that can meet zero net energy.



5

While the available information shows that net zero energy buildings are achievable as a concept, there is no set of standards that can be applied to all types of buildings on all possible sites. This could be a concern when applying net zero as a requirement for all large buildings, especially in a city such as Cambridge, where most sites do not have the characteristics (large lot areas, low-scale buildings, and favorable weather conditions) that contribute to the feasibility of net zero energy.

⁴ B. Griffith et al., "Assessment of the Technical Potential for Achieving Net-Zero-Energy Buildings in the Commercial Sector," NREL/TP-550-41957

⁵ <http://www.buildinggreen.com/auth/article.cfm/2010/7/30/The-Problem-with-Net-Zero-Buildings-and-the-Case-for-Net-Zero-Neighborhoods/>

2. RECs

What is a “REC”?

RECs were created as a regulatory compliance mechanism and are used in various jurisdictions around the United States. The specific way in which they are used varies state-by-state. The abbreviation usually stands for “Renewable Energy Certificate” but sometimes stands for “Renewable Energy Credit.” RECs are also created and sold in voluntary markets.

In concept, a REC is a virtual, tradable commodity that serves as “proof” that a certain amount of electricity (typically, one megawatt-hour per REC) has been generated by a renewable energy source. The REC is sold separately from the energy itself. Therefore, an energy generator can sell its energy to utilities at the prevailing market rate, and also receive a “bonus” by selling the REC. The REC represents the renewable energy technology by which the electricity was generated, as opposed to conventional energy generation. Utilities purchase RECs to comply with regulatory requirements, primarily “renewable portfolio standards.” Consumers also purchase RECs in regulated or voluntary markets to support green technology or for uses such as earning credits for green building standards such as LEED.

In Massachusetts, a REC is a “Renewable Energy Certificate” (although the proposed zoning uses the word “Credit”) and is a component of the Massachusetts Renewable Portfolio Standard (RPS)⁶, a state regulation administered by the Department of Energy Resources (225 CMR 14.000). The RPS requires that electricity suppliers obtain a certain percentage of the electricity they provide to retail customers from renewable generation units. Currently, the regulation is separated into “Class I” units, which includes solar photovoltaic, solar thermal electric, wind energy, small hydropower, landfill methane and anaerobic digester gas, marine or hydrokinetic energy, geothermal energy (not including ground-source heat pumps) and eligible biomass fuel. The current Class I requirement is 8% of electricity sold, and increases by one percentage point annually until it reaches 15% in 2020. A portion of the required Class I energy must be specifically from solar energy systems. A “Class II” regulation requires that a certain percentage must be purchased from other types of renewable energy or waste energy generators. The RECs are purchased by energy suppliers to certify that they have met the requirement.

Massachusetts is part of a regional electric grid managed by ISO New England and RECs are documented under the ISO’s generation information system. In the voluntary market, RECs are certified by third party organizations, with the Green-e program of the Center for Resource Solutions being the most prominent. A REC is not necessarily equivalent to a carbon offset, and there are separate voluntary, third-party certification programs for carbon offsets.

How much do RECs cost?

Because the Massachusetts RPS requires that a set quantity of RECs must be purchased, their price does not behave in the same way as RECs generated for the voluntary market, which are subject to supply and demand. Massachusetts also sets an Alternate Compliance Payment Rate that is charged to

⁶ www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/rps-aps/

suppliers who do not comply with the requirements by purchasing RECs, which places other artificial constraints on the price of RECs certified under the Massachusetts Class I RPS. As a result, there is a wide disparity in the price of Massachusetts Class I RECs and voluntary RECs (e.g., wind energy RECs from the Midwest). A Massachusetts RPS Class I REC currently costs roughly \$65, while a REC certified by another authority can cost \$1 to \$2. Also, since the Massachusetts RPS requirement increases every year, the price continues to increase.

Under the proposed zoning, the requirement to purchase RECs certified under the Massachusetts Class I RPS would be a significant cost to building owners, which would likely get passed along to tenants since it would be assessed on an ongoing basis. In addition, because it would add new demand for these RECs in a market in which demand is already set artificially high (and increasing) by the state regulations, it could increase the cost of RECs for electricity providers, which would get passed along to energy customers throughout the state, including residential and small commercial ratepayers.

3. Green Power

The petition recognizes the option for property owners to purchase electricity from renewable sources. NSTAR provides a green power option called NSTAR Green to residential and some small commercial ratepayers. The ratepayer can opt to pay a premium for electricity that is generated from wind farms in New York and New Hampshire for which the power and the RECs have been bundled. NSTAR Green is not available to large commercial customers.

Most large commercial customers purchase their electricity from competitive suppliers. NSTAR only transmits the power to the properties. Under competitive supply contracts, customers can negotiate for green power. However, this could take different forms, and could possibly involve marrying conventional power sources with RECs generated outside the ISO New England grid, resulting in a small additional premium for using green power. It would be possible for competitive suppliers to provide Massachusetts Class I RECs along with the power from conventional sources, or the contract could provide both power and RECs from a renewable energy source, and there would be a substantial cost difference in these approaches. It is not clear how the proposed requirements would apply to this type of scenario.

4. Sustainability Considerations

The proposed zoning requirement is intended to encourage energy efficiency and on-site energy in buildings, both of which would benefit the City's goals of greenhouse gas reduction. However, the concept of "net zero energy" does not always align perfectly with the City's greenhouse gas emission goals. There are some broader sustainability considerations that should be taken into account in evaluating the proposal.

- Cambridge is a densely settled community, and one of its overall sustainability benefits is the ability to share resources in close proximity. Requiring buildings to be self-sufficient in terms of their energy use may not be a feasible or desirable goal when distributed renewable energy systems and area-wide efficiency improvements may have greater benefits across a larger area.

- Because net zero energy on a site-by-site basis is most feasible on relatively large sites with relatively low-density development, the environmental goals of net zero energy buildings need to be weighed against the potential impacts of encouraging lower-density, “sprawl” forms of development.
- Although improving the energy performance of new buildings and increasing the amount of on-site renewable energy would help to minimize the increase in overall greenhouse gas emissions in Cambridge, the requirement of Cambridge property owners to purchase RECs may not have the same benefits. It is unclear whether the incremental investment of Cambridge owners would lead to additional renewable energy installations in the region. Cambridge accounts for approximately 2% of electricity demand in Massachusetts, so new development only accounts for a very small percentage of electricity demand for the region.
- New development is still a fraction of the overall building stock in Cambridge, and therefore reducing energy use in existing buildings may be imperative. Many of the City’s sustainability initiatives focus on reducing energy use in existing buildings across Cambridge. If Cambridge real estate owners, and the companies and residents who lease from them, are required to expend resources on RECs to support renewable energy generators such as wind farms and methane digesters across the Northeast, it could result in fewer resources to invest in sustainability initiatives in Cambridge.

5. Zoning Issues

The structure of the proposed zoning is unique compared to other zoning regulations, most of which can be met by following a straightforward set of building design and use standards. In some cases, discretionary findings must be made and a special permit or variance issued before a project can proceed. Zoning compliance is verified by reviewing plans before a project is permitted to be built or occupied. Unless a project is changed in the future, which would require a new building permit or certificate of occupancy, no ongoing review is required to ensure zoning compliance. The proposed zoning is different because it would require discretionary approval followed by a strict standard (energy reporting and purchase of RECs) that would need to be met after the building has been constructed.

The current zoning regulation that seems to be the basis for much of the proposed zoning text is the Traffic Mitigation Plan provision in Section 18.10 of the ordinance. Section 18.10 lists ongoing requirements that the Planning Board may require as part of traffic impact mitigation, such as subsidized transit passes and shuttle services. In the case of the Greenhouse Gas Mitigation Plan, the permittee may “consider and adopt as appropriate” mitigating measures such as increased building energy efficiency, on-site renewable energy generation, reporting on-site energy consumption and generation on a quarterly basis and purchasing of Massachusetts Class I RECs to “balance” the difference (which is listed in the proposed zoning both as potential mitigation and as a strict requirement), virtual net metering, and requiring compliance by tenants.

The proposal raises the following concerns with regard to zoning compliance, administration and enforcement that should be considered:

- Project Review/Approval: In order to comply with a zoning requirement, a property owner generally has to either meet a specific prescriptive standard or qualitatively demonstrate that a project meets certain criteria in order to receive discretionary approval. It is not clear whether the proposed requirements are prescriptive or discretionary. No specific criteria are enumerated, therefore it is not clear how the Planning Board would make a finding. It is also not clear how the Planning Board's review would relate to the prescriptive requirement to purchase RECs. For example, could the Planning Board approve some other measure, such as carbon offsets, in place of RECs? Conversely, if the developer meets the requirement to monitor energy and purchase RECs, could the Planning Board still reject a project on some other discretionary basis?
- Ongoing Compliance: There are many variable factors that might affect a property owner's ability to comply with the ongoing requirement to monitor energy and purchase RECs. Even when best practices are used, it is difficult to predict the energy performance of a building with a high degree of certainty, and similarly difficult to predict the cost and availability of RECs to be purchased. Also, in many buildings, energy use is controlled not by the property owner but by tenants, and only the property owner can be held responsible for zoning compliance. As a result, a property owner might not be able to accurately evaluate a building's level of compliance while at the design stage. Even if a project seems to comply at first, the future circumstances of the owner, future owners, or tenants may affect the ability to comply with the requirement over time.
- Administration and Enforcement: Under the proposed zoning, each new building subject to the requirements would need to undergo an ongoing administrative review, with reports that would need to be submitted and certified four times per year. Not only would this would require a significant increase in City resources to administer, it would put enforcement officials in a challenging position. Prior to construction, it is the property owner's burden to comply with zoning because otherwise, the project would not be permitted. After a building is completed, it becomes the City's burden to actively enforce compliance and to prosecute property owners who do not comply, which requires a different level of administration and different enforcement tools. When withholding permits is not an option, the only punishment provided by state zoning law is a fine of no more than \$300 per day per zoning violation. Even if the violation were the fault of a tenant, the City could only hold the property owner responsible, leading to possible multi-party conflicts. If a project fell out of compliance and required enforcement action, it could divert the City's resources away from other environmental initiatives in order to resolve legal conflicts.

6. Potential Outcomes

Affected Projects

All new projects subject to Project Review Special Permit requirements (Section 19.20) would be affected by the proposed new zoning. This would include nearly all projects of 50,000 square feet of floor area or more, whether they are residential, non-residential or mixed-use. (In some instances, the threshold is less than 50,000 square feet.)

Since Section 19.20 was adopted in 2001, the Planning Board has granted about 50 Project Review Special Permits, most of which have been completed or are currently in construction. This is an average rate of four or five projects approved per year. In total, Project Review Special Permits have accounted for about 5.7 million square feet of completed development, including:

- 1,600+ residential units
- 1.5+ million square feet of office/lab development
- 50,000+ square feet of retail space
- 1.3+ million square feet of institutional (non-residential) space
- 1,500+ dormitory beds

Another 4.1 million square feet of development is in construction and 6.5 million square feet more is permitted. Roughly half of the new development (by floor area) that has been built in Cambridge over the past ten years has received a Project Review Special Permit.

Benefits and Potential Risks

If the proposed zoning were to meet its intended goals, each new large project would meet the highest possible standards for energy efficiency and renewable energy generation, and property owners would develop the capability to continually report the project's energy use on a quarterly basis and compensate for any non-renewable energy consumption through the purchase of Massachusetts RPS Class I RECs. This would benefit Cambridge's sustainability goal to reduce non-renewable energy consumption, assuming that about the same (or higher) proportion of new development would continue to seek approval under the Project Review Special Permit requirements.

However, there are significant risks of unintended consequences that would need to be considered, including the following:

- Given the likelihood that many new large projects in Cambridge would not be able to feasibly achieve a net zero energy goal through improved efficiency and on-site renewable energy generation alone, projects would need to purchase large quantities of RECs to comply. While this might have some broader environmental benefits, it would not have as direct an impact on energy use in Cambridge buildings.
- The potential variability in the cost and availability of Massachusetts RPS Class I RECs could cause issues in two different ways. If the cost turns out to be too high or too volatile, it might make projects less financially feasible and result in developers putting off projects or seeking ways to avoid the requirements. If the cost turns out to be too low, it could encourage developers to "buy out" of the requirement rather than implement meaningful efficiency measures.
- If the cost or financial risk of projects becomes high enough – due to the added cost of efficiency improvements, on-site energy systems, and RECs – developers may be discouraged from investing in other public benefits, such as transportation improvements, utility improvements, open space or other initiatives.

- Rather than comply with requirements, property owners and developers may try to avoid them by “scaling back” projects or reconfiguring lots to stay below the Project Review Special Permit threshold. As a result, a smaller proportion of projects would be subject to the proposed “net zero” requirements, as well as the traffic mitigation and urban design requirements in Section 19.20, and the current green building standards for projects of 50,000 square feet or more (which is currently LEED Silver in most districts).
- Adding a set of requirements that impose ongoing and unpredictable costs may create a “market imbalance” for everyone with a stake in Cambridge real estate, including developers, companies and residents. More developers may decide to work in other communities where the standards are easier to meet. For projects that are built, future owners or tenants would bear the burden of the ongoing costs, resulting in higher rents for housing and office space. Because surrounding communities would not impose these ongoing costs, companies and residents may seek more affordable options outside of Cambridge. This trend could also increase prices for existing building space in Cambridge that is not subject to the requirements.

NET ZERO BUILDING DATABASE (~ >50,000 SQFT)

PROJECT NAME	SQFT	PARCEL (SQFT)	FL	USE/TYPE	STRATEGIES	LOCATION	DATE	HEATING DEGREE DAYS	COOLING DEGREE DAYS	CONSULTANT/ CERTIFICATION
J. Craig Venter Institute	45,000	76,200	3	Non-Commercial Laboratory	pv panels, natural day lighting and views, natural ventilation/passive cooling, 90,000 gallons of rainwater harvesting, native low-water landscaping, regional materials, green roof	La Jolla, San Diego	NC/2013	486	566	ZGF Architects
National Renewable Energy Laboratory	222,000	-	4	Laboratory	advanced heat recovery technologies, 1.6 megawatts of PV power, daylighting, natural ventilation, energy data center	Golden, Colorado	NC	3755	1664	Stantec - LEED Platinum
Pearl River Tower	2.3 mm	114,000	71	Offices	radiant cooling with floor-fed ventilation, triple glazing, motorized venetian blinds that follows the sun, integrated pv panels, vertical-axis wind turbine for electricity, four large opening for ventilation and increase in air speed, hydrogen fuel cells to store excess generated energy	Guangzhou, China	2011	-	-	SOM
UC Davis West Village	5.7 mm	-	4	Residential, Commercial	solar reflective roofing, radiant barrier roof sheathing, extra insulation, indoor occupancy sensors, daylighting techniques, web-based tool for energy monitoring , smart phone apps, 4 megawatt pv	Davis, California	2011	1798	1848	Chevron Energy Solutions
Goes Net Zero Energy Neighborhood	1.1 mm	-	2/3	Residential, Mixed-use	1.3 megawatt pv system, 5 mm btu geothermal system, optimize urban density and considered orientation, passive solar homes with air tight envelopes and heat recover ventilators, high in density	Arvada, Colorado	NC	3623	1764	David Kahn Studio - LEED Silver
Center of Excellence at Okanagan College	76,000	-	2	Education	ventilation chimneys, solatube skylights and sun-tracking light pipes	Kelowna, British Columbia	2011	-	-	Recollective Consulting
North Shore Community College Health and Student Services Building	58,700	-	3	Education	natural ventilation, lighting, green roof, building orientation, chilled beams, geothermal energy technologies and 340 kw pv panels harvesting solar energy, 50-well vertical geothermal closed-loop system. The demand is only 27 kBtu per sqft per year (normal: 60 - 80 kBtu/year) with the design	Danvers, Massachusetts	2011	4043	1247	LEED Gold
Bullitt Foundation Cascadia Center for Sustainable Design and Construction	52,000	-	6	Office	responsible site selection, 100% water needs provided by harvested rainwater , pv panels	Seattle, Washington	2013	3260	513	LEED Platinum
Electrical and Computer Engineering Building and University of Illinois	120,000	-	3/5	Education, Laboratory	300 kw pv cells, chilled beams system to cool and heat the classroom, occupancy sensors, 8 years payback	Urbana Champaign, Illinois	NC/2013	3625	2062	LEED Gold
Lady Bird Johnson Middle School	152,000	764,900	2	Education	increase insulation, rain water collection, high efficiency glazing, grey water harvesting, energy monitoring, energy star rated kitchen, laptop computers/wireless network, light harvesting/solar shading (light shelf), day light in classrooms, reduction in runoff via permeable paving	Irving, Texas	2011	1112	4473	LEED Gold
NASA Sustainability Base	50,000	-	2	Office	ground-source heat pumps from 72 geothermal wells , cut water usage by 90 percent, solar hot water collectors, data collection	Mountain View, California	2012	1198	932	LEED Platinum
University of South Carolina Darla Moore School of Business	252,000	-	4	Education	green roof, maximize natural light and shade for cooling, pristine air quality and control of heating, air and lighting in each space.	Columbia, South Carolina	NC/2013	1181	3359	LEED Platinum
Richardsville Elementary	77,300	-	2	Education	insulated concrete blocks , sensors, active daylighting strategies - solar tubes, light trays, pv panels	Bowling Green, Kentucky	2010	2174	2890	Energy Star/ LEED Gold
Solvis Factory Braunschweig	874,000	-	2	Commercial Factory	600 sqm of PV roof, electricity is supplied by a rapeseed oil combined heat and power plant, solar thermal collectors, daylight via a multitude of skylights	Braunschweig, Germany	2002	-	-	Banz & Riecks Architekten BDA

* NC = NOT COMPLETED

* Heating degree days: demand degree days for energy needed to heat a building

* Cooling degree days: demand degree days for energy needed to cool a building



Left to Right, Top to Bottom

1. J. Craig Venter Institute
2. National Renewable Energy Laboratory
3. Pearl Tower
4. UC Davis West Village
5. Goes Net Zero Energy Neighborhood
6. Center of Excellence at Okanagan College
7. North Shore Community College Health and Student Services Building



Left to Right, Top to Bottom

1. Bullitt Foundation Cascadia Center for Sustainable Design and Construction
2. Electrical and Computer Engineering Building and University of Illinois
3. Lady Bird Johnson Middle School
4. University of South Carolina Darla Moore School of Business
5. 5. Solvis Factory Braunschweig

