Solar Siting Committee

Town of Concord, MA

October 2011

Contents

Executive Summary

In October 2010, the Concord Municipal Light Board voted to adopt a strategy to develop 25 megawatts of utility-scale solar generation capability within the Town borders over a period of 25 years in 5-megawatt increments. Using current photovoltaic solar technology, this requires approximately 125 acres of land (i.e., five acres per megawatt). In response, the Board of Selectmen established and charged the Solar Siting Committee in early 2011 to identify and evaluate municipally owned land for the purpose of hosting ground-based solar arrays. This is the preliminary report of the Solar Siting Committee.

The Town of Concord and the Concord–Carlisle Regional School District together own about 848 acres of land in Concord in 73 parcels that are not designated as conservation land and/or are not protected by deed restrictions or other legal instruments. The Committee limited its focus to sites that could support at least one megawatt of power—i.e., at least five acres—to minimize the overhead cost of developing and operating the solar arrays.[1] Of the remaining available sites, the Solar Siting Committee has identified six as being suitable for hosting ground-based or utility-scale solar power systems and as worthy of further discussion and evaluation by Town government and residents. Together, these sites could accommodate approximately 12–19 megawatts of photovoltaic solar arrays. The Committee has also identified an additional three sites as suitable but for which legislative or regulatory hurdles exist.

The Committee undertook its assessment of available municipal land for solar power generation with an open mind. The list of sites presented below and described in more detail in the body of the report is a starting point for broader community discussion. For various reasons, all of the sites are likely to be

[1] The Concord Municipal Light Plant is launching a separate program for fostering smaller solar power installations on residential rooftops and backyards.

controversial. Most of them are forested, for example, and implementing solar power on them would necessarily involve cutting down trees. Some of the sites have other uses currently and/or are the subject of other planning efforts in Concord. The Committee also notes that the suitable municipally owned sites are insufficient to meet the Light Board's goal of generating 25 megawatts of power within the Town's boundaries.

Based on its findings, the Committee recommends that the Board of Selectmen:

- Determine how to find the 125 acres of land required to meet the Light Board's goal, either by using municipal land in combination with purchasing or leasing additional acreage, or by purchasing or leasing the entire 125 acres.
- Investigate the scope and impact of the regulatory hurdles that affect the Town's ability to use three of the sites identified in this report.
- Direct the Town's Planning Board to prepare a Solar Bylaw, modeled on the Department of Energy Resources' As-of-Right Zoning Bylaw (Appendix 8 and including the 50-foot setbacks (when abutting residentially zoned property) and the landscape, signage, and lighting requirements of the Town's existing Zoning Bylaw (see Appendix 9), for approval by Town Meeting.

This report includes in Appendix 9 a compilation of the written comments that the Committee solicited from Town boards, commissions, and committees, as well as from the public via an Open House and Forum held on September 14, 2011.

The following sites, some of which combine several parcels, were identified as possible sites for hosting solar arrays. They are listed in order of total parcel size, with the range of potential power that each could generate:

- Portions of the Concord–Carlisle High School site (in conjunction with the High School Building project): 94 acres, 1–2 megawatts.
- Portions of the White Pond Reservation: 40 acres, 3–5 megawatts.
- The former Town landfill site: 35 acres, Up to 5 megawatts.
- The southeast corner of the Sanborn School site: 31 acres, 1–2 megawatts.
- Part of the Wastewater Treatment Plant site, along with the fields and woods located immediately to the south: approximately 20 acres in multiple parcels, 2–3 megawatts.
- The Concord Municipal Light Plant site: 24 acres, 1–2 megawatts.

The following sites were also identified but have significant legislative or regulatory hurdles:

- The Benson Well site: 17 acres, 2–3 megawatts.
- A portion of the Jennie Dugan well site, in conjunction with the adjacent Sanborn School site (mentioned above): 13 acres, 1 megawatt.
- The wooded area immediately to the north of The Knoll at Sleepy Hollow Cemetery, along with part of the field south of the Wastewater Treatment Plant: approximately 10 acres in multiple parcels, 1–2 megawatts.

The two well sites were acquired for public water supply purposes and would need Department of Environmental Protection (DEP) and/or legislative approval

either to allow dual uses (solar and water supply) or to re-purpose them. The wooded area and field near the Treatment Plant are part of an identified Natural Heritage Endangered Species Program (NHESP) estimated habitat for Blanding's turtles.

These two lists were the result of a five-point ranking system that the Committee developed and applied to all parcels in excess of five acres. The rankings are:

A. Parcels that are suitable for hosting a utility-scale solar array of at least one megawatt and are worthy of further discussion and debate by the Town.
B. Parcels that satisfy the criteria of A-ranked parcels except for regulatory or legislative hurdles that prevent their immediate consideration.
C. Parcels that would be capable of supporting utility-scale solar arrays but that would have significant community impact and require substantial buffering or mitigation in order to be acceptable.
D. Parcels that are already fully developed for other municipal or school purposes, which would be expensive or impractical to relocate.
E. Parcels that are physically inappropriate for accommodating utility-scale solar arrays.

Because many of the sites are wooded or forested and would have to be cleared to host a ground-based solar array, the Committee evaluated the carbon and greenhouse gas impacts of solar arrays versus forested land. The Committee's research (documented in the body of this report) shows that a photovoltaic solar array in the climate and latitude of Concord offsets at least ten times the amount of carbon dioxide per acre each year that a mature forest of the same size can sequester. Similarly, a solar array maintains about two to eight times as much oxygen in the atmosphere per year than the forest could generate. Taking into

consideration only the production of carbon dioxide, solar is favored over woodland. However, the value of a forest in terms of habitat, recreation, and community benefit goes beyond sequestering greenhouse gases. It is for the people of Concord to determine the balance between creating a renewable energy supply and maintaining or advancing other community values.

As noted above, the total amount of municipally owned land identified by the Committee is not likely to be sufficient to support the Light Board's goal of 25 megawatts of solar generation in 25 years. Therefore, additional land may eventually have to be purchased or leased. It is outside the Committee's scope or expertise to set thresholds for the prices of land purchases or leases. However, the Committee suggests that these prices be evaluated in terms of cost per kilowatt-hour over the lifetime of an installation, based on information known at the time of the purchase or lease. Obviously, this threshold would change as the cost and efficiency of solar arrays changes over time and as the general price of electricity from other sources also changes.

The Committee has met bi-monthly from February 2011 through June 2011 and monthly from July through October. The Committee has conducted its activities in accordance with the Open Meeting Law and other relevant laws.

During this period, the Committee has:

- Developed a database of all Town- and School-owned land in Concord that is not designated as Conservation land (with the valuable assistance of Ms. Julie Vaughan, Senior Planner).
- Established criteria for evaluating such land for use for solar power generation, including a brief survey of applicable local bylaws of other communities.
- Developed a five-point A—E rating scale for ranking parcels for suitability for further consideration.

- Reviewed all parcels of at least five acres in the Town's GIS system and, based on its criteria and ranking system, conducted site visits to seven of them.
- Reviewed all parcels between one and five acres in the Town's GIS system for proximity to larger parcels in terms of solar potential.
- Circulated a draft Executive Summary for comments by Town boards, commissions, and committees, as well as by Town and School District staff. Received comments appear in Appendix 9.
- Submitted a draft report to the Board of Selectmen at the Selectmen's meeting on July 25, 2011.
- Prepared recommendations regarding setback requirements.
- Planned and conducted an open house at the Harvey Wheeler Center on September 14, 2011, to present maps of the identified A-ranked sites and to receive public comment. Approximately 60 people attended the open house. Comments and letters received at the meeting and afterwards appear in Appendix 9.
- Finalized this report of the Committee's findings.

Respectfully submitted,

Town of Concord Solar Siting Committee

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I. Introduction

The Solar Siting Committee was charged by the Concord Board of Selectmen with identifying and evaluating all municipally owned land within the Town of Concord to determine whether the Town has enough land suitable for hosting ground-based solar arrays, pursuant to the Municipal Light Board's 25-year, 25-megawatt solar strategy. The Selectmen's charge can be found in Appendix 2 on page 36. A copy of the Light Board's "Utility-scale Solar Strategy" and its broader renewable energy strategy can be found in Appendix 3 on page 45 and Appendix 4 on page 50, respectively.

The Committee was able to identify six parcels of municipally owned land capable of supporting about 12–19 megawatts of solar generation capability. However, all of this land already has other uses and purposes, and it will require a broad discussion within the Town to determine a balance between renewable energy generation and those other uses. A second conclusion is that even if the Town decides to commit all of the parcels to solar power generation, there is still not enough to support the 25-megawatt strategy. Therefore, additional land would have to be acquired at some point in order to complete that strategy.

The analysis and conclusions of the Solar Siting Committee are found in this document, which is organized as follows:

- The Executive Summary, beginning on page iii, is a brief summary of the conclusions of the Committee, a listing of the identified parcels, and a summary of the criteria that the Committee used to rank parcels.
- Section I is this introduction.
- Section II, immediately below, describes the criteria the Committee adopted to evaluate parcels of municipally owned land for the purpose of hosting solar arrays. The first list of criteria is comprehensive. The second

list, starting on page 5, is a distilled version of the first, and includes a five-point scale which the Committee used to rank the parcels it evaluated.

- Section III, starting on page 13, is a narrative description of the parcels ranked A, B, and C+ according to the rankings of Section II.
- Section IV, starting on page 22, discusses the relative impact on greenhouse gases of a solar array compared with an equivalent area of natural forest in Concord.
- Section V, beginning on page 25, is a brief discussion of power and energy to provide context for discussing the trade-offs of using land for solar arrays or for other purposes.
- Section VI, starting on page 35, provides a brief discussion of the financial considerations that would have a bearing on any Town decision to purchase, lease, or otherwise acquire land for the purpose of hosting solar arrays.
- Appendix 1, on page 36, is a full, annotated enumeration of all parcels of land owned by the Town of Concord and the Concord–Carlisle Regional School District that are not conservation land.
- Appendices 2, 3 and 4 have already been cited above.
- Appendix 5, beginning on page 66, contains excerpts of laws and regulations pertaining to conservation land.
- Appendix 6, beginning on page 69, outlines the state regulatory framework for well sites.
- Appendix 7, beginning on page 71, is a model bylaw developed by the Massachusetts Executive Office of Environmental Affairs.
- Appendix 8, beginning on page 81, sets forth the section of Concord's zoning bylaw on landscape buffers recommended for inclusion in the proposed Town solar bylaw.

- Appendix 9, beginning on page 82, contains the public comment on drafts of this report and to the presentations at the Committee's open house in September 2011.

II. Site Selection Criteria

The charge to the Committee included directives to "develop criteria for siting municipal ground-mounted solar installations" and to "develop prioritization criteria for each site including but not limited to: expected energy generation capacity, transmission efficiency, permitting requirements, environmental impacts, proximity to residential, competing uses, [and] other criteria." Accordingly, one of the first activities undertaken by the Committee was to determine a list of criteria for evaluating Town-owned sites as potential hosts of ground-mounted solar arrays.

Taking its lead from the Selectmen's charge, the Committee considered evaluation criteria that went well beyond considerations of solar power generation alone. The Committee was committed to identifying a comprehensive list of criteria that included potential competing uses for land parcels, impacts on neighborhoods, aesthetics, environmental impacts, and any other relevant factors. As noted elsewhere in this report, the purpose of establishing these criteria was not to come to a final recommendation as to which sites should be developed for solar-generated electricity. Rather, the purpose was to screen out those sites that are clearly inappropriate, and to list and rank those sites that do have potential while also keeping in mind other factors that will no doubt be relevant to the ultimate decision makers—Concord's citizens and their representatives.

The Committee developed two lists of criteria: the first is a detailed list that includes the full range of potential considerations relevant to siting solar arrays. The second is a distilled version of the first—a simplified scoring sheet for screening land parcels. Both of these lists are given below.

Comprehensive list of evaluation criteria

(Note: not all of these criteria are mutually exclusive. That is, some factors might be considered by more than one criterion. For example, the potential for agricultural use of a site is a factor in several of these considerations.)

PHYSICAL SITE CHARACTERISTICS			
	Consideration	**Comment**	**Evaluation**
P1	**Site Size and shape.** Size in acres, including combinations with adjacent available (town-owned) lots. The site's shape is also a consideration. For example, a long and narrow parcel, such as a former railroad right-of-way, would be unsuitably difficult to develop for solar electricity.	The larger the site, the larger the potential array and the greater the amount of electricity that can be generated. Present Light Board criterion is for a minimum of 5 acres, which can support an array that can generate about 1 MW of electric power with current technology.	• **Acceptable**: 5 acres or more. Site is not very narrow or irregular. • **Potentially acceptable**: can be combined with other parcels for 5 acres or more • **Unacceptable**: <5 acres. Narrow or very irregular shape (e.g., railroad right-of-way)
P2	**Quantity and quality of solar energy (solar irradiance)** available throughout the site.	The amount of solar energy that is incident upon a given land surface area is dependent upon several factors. These include latitude, which determines the angle of the sun and the hours of sunlight throughout the year, and the amount and density of cloud cover, which will reduce the amount of solar energy. Taking these factors into account, our region of Massachusetts averages about 3.7 kWH per square meter per day (+/- 20%) of solar energy This is about 1350 kWH per square meter per year.[2] Sites that are level, or slope generally south toward the sun are preferable to those that slope northward, away from the sun.	• **Acceptable**: mostly unshaded by vegetation or structures, flat or generally sloping south • **Needs further evaluation**: some shade, generally east or west slope, or moderate northward slope • **Unacceptable**: partial or full shade; significant northward slope

[2] NASA Surface Metrology and Solar Energy website, http://eosweb.larc.nasa.gov/cgi-bin/sse/sse.cgi?+s01#s01 l, (select 'Data tables for a particular location' and enter location data for Concord into on-line calculator). Accessed 25 July 2011.

P3	**Vegetation and shading** (on and off property)	Sites that are forested or covered with dense vegetation are less desirable for solar arrays because trees would have to be cut down and vegetation controlled in order to optimize electricity generation. (Even a partial shadow on a solar panel can reduce its generation capacity to zero.) Moreover, trees and other vegetation have value as species habitat and for recreational and aesthetic reasons. Trees and other plant life also absorb carbon dioxide and environmental toxins, thus helping to fulfill the objective that solar power is intended for. (See section V.)	• **Acceptable**: unforested. Solar array would have minimal impact on plant life. • **Needs further evaluation:** treed but judged possible to cut trees with minimal impact on neighbors or conservation • **Unacceptable**: site is forested and it is unlikely to be acceptable to cut trees; or major impact on other vegetation
P4	**Shading from nearby buildings and other structures**, and by local topography (on and off property).	As with shading by trees, shading from other structures or hills, even during part of the day, can substantially reduce the value of a solar array. Sites that are shaded by the presence of these elements were deemed unsuitable.	• **Acceptable**: no shading from nearby structures • **Unacceptable**: partial or full shading from nearby structures or potential building development
P5	**Proximity for interconnection to existing transmission lines** (the present electricity grid.)	Sites with close and easy interconnection to the electricity grid are preferable because their cost to connect them to the grid will be much less than sites that are distant, or whose terrain or other factors make them more difficult to connect.	• **Acceptable**: site borders right-of-way leading to CMLP interconnection point • **Needs further evaluation:** Is the site located near future grid expansion as outline in CMLP master plan (assuming such a document exists) • **Unacceptable**: site is land-locked and/or difficult and expensive to access CMLP interconnection location

P6	**Soils and ground stability.**	Because solar arrays are structures, they need stable ground upon which their foundations can be built. Access for maintenance vehicles is also a requirement. Loose or soft soils are less desirable, as are those on ledge or rock that would add complexity to building foundations.	• **Acceptable**: stable soil, or can be easily stabilized • **Needs further evaluation:** Soil testing recommended to determine soil bearing capacity and ground water elevation. • **Unacceptable**: unstable, loose, sandy, organics, etc. soils or exposed or shallow ledge
P7	**Topography and micro-climate.**	Level, dry sites are ideal. Irregular or hilly sites, or those prone to fog or seasonable moisture are less so.	• **Acceptable**: generally flat or moderate variation in terrain • **Needs further evaluation**: Soil and micro climate testing recommended • **Unacceptable**: very hilly, steep, or irregular terrain; or pockets in terrain that would trap fog; wetlands
P8	**Access for maintenance**	Although solar arrays require little maintenance, they still need occasional repair, upgrades, and cleaning. Thus, the best sites border public ways, and landlocked sites are much less desirable.	• **Acceptable**: site borders public ways and vehicle access can be incorporated • **Unacceptable**: landlocked site or otherwise difficult and expensive to provide access for vehicles

P9	**Regulatory / legislative issues**	Sites that are otherwise very suitable for solar arrays may be burdened with legal or regulatory restrictions. For example, current Massachusetts regulations prohibit any other use on sites designated as well sites for the public water supply.	• **Acceptable**: site is unencumbered by law or regulation • **Provisionally acceptable:** site is otherwise acceptable, but would require amendment to regulations or laws (e.g., designated well site) • **Unacceptable**: law or regulation prohibits use as solar site, and is unlikely to be changed
P10	**Other Physical factors**	Any other physical characteristic of the site that would affect its use for solar energy.	

HUMAN AND ENVIRONMENTAL INTERACTION CHARACTERISTICS			
	Consideration	**Comment**	**Evaluation**
H1	**Neighbors, abutters, zoning.** Current and future uses	The best sites are those with little or no adverse impact on nearby residents, neighborhoods, schools, businesses, or other neighbors. Those where a large solar array would be a major visual element, which might divide residents from one another, which might shade neighboring land, or have other negative impact were considered unsuitable. In this regard, the Committee attempted to make a subjective assessment of the magnitude of these impacts.	• **Acceptable**: (see comment, left) Site judged to have no adverse impact on any neighbors. • **Unacceptable**: (see comment, left) Site judged to have adverse impact on neighbors if used as solar site
H2	**Cultural or historical importance**	Few towns have as much reason to value history and culture as Concord. The Committee determined that the relative value of solar energy versus cultural or historical significance has to be evaluated on a case-by-case basis, but took care to note situations where this is likely to be a point of concern.	• **Acceptable**: site has no historical or cultural significance • **Unacceptable**: site is historically or culturally significant

H3	**Existing natural resources.**	Agriculture, recreation, forestry, and scenery are other, competing and valuable uses for land. So are vernal pools and wetlands, forest canopies, and beneficial understory vegetation. The best sites are those for which such uses are minimal or non-existent.	• **Acceptable**: use as a solar site clearly outweighs current natural resource use • **Needs further evaluation:** unclear whether present use or natural resources are more or less valuable than solar site. • **Unacceptable**: present or potential use for agriculture, forestry, recreation, or conservation land clearly outweighs value of solar site.
H4	**Impact on wildlife** and vice versa.	The Committee downgraded sites that provide unique species habitat, breeding area, or foraging range (such as for the Blanding's Turtle.). Conversely, sites that host wildlife activity that would be detrimental to a solar array, such as flocking birds, were also downgraded.	• **Acceptable**: site is not critical for species; not affected by wildlife • **Needs further evaluation:** Site shows some evidence of important habitat but needs further investigation to verify • **Unacceptable**: site is critical for wildlife; wildlife somehow would negatively impact a solar array.
H5	**Attractive nuisance appeal.**	Locations thought to be prone to vandalism were downgraded.	• **Acceptable**: site judged to have no attractive nuisance appeal • **Unacceptable**: site judged to have attractive nuisance appeal
H6	**Other Human and Environmental Interaction**	Any other factor related to human or environmental impact that could affect the site.	

	MUNICIPAL OR INFRASTRUCTURE CONSIDERATIONS		
	Consideration	**Comment**	**Evaluation**
M1	**Future expansion and compatible use potential.**	The value of solar electricity has to be weighed against other civic infrastructure such as wastewater treatment, roads, sidewalks, parks, buildings, and other facilities – whether these currently exist or could in the future. Included in this category is the potential for future expansion of a solar array.	• **Acceptable**: no present or anticipated infrastructure use • **Needs further evaluation:** Site is mentioned in town's Long Range Plan without a specific use • **Unacceptable**: site hosts present infrastructure facility, or is anticipated to do so.
M2	**Compatible and alternative land uses**	Another consideration of competing land use potential, this category includes agricultural, recreational, and affordable housing development, among others. In addition, the Committee considered where there existed a potential for multiple uses of the site, such as solar arrays combined with animal grazing or low plantings.	• **Acceptable**: site would not displace other valuable land use, or could be used together with other valuable land use. • **Needs further consideration:** unclear whether present or anticipated uses are more or less valuable than solar site. • **Unacceptable**: site presently used for another valuable use (see comment, left) or likely will be.
M3	**Permitting and Zoning**	Are there any issues related to existing zoning or permit requirements?	• **Acceptable**: no zoning restrictions that would affect a solar site • **Unacceptable**: zoning precludes use as a solar site

M4	**Town boundary issues**	Are there any potential difficulties due to abutting or nearby neighboring towns?	• **Acceptable**: solar array on site would no have adverse impact on neighboring town(s) • **Unacceptable**: solar array on site would have potentially adverse impact on neighboring town(s)
M5	**Other Municipal Infrastructure**	Any other factor related to municipal infrastructure that could affect the site.	

Five-point Ranking of Town-owned Parcels

Parcels were ranked according to the following five-point scale:

A. Sites ranked as A are considered by the Committee as prime possibilities to host utility-scale solar arrays. They are large enough and meet all of the criteria. Therefore, they are worthy of being presented for broader community discussion and for consideration by Town Meeting. The Committee identified six sites ranked as A. Considering the areas of each site that could be used for solar, which excludes existing buildings and uses, the Committee believes that these parcels contain a cumulative total of between 60 and 95 acres of possible space for solar arrays (i.e., between 12 and 19 MW, or roughly two-thirds of the Light Board's goal of 25 MW).

B. Sites ranked as B are considered by the Committee to be very good possibilities to host utility-scale solar arrays as potential dual uses. However, legislative or regulatory approval would be required before planning could proceed. The Committee identified three parcels containing a cumulative total of about 15-20 acres.

C. Sites ranked as C could host utility-scale solar arrays, but they would have a serious community impact—because of proximity to existing residences or for other reasons that would cause voters to prefer not to use them for solar. Much of the Town-owned land falls into this category. There were two parcels ranked as C+, both near Peabody School, because the Committee felt that, if

absolutely necessary, they could be used for solar purposes if sufficient buffering and other mitigation could be provided to reduce the impact on the school and neighboring residences.

D. Sites ranked as D are in use for other municipal or school purposes, and relocating those existing uses would be prohibitively expensive relative to the value of a solar array.
E. Sites ranked as E are considered physically inappropriate for solar arrays for a variety of reasons, including wetlands, inappropriate or excessive slopes, limited size after allowing for setbacks, or awkward shapes.

The Committee recommends that initial efforts be focused on parcels ranked as A. It is likely that the first two 5MW installments of solar arrays could be accommodated on these parcels. In parallel, the Committee recommends that the Town consider applying for state approval for dual uses in the Zone 1 areas around the Jennie Dugan well and the potential Benson Well. The Committee also recommends re-opening the question of the strip of woods on the Sleepy Hollow Cemetery property north of The Knoll and the "cornfield" in front of the Wastewater Treatment Plant. This is an attractive site for several megawatts, provided issues with Blanding's Turtles can be resolved.

Parcels ranked as C are debatable. Voters could decide to redirect them from their current uses and/or to adopt mitigation efforts to reduce the impact of solar arrays. Alternatively, voters could decide that it would be better for the Town to lease or purchase other land for the purpose of hosting utility-scale solar operations.

III. Annotations of Ranked Parcels

Parcels Ranked A

The following parcels are ranked A according to the scale outlined above. They are listed in order of overall size. The order of this listing does *not* indicate any preference by the Committee of any of these parcels over others of the same rank.

Concord–Carlisle High School

This 94-acre site is owned by the Concord–Carlisle Regional School District, not the Town of Concord. The Committee believes that a significant amount of solar generation—up to 2 MW—could be accommodated on this site. At this writing, conceptual plans and a site outline for a new building have been submitted to the Massachusetts School Building Authority (MSBA) and, if approved, will be brought before both the Towns of Concord and Carlisle for votes in the fall of 2011. The proposed new building will be located on the hillside, behind the existing building. When construction is completed, the existing building will be demolished, leaving a broad open space between the existing Beede Swim & Fitness Center and the community entrance to the new high school building.

Both the existing site plan and the proposed site plan include approximately five acres of parking lot, some associated with the Beede Swim & Fitness Center but most surrounding the school on the south side. The parking lots would be ideal locations for pillar-mounted "solar trees." In addition, the perimeter of the site faces Route 2 on the southeast and the MBTA commuter rail line on the southwest. Both are candidates for linear arrays of solar panels, perhaps mounted on pillars, which could cover a large area without interfering with school operations and playing fields. Finally, the Beede Swim & Fitness Center parking lot and the grassy area along the driveway toward the east provide potential additional space for solar panels.

The new school building is expected to consume approximately 2 million kilowatt-hours of electrical energy per year. Two megawatts of on-site solar generation would provide slightly more than this amount of energy per year. Therefore, this offers the tantalizing possibility of achieving "net zero" electrical energy usage by the Regional High School, a goal expressed by the Regional School Committee and the School Building Committee.

The Regional School District is a separate legal entity from either the Town of Concord or the Town of Carlisle, and therefore would be the likely owner of any solar array(s) on its site. This would provide the District with a reliable source of energy at a fixed, inflation-proof price to meet much of the high school's daytime needs for electricity. Any surplus would provide an additional source of revenue to offset the District's other energy bills. Such a clear financial advantage to the Regional School District would also benefit both towns.

The Committee recommends that the Light Board and Light Plant work actively with the Regional School Committee and the High School Building Committee to incorporate the space and infrastructure for solar arrays into the final plans. In addition, all interested parties should work together to seek additional funding — separate from the school construction costs — to make it possible to move toward this net zero goal.

Please see Appendix 9 for public comment on this proposed site.

White Pond Reservation

This 40-acre site is bounded by White Pond to the north, the White Pond Well site to the east, a residential development in the Town of Sudbury to the south, and the Bruce Freeman Rail Trail to the west. The Town purchased the site "for municipal purposes," and the Committee believes that it was once considered as a wastewater treatment site for the White Pond neighborhood.

The site itself includes some hills and steep slopes at the east end, but it is relatively flat on the west side. Many trails run throughout the site, and it is currently used for recreational activities such as hiking, horseback riding, and cross-country skiing. There are no buildings or formal, organized activities on the site. The only direct impact on neighbors would be to the houses in Sudbury abutting the Town line on the south side. The obvious connection to Concord's electricity grid would be at the White Pond Well, but it may also be possible to build a conduit under the rail trail.

An important consideration is the impact on the water quality of White Pond itself. An assessment would need to be made as to how the clearing of portions of the site to accommodate solar panels would affect the run-off and the water quality of the area.

The Committee feels that rather than convert the entire site to solar generation, pockets of solar arrays should be scattered throughout the site. This way, the network of trails could be preserved, along with much of the wildlife habitat. An access road would be needed for service, probably from the White Pond Well, to each of the scattered arrays. Also, a trench would need to be dug for the electrical connections back to the grid.

The Committee has been advised that the White Pond Advisory Committee is actively trying to secure funding to prepare a long-range plan for this site.

Public comment on this site appears in Appendix 9.

Former Landfill

The site of the former Town Landfill is about 35 acres on the south side of Route 2 at the intersection of Walden Street. A small part of it is currently used for composting and snow storage. The Committee believes that this is an ideal site

for up to five megawatts of solar arrays without interfering with current operations. There would be no impact on any residential neighborhoods, and it is sufficiently far from the Walden Pond State Reservation that it would not affect activities there.

One issue is state certification of a closed landfill. In the normal course of events, the Town does not expect this to be completed for a number of years. The Committee learned informally that the usual delay in such certifications is that the State Department of Environmental Protection (DEP) has severely constrained staffing and therefore has set its priories according to imminent needs. Committee members have been told that active plans for reuse of a landfill would raise the priority for DEP staff to do the permitting, so that permits are typically issued in a timely manner. Whether this is actually the case would have to be confirmed through official channels.

A second, more controversial, issue is the proposal and planning by the Walden Woods Project for this site. These plans envisage a wildlife corridor and crossing of Route 2, and they seem to exclude any Town operations, including the current uses, and any solar arrays. A discussion of a utility-scale solar facility on the site is likely to rouse a vigorous debate, with much invoking of the wisdom and legacy of Henry David Thoreau. That being said, the Committee is enthusiastic about using the former landfill for utility-scale solar power generation.

Public comment on this site appears in Appendix 9.

Sanborn School

The southeast corner of the Sanborn School site slopes downward from the level of the school building and large playing fields. The Committee estimates this broad, wooded, southerly and southeasterly facing slope to be 5–10 acres, enough for 1–2 megawatts. The foot of the slope reaches the edge of the lower playing field and abuts the Jennie Dugan Well property. The west end of the slope is at

the access road to the well. The slope is covered by mature woods comprising a mixture of pine and hardwood.

If a solar array were located on this slope, there likely would be no impact on any residential neighborhood, school operations, or playing field activities. Easy interconnections to the electricity grid are available at the school building and via the power line supplying the Jennie Dugan Well.

An extra opportunity for additional generating capacity is presented by the well site itself, which is ranked as a B. If a permit could be obtained from the DEP for dual use, the solar array could be expanded onto the Jennie Dugan Well property into the 400-foot DEP zone of influence.

Public comment on this site appears in Appendix 9.

Concord Municipal Light Plant

The main CMLP operations facility and equipment yard occupy the center of this 24 acre site between Route 2A and Route 2. Most of this land is forested, but a small triangle at the east end, adjacent to the gas station, is open. There is a long, narrow wetland on the northern edge, parallel to Route 2A.

The Committee estimates that at least five acres, possibly up to ten acres, of the CMLP site could be adapted for use for solar arrays, particularly if a permit could be obtained for minimal setbacks from the wetlands. Most of the land is to the east of the building, but a small area is possible on the west side of the driveway and a somewhat larger section is available at the west end of the property facing Route 2. A vegetative buffer would have to be provided to protect the homes in the Lalli Woods development, which abuts the site to the west.

Sleepy Hollow and Wastewater Treatment Plant area

This site comprises the existing fields in front of the Wastewater Treatment Plant

plus the wooded area immediately to the west and at the same level. These parcels were part of the Article 64 lease authorization voted by the 2010 Annual Town Meeting. In the summer of 2010, the Town issued an RFP and accepted bids for a solar vendor to lease the land, build a solar array, and sell the electricity to CMLP. The contract negotiations for this lease are still in progress.

The large field comprises about 20 acres of flat, open space separated from the Peter Spring Road neighborhood by the access road to the Treatment Plant. The wooded area is immediately north of The Knoll section of Sleepy Hollow Cemetery and west of the large field; it continues as flat terrain for about five acres before sloping to the west and down to wetlands.

The field is currently cultivated by a local organic farm, under contract with the Town. The southern third appears to be organic vegetable crops, the middle third appears to be some other kind of crop, and the northern third is a cover crop that provides a nesting habitat for Blanding's turtles. The entire site is listed as an NHESP (National Heritage Endangered Species Program) estimated habitat area. The Committee debated whether this site should be in category A or B based on this.

In addition, all or a portion of the field has been considered by the Wastewater Planning Task Force as a possible area for subsurface wastewater disposal.

Based on its size and level topography, this field would appear to be an ideal site for a large amount of solar power generation. However, it is also likely to be controversial because it is partly in agriculture and includes endangered species habitat. A vegetative buffer may have to be provided for the residences along Peter Spring Road.

The Committee considered whether a dual or triple use of this site might be possible. If the solar arrays were mounted high enough, on sturdy posts (in the

style of the solar arrays at Terminal B of Logan Airport, for example), and far enough apart, it might be possible:

- to continue to cultivate the field,
- to support subsurface wastewater disposal beneath the soil and between the posts, and
- to protect the Blanding's turtle habitat by mounting the panels far enough apart to provide plenty of warm areas in which the turtles can lay their eggs.

This would clearly be a less dense array, so that each megawatt may require more than five acres. It is worth additional discussion in the community and possibly a study by an outside consultant.

Public comment on this site appears in Appendix 9.

Parcels Ranked B

The following three parcels are ranked B. All three are attractive for solar arrays, but each presents a regulatory or legislative hurdle that must be overcome before being considered.

Portion of Sleepy Hollow and Wastewater Treatment Plant site

The flat, wooded five-acre portion and the northern third of the cultivated field would need permits in order to protect the NHESP-designated Blanding's turtle habitat areas. It is not known how difficult such a permit would be to obtain.

Benson Well site

The Benson Well property was acquired by the Town for a new well. However, no well has been developed, partly due to regulations that were adopted after the site's acquisition and partly because the Town has effectively managed its peak water demand. This is a very attractive property, mostly open field but partly

wooded. There would likely be no impact on any residences, and the property is not visible from the road. If properly developed, the site might support up to three megawatts. The nearest connection to the Concord electricity grid is on Balls Hill Road.

Town Meeting specifically voted to acquire it for water supply purposes. Therefore, to use it for a solar array, one of two things would need to happen. Either (1) the state would grant a permit for dual use of the property for both water supply purposes and solar generation purposes, or (2) Town Meeting would vote to re-purpose this land from water supply to electricity supply. Under the Committee's understanding of the law regulating sites for Public Water Supplies, the state Legislature would have to concur. This process would have to be verified with the Department of Environmental Protection.

Jennie Dugan Well site

This 13-acre parcel is almost completely taken up by the 400-foot DEP zone of influence around the well. The site itself is partly wetlands and partly dry. The dry portion abuts the lower playing field and sloped area of the Sanborn School site. It would be an attractive extension of a solar array on the slope behind the school. There would likely be no impact on the surrounding community, and there is easy access to a connection to the Concord electricity grid.

To make this happen, the Town must specifically apply to the DEP for a dual-use permit. There is no intention to stop using the site as a public water supply.

Public comment on these sites appears in Appendix 9.

Parcels Ranked C+

Many parcels in the Town's inventory of municipal property were ranked C. Two parcels listed in this section originally ranked A before the Committee visited them, after which Committee members reluctantly downgraded them to C+.

The two parcels in question are parcel #2999 and parcel #3000, representing the Peabody School site itself and the playing field on Old Pickard Road behind Peabody School, respectively. On the map, they would together form about 5–10 acres of area suitable for a solar array. Upon visiting them, it was found that the woods are thin and immature. There are a few abutting residences that can be seen from all points in the proposed area, and the area is also visible from across Old Pickard Road. Most importantly, the two parcels have a gentle slope to the north—i.e., the wrong way.

There is also a small stream crossing from the school toward the playing field, where it enters a drainage culvert. This stream has formed several pools. However, according to existing GIS data layers, there are no designated wetlands and/or certified vernal pools on the site.

If the Town should decide to use this combined site for a solar array, a vegetative buffer would probably have to be provided to shield the school and abutting residences.

IV. Setbacks

The Committee recommends that the Town adopt a solar bylaw based on the Department of Energy Resources Model Bylaw for large-scale ground-mounted solar installations (*see* Appendix 7). The recommended bylaw would include minimum 50-foot setbacks where solar abuts residential, plus a screening requirement consistent with the Town's existing zoning bylaw for residential sites.

In addition, the Committee recommends that the Town explore the possibility of requiring smaller setbacks from non-residential property lines, like major highways and railroads—with safety being the principal consideration in determining the amount of the setback. The Committee believes that perimeter siting—for example, along the corridor of the landfill, the Concord–Carlisle Regional High School, and the Light Plant—holds promise, but depends on latitude in setback requirements.

V. Greenhouse Gas Impact

Concordians understandably value the pastoral character of the town. Large portions of Concord are devoted to forests, open meadows, agricultural land, and other uses that are comprised primarily of vegetation of some sort. The installation of PV solar arrays, however, will necessarily displace some plant life, and several of the Committee's A-ranked sites are partly or completely forested.

Trees and other plants absorb carbon dioxide (CO_2), thus helping to alleviate the problem of global warming caused by the emissions of CO_2 from burning fossil fuels. Indeed, research estimates indicate that the amount of carbon stored in US forests is many times the carbon the US emits each year; deforestation around the world, especially in heavily forested areas of the earth like rainforests and northern Boreal forests, has been attributed as a cause for global climate change.[3] At the same time, the major motivation for considering the development of solar power is to avoid carbon emissions from burning fossil fuels to generate electricity. Thus, it is reasonable to ask whether a solar array is more or less effective in avoiding greenhouse gas emissions than leaving whatever plant life exists on a potential solar site.

Calculating the GHG benefit of a solar array is a fairly straightforward matter: the GHG emissions of various fuels has been studied and measured extensively, and data is easily accessible.[4] The Concord Light Plant purchases electricity generated by Natural Gas almost exclusively; Natural Gas produces approximately 1.3 lbs. of CO_2 for every KWh of electricity generated. As noted

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[3] *Intergovernmental Panel on Climate Change Special Report on Land Use, Land Use Change and Forestry*, available at http://www.grida.no/publications/other/ipcc_sr/?src=http://www.grida.no/climate/ipcc/Accessed 25 July 2011.

[4] US Energy Information Agency, *Carbon Dioxide Emissions from the Generation of Electric Power in the United States - July 2000*, available at ftp://ftp.eia.doe.gov/environment/co2emiss00.pdf. Accessed 25 July 2011.

earlier, a 5-acre, 1 MW solar array will produce about 1.15 Million KWh every year, thus displacing about 680 metric tons of CO_2 every year the array exists. Thus, **current solar technology will displace about 136 metric tons per acre per year**.[5]

Whereas solar arrays **displace** CO_2 emissions by avoiding the burning of fossil fuels, the carbon value of natural landscapes stems from the fact that plants and soils **absorb** CO_2. (Plants take in CO_2 in the process of photosynthesis, and give it off in respiration just as animals do. In general, however, the rate of absorption is greater than that given off in respiration, so most plants accumulate a net stock—they are a *sink*—of carbon.)

The carbon value of forests and other land uses is highly variable and dependent on a number of factors that differ from location to location. Data from scientific studies show great variation in the amount of carbon absorbed by trees and other vegetation; this appears to be an area of considerable current research by foresters, biologists, and climate scientists. While members of the Committee are not experts in this area, our literature search indicates that the sequestration rate of forests is considerably lower than the rate of CO_2 displaced by solar electricity generation. A 1992 study of carbon sequestration rates in Northeast US forests shows that, depending on the predominant tree species, **the rate of carbon sequestration in Northeast forests ranges from 0.10 to 0.20 kg per square meter, or about 3 metric tons of CO_2 per acre**[6], a small fraction of the 136 metric tons displaced by generating electricity with solar panels.

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[5] This presumes that the rate of electricity use is unaffected by the change to solar generation from more traditional methods such as natural gas-fired power plants. If Concordians were to start using more electricity from solar—a manifestation of the so-called "Rebound Effect" or Jevon's Paradox—this would negate some gains in GHG emissions reduction.

[6] Lloyd C. Irland, and Mike Cline, *Role of Northeastern Forests And Wood Products In Carbon Sequestration: Report to Northeast Regional Biomass Program CONEG Policy Research Center, Inc. New York State Energy Research and Development Administration College of Environmental Science and Forestry, SUNY,* February 20, 1999. Available at http://www.nrbp.org/pdfs/pub17.pdf. Accessed 25 July 2011.

There are some additional factors worth noting in comparing the carbon value of forests and solar arrays. First, as trees mature, their rate of carbon sequestration declines: developing forests have the greatest value in absorbing carbon. Moreover, the great majority—nearly two-thirds—of carbon sequestration by forests is by the soil, not the trees themselves, although trees constantly contribute to soil development by shedding leaves and woody material.[7,8] This suggests that the loss of carbon absorption when trees are lost can be significantly mitigated by maintaining vegetation, such as grasses or low plantings, that would not shade the solar panels. Examples exist of land devoted to dual uses of solar electricity and vegetation.[9]

The foregoing should not be taken to suggest that solar arrays should always trump other land uses such as forests, agriculture, or recreational fields. These other land uses have their own intrinsic values that solar arrays do not—as an example, one cannot eat the output of a solar panel. All such factors must be weighed against one another by the ultimate decision makers, the citizens of Concord and their representatives.

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7 Ibid.

8 W. M. Post and K. C. Kwon, "Soil Carbon Sequestration and Land-Use Change: Processes and Potential", *Global Change Biology (2000)* 6, 317–328.

9 See, for example, http://www.solarserver.com/solarmagazin/anlage_0606_e.html.

VI. Power and energy explained

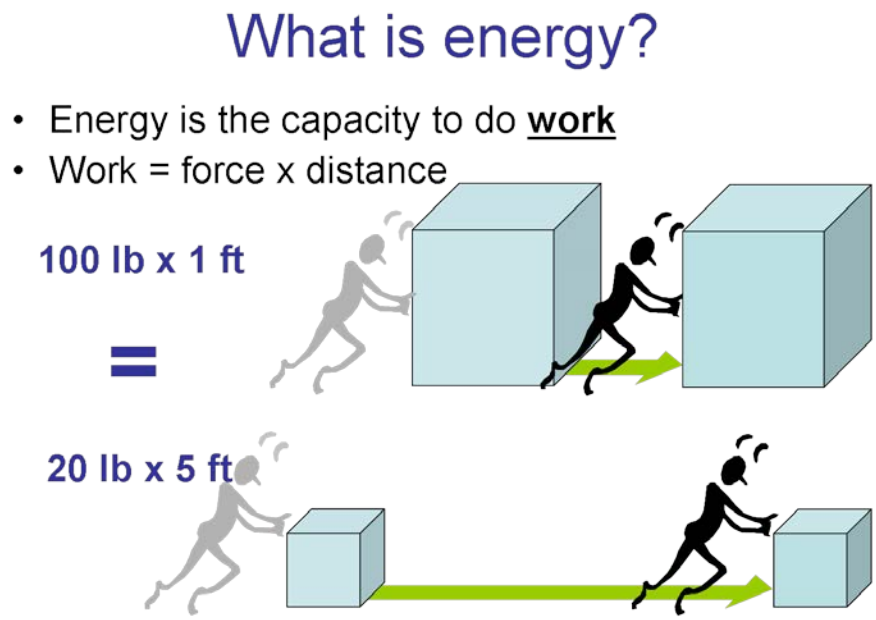
When discussing the size and rating of an electricity generating facility—whether a photovoltaic (PV) solar array or a conventional electric generating station like a coal-fired plant—one inevitably encounters technical terms like power, energy, watts, and other words that can be sources of confusion, and can even work against understanding if everyone does not understand them. This section is intended explain some important words and concepts in non-technical language.

In particular, for the purposes of this report it is necessary to clarify and distinguish the meanings of *power* and *energy*, as well as their units of measurement: *watts* (or kilowatts or megawatts) and *watt-hours* (or kilowatt-hours, etc.) In so doing, we hope to make clear how to express the generating capacity of solar PV arrays (or, for that matter, any kind of electricity generator.)

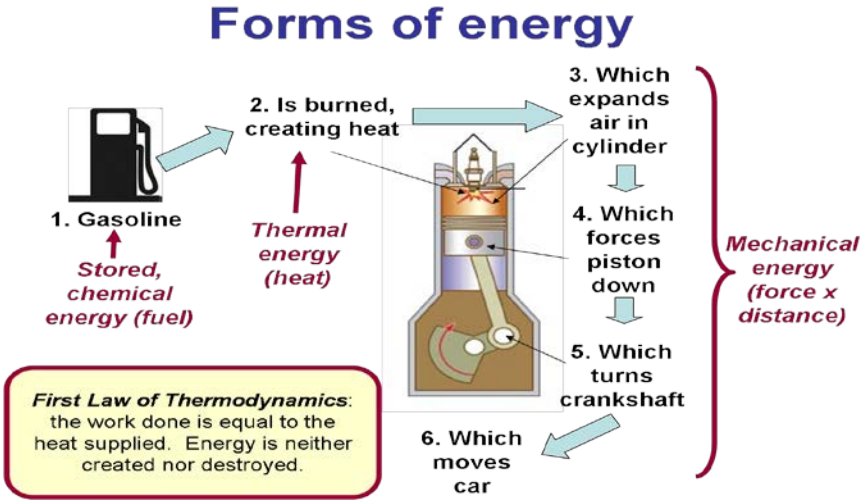
As an initial point, it is important to realize that, in the technical sense, *power and energy are not the same things*, even though, in everyday non-technical conversation, the two words are often used almost interchangeably. (For example, we may say the *power* company provides electric *energy*.) Though related, power and energy denote different physical quantities and are quantified with different units of measure.

What is energy?

Physics defines energy as the ability to do work. Work, in turn, is defined as the force applied to an object times the distance the object is moved. Thus, ***energy is what it takes to move something***.

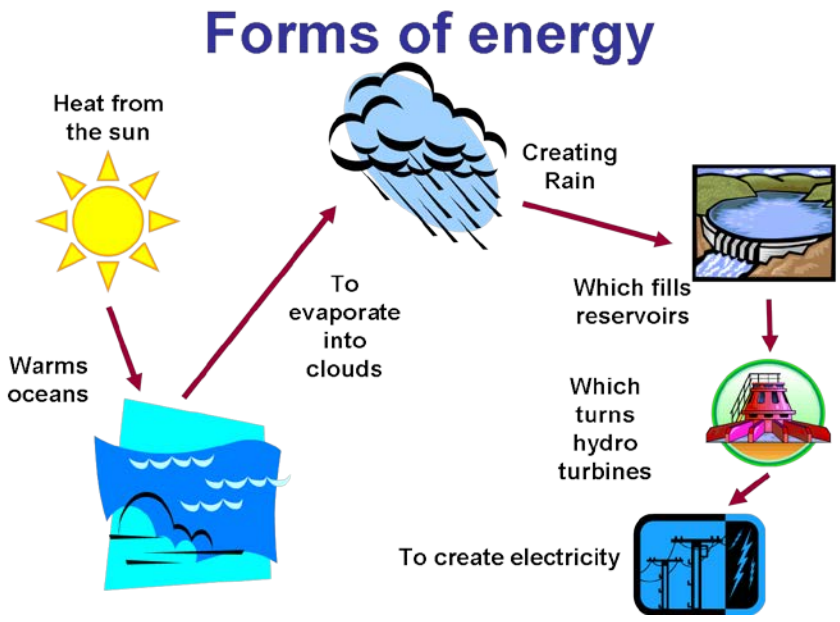


If we move a 100 lb. object 1 foot, we performed 100 foot-lbs. of work, meaning we have used 100 foot-lbs. of energy. If we had moved a 20 lb. weight 5 feet, we would have performed the same amount of work and used the same amount of energy. While this is a straightforward definition, it may seem somewhat limiting. We know, after all, that energy is used to light lamps, heat food on the stove, and perform many other tasks that do not seem to involve moving anything – how can these, too, be work or energy? The answer to this riddle is that energy can exist in many different forms that can be converted from one to another. A car's engine provides a good example of several energy conversions:

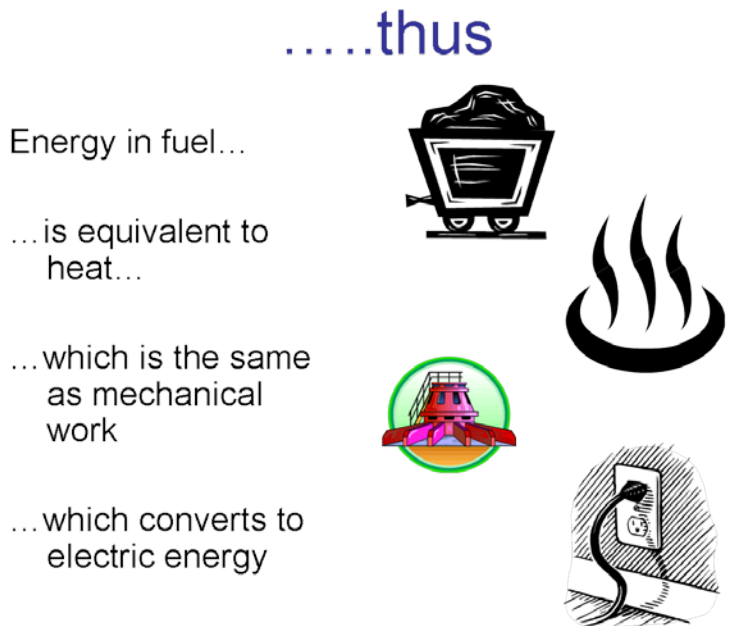


An engine like this can be put to many uses. Instead of moving a vehicle, for instance, it could be used instead for a small electric generator, which would create electricity to light a light bulb or heat a stove.

Ultimately, all of our energy on earth comes from the sun, and nature is constantly converting energy from one form to another:



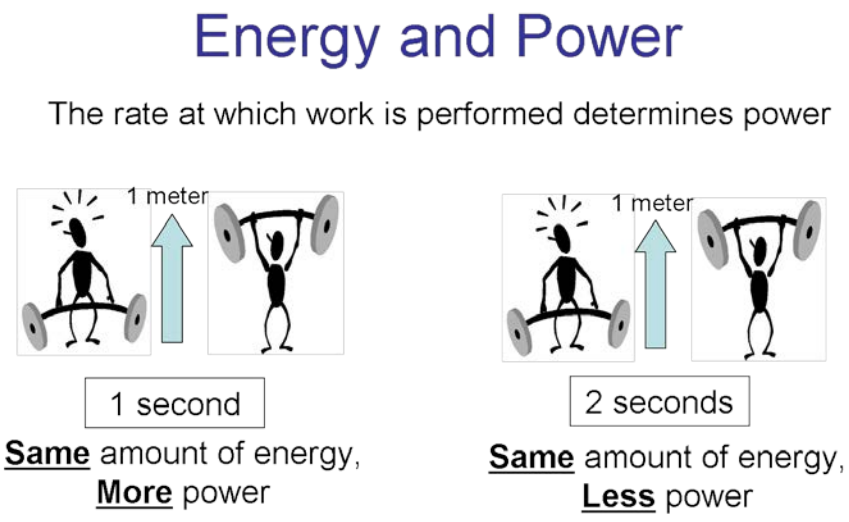
Hydropower, of course, is just one way to make electricity. More common is the use of fossil fuels, which were created long ago as living organisms that stored the sun's heat that enabled them to grow and live.



Solar photoelectric (PV) panels bypass the creation of fuel and heat; they take the energy in sunlight and convert it directly into electricity.

What is power?

Power is the <u>rate</u> at which energy can be converted from one form to another. Put another way, power involves the amount of ***time*** it takes to do work: higher power means that a given amount of work is done in less time.



Time is thus the dimension that relates energy and power:

- ***Power is the rate at which energy is used.***
- ***Energy is the product of power and the length of time it is employed.***

The time relationship between power and energy is analagous to the speed and distance traveled by a car: the car's speed is instantaneous – how fast it is traveling at a particular moment. Its distance traveled is the accumulation of the car's speed times the length of time it has been traveling. The car's speed, by itself, says nothing about how far it has traveled, nor does its distance traveled imply anything about its speed – unless you know about its time on the road. Similarly, power is also instantaneous – it is the capability of using energy at a particular moment. Energy is the accumulation of power times the length of time that power was employed. A device's power does not indicate how much energy it uses, nor does the energy it has used indicate its power – again, unless we know about the amount of time it was in operation. The importance of this distinction will be clearer when we consider units of measure.

Examples: Power & Energy

Energy = Power x Time (KWh = KW x Hours)

	Power	*Time used*	*Energy used*
	1000 W	15 min (.25 hrs)	1 kW x 0.25 hrs = 0.250 kWH
	4000 W	30 min (½ hr)	4 kW * .5 hrs = 2 kWH
	1800 W	5 min (0.083 hrs)	1.8 kW x 0.083 hrs = .15 KWH
	1200 W	8 min (0.133 hrs)	1.2 kW x 0.133 hrs = .16 KWH

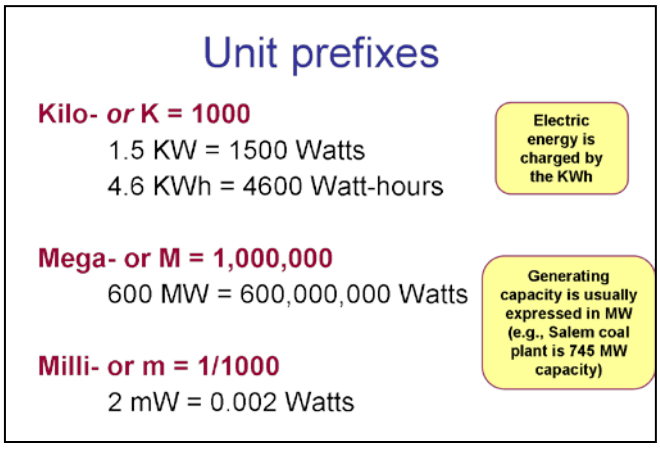
In the examples above, note that the *lower power* hair dryer uses a bit *more energy* than the higher power hair dryer, because it needs to be used longer.

Units of Measure for Power and Energy

The Watt is the familiar unit of measure that is used to quantify power. We know that a 100W light bulb will create more light (and heat) than a 40W light bulb. Watts can quantify both how much power is needed to operate a device (a large refrigerator might require 2000 Watts to run, while a smaller one might need only 1500 Watts), or how much a generating device can deliver. Thus, a gasoline generator rated for 1000 Watts can power 10 100W light bulbs. A similar generator rated at only 400 Watts can power only 4 100W bulbs.

Since energy is the product of power and the length of time it is employed, the units of energy are units of power times units of time: watt-hours. Thus, the energy used by a light bulb depends both on its power and the amount of time it is used: a 100W bulb that is on for 1 hour uses 100 watt-hours. A 40W bulb uses only 40 watt-hours of energy in an hour; in 2 ½ hours, it uses the same amount of energy as the 100W bulb in 1 hour. (Foot-lbs, the energy unit used in the initial example, are directly convertible into Watt-hrs—they are, like meters and feet, simply two different units for the same thing.)

Both watts and watt-hours are often preceded by the prefixes *kilo* or *mega* as a shorthand way of expressing large values: a megawatt simply means one million watts, and a kilowatt means one thousand watts. The fundamental unit—the Watt—remains the same. The same is true for watt-hours.



Solar panels and arrays are specified by their power, in watts. In other words, PV systems are quantified by the *maximum rate* at which they can convert sunlight into electricity. A typical solar panel today—a flat rectangle about 5 ft. x 3 ft. in area—has an electric power rating of about 100 Watts when it is fully illuminated with sunlight, so one such panel can power a typical incandescent light bulb. Many hundreds, or even thousands, of such panels are combined together to create utility-scale arrays like those being considered for Concord. A five-acre site can host enough panels in an array to generate about 1 megawatt (abbreviated MW) of electric power when the sun is shining brightly. However, this 1 MW rating only represents the array's *maximum instantaneous* generating capacity. At night when the sun isn't shining a solar array's power is zero. On a hazy or cloudy day, the power capability of a "1 MW" array will be much lower—perhaps 500 KW or 100KW, depending on the intensity of the sunlight. As the amount of sunlight varies due to changes in cloud cover or the sun's angle, the electric power available from the solar array will instantaneously vary, too. Never, however, will the solar array's power be greater than its maximum power rating.

Since factors like the cloudiness and the hours of sun per day all vary continuously, a PV array's *power* rating—such as our example of 1 MW—doesn't tell us much about how much *energy* it will produce; we have to take these environmental factors into account. Our 1 MW solar array in Massachusetts in December will produce, on average, about 2081 KWh of *energy* per day—the days in December are short, the sun is low in the sky, and December is a relatively cloudy month in Massachusetts. The very same solar array would produce about 3870 KWh in Arizona in December, because the air is clearer there, the sky is seldom cloudy, and the sun is higher in the sky because Arizona is farther south. In July, our Massachusetts 1 MW array can be expected to produce 3558 KWh per day, on average, while the same array in Arizona would produce about 4244 KWh per day.

So here is the bottom line: over the course of a year, the 1 MW PV array will produce about 1.15 Million KWh, +/- 10%, in Concord, or about 230 Thousand KWh per year per acre.[10]

How is electricity paid for?

Fundamentally, we electricity customers pay for the KWh we use: *we pay for energy*. Here in Concord, the Light Plant currently charges (in addition to a modest constant "meter" charge) $0.15910 per KWh up to 1400 KWh per month, with escalating cost rates for KWh used above 1400.

The Light Plant is a distributor of electricity; it does not generate electricity itself. Thus, the Light Plant buys electricity at wholesale from electricity generating companies – the companies that own and operate power plants. The rates the CMLP (and any large commercial or industrial customer) pays are not as straightforward as those for residential customers:

- Like any other purchaser of electricity, the primary charge the CMLP pays for is for the KWh (energy) it buys and resells to its customers.
- CMLP also pays *transportation charges*, which cover the cost of transporting electricity from power plants over transmission lines from distant power plants to Concord.
- CMLP also has to pay for power in addition to energy! This is because the need for electricity is "peaky", so generating companies have to maintain reserve capacity to be able to meet peak demand periods, such as on hot humid days when air conditioners are being used at their maximum. Most

10 The National Renewable Energy Laboratory, an agency of the US Department of Energy, has produced a convenient online calculator for determining the power produced by a photovoltaic array at any location in the US. This calculator, called PV Watts, was used with location data for Concord and Tucson, AZ to produce the values reported here. (These calculations assumed flat-plate collectors fixed at a tilt angle equal to the latitude of each location.) PV Watts is available at rredc.nrel.gov/solar/calculators/PVWATTS/version2/pvwattsv2.cgi.

of the time, this reserve power capacity is unused, But since this power is available if needed, the customers of the generating companies must pay for it.

A solar PV array built in Concord can save CMLP money in several ways:

- With today's technology, the PV array can generate energy (KWh) at a cost rate competitive with conventional plants like coal plants.
- Because it is in town and connected directly to CMLP's own grid, there are no transportation charges.
- PV arrays have the most power on sunny summer days – just when power peaks are most likely due to the need for air conditioning. This means that PV arrays help reduce CMLP's peak power requirements, thus reducing its power charge.

VII. Financial Considerations for Acquiring Property

There has been much debate as to whether the Town should purchase or lease property to host its utility-scale solar arrays. Obviously, any land that is considered for a lease or purchase should satisfy the criteria outlined in Section II.

With regard to financing, the driving consideration should be cost per kilowatt-hour over the lifetime of a solar array on that land. For example, if one acre could support a 200-KW array, it might be able to generate 250,000 kWh in one year or about 5,000,000 kWh in twenty years. If the purchase price of this one acre of land, including principal and interest, were $50,000, the cost would be 1¢/kWh. Likewise, if the cost of a lease were $2,500 per year, it would also cost 1¢/kWh per year.

It is outside the scope of the Solar Siting Committee to decide a suitable threshold for purchase or lease prices. That has to be determined by the Town Manager and Light Plant Director, with the advice of the Light Board, and in the overall context of the cost of purchased power and of offsets to capacity and transmission charges. In addition, it should be noted that publishing a threshold price or discussing it in an open meeting would likely compromise any active or future negotiations that the Town Manager might undertake regarding any land purchase or lease in Concord, not just for solar arrays.

Appendix 1 Listing of municipally owned parcels

This appendix includes four spreadsheets listing an inventory of municipally owned land in Concord that is not designated as conservation land. The listing is subdivided into four categories:

- Parcels greater than 5 acres with buildings
- Parcels greater than 5 acres without buildings
- Parcels less than 5 acres
- Parcels eliminated or protected

PARCEL_ID	OWNER	LOCATION	ACREAGE	RANK	NOTES	EXISTING USE
298	CONCORD-CARLISLE REGIONAL SCHOOL DISTRICT	500 WALDEN ST	93.75927456	A	School building and playing fields.	CCHS, fields, trees. This has a lot of possibilities in conjunction with the new High School building. There are at least five acres of parking lot, lots of rooftop, and plenty of other possibilities. Work closely with the CCHS School Building Committee to develop something mutually beneficial. They are open to such ideas.
3416-1	TOWN OF CONCORD	48B FITCHBURG TPKE	40.45	A	A very attractive site south of White Pond, with no impact on neighbors. MEETING NOTE: Type of protection being investigated	This was reputed to be permanently protected open space, but we are unable to turn up any formal protections or deed restrictions. Part of this land was once considered for wastewater treatment for the White Pond neighborhood.
4039	TOWN OF CONCORD	755 WALDEN ST	35.40720845	A	Very attractive site MEETING NOTE: Possible regulatory issue.	Landfill, Walden Woods Project.
3010-2-1	CONCORD PUBLIC SCHOOLS	835 OLD MARLBORO RD	31.29201102	A	School and playing fields. Sloped area on south side is wooded and used. Could be a possibility, esp. if combined with Jennie Dugan well site (3008-1). SITE VISIT MAY 6	Sanborn Middle School, fields, parking lots.
1999-1	TOWN OF CONCORD	1175 ELM ST	24.16655188	A	May be possible, even allowing for expansion of CMLP facilities. Also look at parcels 2010 and 1999, both owned by state. Use forested section to east of buildings SITE VISIT MAY 6	CMLP, trees.
1195	TOWN OF CONCORD	509 BEDFORD ST	5.5	A-	East side of Wastewater plant. Cell towers and filter beds occupy part.	WWTP. Part of this could be possible if combined with other parcels. This has the potential to add to the Article 64 array. The potential community impact of nearby residences could be mitigated with a vegetated buffer.
1213	TOWN OF CONCORD	34A BEDFORD ST	95.21999541	B	Part of this was bid for Article 64 array. Some upland, some wetland. Look at this carefully. MEETING NOTE: Investigate NHESP designation (for Blanding's Turtles)	Sleepy Hollow, forest. This is still a possibility, subject to the Endangered Species issues.
3008-1	TOWN OF CONCORD	97A OLD MARLBORO RD	13.38000459	B	Jennie Dugan well site. Could be usable if regulations allow. SITE VISIT MAY 6. Regulations being investigated.	W/S Facility - wetlands, lightly forested. This parcel is very attractive, and it would be worth pursuing a permit or waiver to put an array within the 400 Zone 1 radius. This would be combined with an array on parcel 3010-2-1, Sanborn School.

PARCEL_ID	OWNER	LOCATION	ACREAGE	RANK	NOTES	EXISTING USE
2999	CONCORD PUBLIC SCHOOLS	1231 OLD MARLBORO RD	7.98964646	C+	School Building. Possible use of south corner if combined with part of #3000 SITE VISIT MAY 6	Peabody Middle School, parking lots, trees. See notes on parcel 3000 on adjacent sheet. It might be possible to do something with these two parcels together.
221	CONCORD PUBLIC SCHOOLS	91 LAUREL ST	27.02582645	D	School building and playing fields. Strip along southwest side might be usable, esp. if combined with parcel 217. Partial use possible?	Alcott Elementary School
3476	CONCORD PUBLIC SCHOOLS	185 POWDER MILL RD	18.90273186	D	School building and playing fields. Potential partial use? SITE VISIT MAY 6	Willard Elementary School, rooftop solar
2476	CONCORD PUBLIC SCHOOLS	29 PRAIRIE ST	18.00137741	D	School and playing fields fully occupy this site	Thoreau Elementary School, fields, parking lots
4187	CONCORD PUBLIC SCHOOLS	120 MERIAM RD	17.75792011	D	School building and playing fields	Ripley School, ballfield
186	TOWN OF CONCORD	26A STOW ST	14.00137741	D	Public park and playground	Emerson Playground
2244	TOWN OF CONCORD	61 LAWS BROOK RD	11.00222681	D	Active playing fields and playground	Rideout Playground
1682	TOWN OF CONCORD	141 KEYES RD	9.70913682	D	Public Works yard	CPW Complex, HDC
1198	TOWN OF CONCORD	40S BEDFORD ST	8.96999541	D	Wastewater treatment plant and CPW storage yard. A few acres possible on southwest corner	WWTP
3646	TOWN OF CONCORD	363 OLD RD TO 9 AC COR	29.51000918	E	HCL: Deaconess well site. Very wet. SITE VISIT MAY 6	Deaconness WTP, wetlands, forest
1986-6	CONCORD PUBLIC SCHOOLS	14A STRAWBERRY HILL RD	19.29237833	E	Buffer surrounding Finigan Way neighborhood	Finigan Way, wetlands, trees
3417-2	TOWN OF CONCORD	205 HEMLOCK ST	18.61446281	E	White Pond well. Rolling terrain. Forested, hilly, conservation land.	W/S Facility - wetlands, forested
220	TOWN OF CONCORD	416 WALDEN ST	8.69618916	E	South end is part of Hugh Cargill well site. May be usable with regulatory permission and combined with part of #221 and 217. Not part of community garden. SITE VISIT MAY 6	
2971-3	TOWN OF CONCORD	3 FOREST RIDGE RD	5.6	E	Main CMLP substation; possible area on north side. MEETING NOTE: Remaining space too small	CMLP Substation, forest

PARCEL_ID	OWNER	LOCATION	ACREAGE	RANK	NOTES	EXISTING USE
1374-1	TOWN OF CONCORD	26A BALLS HILL RD	17.11999541	B	Benson Well site; not currently in use; purchased for water purposes	forested, wetlands
3000	CONCORD PUBLIC SCHOOLS	7B OLD PICKARD RD	9.96000918	C+	Playing field occupies flat area on east side. Rest of parcel is a possibility, which could be combined with south corner of Peabody School lot (1231) MEETING NOTE: Considering only the part not used by playing fields SITE VISIT MAY 6	Fields adjacent to Peabody Middle School. There is a stream running through the middle of it, with some pooling. However, there are no registered wetlands or vernal pools on this site. On one hand, the land slopes the wrong way. On the other hand, it may be possible to do something if there is sufficient buffering of neighboring properties.
3479-1	TOWN OF CONCORD	139A SUDBURY RD	27.5	C	Former Howe Land. Willow Guzzle, currently farmed (corn) by Verrill. MEETING NOTE: Check on type of protection	Permanently protected open space, wetlands
477	TOWN OF CONCORD	10A RIVERDALE CIR	22.49912764	C	Playing field on north side. Some wetlands. MEETING NOTE: Check on type of protection SITE VISIT MAY 6	Permanently protected open space, wetlands
1196	TOWN OF CONCORD	50X BEDFORD ST	13.36999541	C	Reserved for future WWTP expansion; not currently in use Potential dual use? MEETING NOTE: Check on status of WWTP planning	WWTP - leaching beds
4185-2	TOWN OF CONCORD	11A OLD BEDFORD RD	12.71999541	C	Rear of Burke Land (recently acquired); currently in agriculture. MEETING NOTE: Check with Delia Kaye (NRC).	
4209	TOWN OF CONCORD	33X OLD BEDFORD RD	11.83002755	C	Major impact on neighborhood; community garden; not much area left after setbacks.	Ammendolia Land
1201	TOWN OF CONCORD	40R BEDFORD ST	11.3	C	Part of "cornfield" along with #1200. Ideal for solar.	WWTP - organic farm
1200	TOWN OF CONCORD	40W BEDFORD ST	9.1	C	Part of corn field. Ideal for solar.	WWTP - corn field?
1986-5	CONCORD PUBLIC SCHOOLS	41A BARRETTS MILL RD	7.47137282	C	Highly conspicuous farm field at corner of Barretts Mill and Strawberry Hill Roads. MEETING NOTE: Historic District	Farm
1965-1-6	TOWN OF CONCORD	76B STRAWBERRY HILL RD	7.98000459	D	East side of Bateman's Ridge Road. MEETING NOTE: Check on nature of protection	Permanently protected open space, forested. This is protected by deed restriction.
1397-19	TOWN OF CONCORD	6A MONUMENT FARM RD	14.56000918	E	Vegetated buffer around Monument Farm neighborhood. 50 feet deep on west, very narrow on south, too small on east. Too wet?	Odd shape, wetlands, forest.

PARCEL_ID	OWNER	LOCATION	ACREAGE	RANK	NOTES	EXISTING USE
3080	TOWN OF CONCORD	42B OLD RD TO 9 AC COR	14.31000918	E	Looks very wet from map. Part of Deaconess Well field.	Wetlands, forested.
2970-1-10	TOWN OF CONCORD	8X FOREST RIDGE RD	12.2	E	Vegetated buffer separating Camp Thoreau from Thoreau Hills neighborhood on east and from Nuclear Metals on north. Not much area after setbacks. Very forested.	Very oddly shaped, forested parcel.
1249	TOWN OF CONCORD	40X BEDFORD ST	10.2	E	Former RR right of way; potential rail trail in future	Long, skinny right of way.

PARCEL_ID	OWNER	ST_NUMBER	ST_NAME	ZONE	ACREAGE	Contiguity	Notes
0069-4-4	TOWN OF CONCORD	4B	WAYSIDE RD	B	4.98	none	partly wet, residential, ridge
3182	TOWN OF CONCORD	30Y	POWDER MILL RD	AA	4.70		shown as Conservation Land (?)
2709	TOWN OF CONCORD	141	HARRINGTON AVE	B	4.61	Town-owned land	
222	TOWN OF CONCORD	24B	WALDEN ST	A	4.34		Agriculture, Wet, Flood
3418	TOWN OF CONCORD	14X	HEMLOCK ST	A	4.00	Town-owned land	Wet, Flood
3101-2	TOWN OF CONCORD	14Y	JENNIE DUGAN RD	AA	4.00	near Sanborn	Wet
1701-1	TOWN OF CONCORD	7B	MAIN ST	B	4.00	none	municipal lot
2022-1	TOWN OF CONCORD	49B	LAWS BROOK RD	B	3.80	none	long, skinny piece at Acton border
1979	TOWN OF CONCORD	40Y	ANNURSNAC HILL RD	AA	3.38	none	
217	TOWN OF CONCORD	42A	THOREAU ST	A	3.37		Agriculture
1197	TOWN OF CONCORD	49X	BEDFORD ST	B	3.31	WWTP	NHESP, Flood
1199	TOWN OF CONCORD	40E	BEDFORD ST	B	3.20	WWTP	"triangle"
1202	TOWN OF CONCORD	49A	BEDFORD ST	B	3.20	WWTP	NHESP, Wet
809	TOWN OF CONCORD	40	STOW ST	C	3.00	none	Emerson Umbrella
4083-2	TOWN OF CONCORD	53Y	LEXINGTON RD	A	2.90	none	Wet, Flood
2447	TOWN OF CONCORD	1276	MAIN ST	C	2.74	none	Harvey Wheeler Community Center
4286	TOWN OF CONCORD	341	VIRGINIA RD	A	2.53		Agriculture, Wet, Flood
3977	TOWN OF CONCORD	720	MAIN ST	C	2.11	none	CMLP
1249-2	TOWN OF CONCORD	18A	MONUMENT ST	A	2.04	WWTP	ROW
93	TOWN OF CONCORD	32B	LEXINGTON RD	B	2.00	none	Wet, Flood
2991-7	CONCORD PUBLIC SCHOOLS	68B	POWDER MILL RD	AA	2.00	vacant land	
1261	TOWN OF CONCORD	34B	MONUMENT ST	A	1.86	none	Caesar Robbins relocation site
1332	TOWN OF CONCORD	47B	LOWELL RD	A	1.80	none	NHESP, Wet, Flood
1213-1	CONCORD HOUSING AUTHORITY	39A	BEDFORD ST	B	1.61	Sleepy Hollow	residential
3479-2	TOWN OF CONCORD	128A	SUDBURY RD	AA	1.60		Agriculture
240	TOWN OF CONCORD	209	WALDEN ST	A	1.59		Public Safety Building
1971-2-15	TOWN OF CONCORD	12X	CHANNING RD	AA	1.59	vacant land	partly wet
1260	TOWN OF CONCORD	31B	MONUMENT ST	A	1.50	none	Parking lot by MMNHP
2891-836	TOWN OF CONCORD	32Y	BORDER RD	A	1.47	vacant land	odd shape
133	CONCORD HOUSING AUTHORITY	34	EVERETT ST	C	1.37	none	residential
0050-4	TOWN OF CONCORD	11B	CHESTNUT ST	B	1.24	none	residential
797	TOWN OF CONCORD	129	MAIN ST	B	1.20	none	Library
10	TOWN OF CONCORD	7A	MONUMENT SQ	C	1.16	none	Town House
1693	TOWN OF CONCORD	12	MAIN ST	B	1.13	none	downtown
1039	TOWN OF CONCORD	50A	BEDFORD ST	B	1.00	ROW	NHESP, Flood, Wet
1749	TOWN OF CONCORD	32B	NASHAWTUC RD	A	1.00	none	residential

PARCEL_ID	OWNER	LOCATION	ACREAGE	NOTES	EXISTING USE	Reason for elimination
3419	TOWN OF SUDBURY	48Y FITCHBURG TPKE	15.50	SITE VISIT May 6	Gravel pit and cell tower	Owned by Town of Sudbury
1965-1-6	TOWN OF CONCORD	76B STRAWBERRY HILL RD	7.98	East side of Bateman's Ridge Road.	Permanently protected open space, forested.	Protected by deed restriction
0319-1	CONCORD HOUSING AUTHORITY	282 THOREAU ST	7.50	Abuts Walden Terrace neighborhood on east and Fielding St. neighborhood on west.	Affordable Housing, rear is entirely wetlands	Owned by Housing Authority, not Town of Concord
1968-6-1	CONCORD HOUSING AUTHORITY	151 STRAWBERRY HILL RD	3.01	none	residential	Owned by Housing Authority, not Town of Concord
147	CONCORD HOUSING AUTHORITY	115 STOW ST	2.93	Peter Bulkeley	residential	Owned by Housing Authority, not Town of Concord
3476-1	CONCORD HOUSING AUTHORITY	145 POWDER MILL RD	1.70	Next to Willard School	residential	Owned by Housing Authority, not Town of Concord
247	CONCORD HOUSING AUTHORITY	275 WALDEN ST	1.62	Next to District Court	residential	Owned by Housing Authority, not Town of Concord

Appendix 2 Charge by Board of Selectmen (December 13, 2010)

A. Purpose

The purpose of the Solar Siting Committee is to identify preferred locations for ground-based solar installations with attention to balancing the competing land use needs in the Town and to provide a forum for the discussion of criteria for siting utility-scale solar installations on municipally owned land in Concord.

B. Membership

The Solar Siting Committee shall be comprised of five residents of the Town appointed by the Board of Selectmen each for a term of one-year as follows:

One member representing the Municipal Light Board
One member representing the Comprehensive Sustainable Energy Committee
One member representing the Planning Board
One member representing Concord CAN
One member with interest / knowledge in energy or land use representing citizens at large.

C. Background

The Concord Municipal Light Board in conjunction with the Light Plant (CMLP) is developing a strategy for renewable energy sources. Within that larger strategy is a Utility Scale Solar Strategy to develop approximately 25 megawatts of solar generating capacity in Concord in units of approximately 5 megawatts deployed incrementally at intervals of five years. Using the current land requirements of approximately five acres per megawatt of capacity, the implementation of this strategy will require about 125 acres of land in several locations.

For the Town to be positioned to proactively implement the installation of utility-scale solar arrays, it is important to establish criteria for the preferred location of these installations.

D. Duties and Responsibilities

1. To meet regularly for a period of six months and elect a chair and clerk.
2. To develop criteria for siting municipal ground-mounted solar installations including minimum setbacks from residential property lines.
3. To identify town owned parcels of land large enough for the installation of 25 megawatts of solar energy generation as a single or multiple parcels developed concurrently.
4. To develop prioritization criteria for each site including but not limited to: expected energy generation capacity, transmission efficiency, permitting

requirements, environmental impacts, proximity to residential, competing uses, other criteria.

5. To develop a GIS map showing locations of sites.
6. To seek comments from relevant staff and town committees and the public on advantages and constraints of each parcel.
7. To develop a recommendation for installations of utility-scale solar.
8. To develop criteria for land that the Town may purchase or lease for solar generation.
9. To prepare a report on the committee's recommendation for installing utility-scale solar on Town owned land within six months of appointment and to report to the Selectmen the results of the committee's investigations with a recommended course of action.

E. Other considerations

The Solar Siting Committee is responsible for conducting its activities in a manner that is in compliance with all relevant State and local laws and regulations, including but not limited to, the Open Meeting Law, Public Records Law, and Conflict of Interest Law. The Committee shall consult with the Town Manager concerning the allocation of town staff or financial resources toward this project.

_____

Jeffrey S. Wieand,
Chair

Appendix 3 CMLP Utility-scale Solar Strategy (October 2010)

This is a summary of the Concord Municipal Light Plant long-term strategy for *Utility-scale* solar power. It is part of a larger strategy for renewable energy sources being developed by CMLP and the Light Board that is discussed in a separate document. This document is intended to provide additional context for the Article 64 discussions regarding large solar arrays within the Town of Concord.

An overall goal of the Concord Municipal Light Plant is simple — to obtain as much of its electrical energy as possible from renewable sources, subject to the constraints of cost, reliability, and availability. Achieving this goal will take a long time — several decades or more — and there are many obstacles along the way. One area in which Concord can to do something proactively and practically on its own initiative is installing photovoltaic arrays within the Town's borders to capture the solar energy.

The term *utility-scale* is used to refer to arrays of solar panels measured in units of megawatts (millions of watts) of electrical power. This is in contrast to residential rooftop and backyard units, which are usually a few kilowatts (thousands of watts), and also in contrast to arrays on municipal, commercial, and institutional roofs and parking lots that are measured in tens of kilowatts. Rooftop solar is a complement to utility-scale solar, not a substitute. It is also part of the CMLP renewable energy strategy but not part of this document. Likewise, wind power is also part of the renewable energy strategy but not part of this document.

Utility-scale Solar Strategy

The CMLP long-term utility-scale solar strategy is

TO DEVELOP APPROXIMATELY 25 MEGAWATTS OF SOLAR GENERATING CAPACITY IN CONCORD IN UNITS OF APPROXIMATELY 5 MEGAWATTS DEPLOYED INCREMENTALLY AT INTERVALS OF ABOUT FIVE YEARS.

Twenty-five megawatts would power more than half of Concord's peak electrical load on the hottest days of the year and most of its midday load on cooler sunny days. This will go a long way toward providing firm capacity to meet Concord's peak demand, thereby mitigating the need to upgrade or supplement the Forest Ridge substation and the transmission lines from Sudbury to Concord.

Incremental deployment at regular intervals has many advantages:–

It helps to manage the financing, so that the funds (and risk) are not committed all at one time but are spread out over time. This will keep the average cost per kilowatt-hour low and will avoid spikes in the electricity rates.

It allows Concord to take advantage of new technologies as they emerge. Obviously, an already installed array is frozen at a particular technological state, but all future arrays can benefit.

Not all of the solar generating capacity would reach the end of useful life at the same time, so that when an old array needs to be replaced, it can be replaced with very modest impact on rates and the newest technology.

Incremental deployment gives the Light Plant a chance to build up the organizational expertise in accommodating solar power into its systems, its operations, and its rate-setting policies.

Intervals of about five years fit nicely with the projected 25-year lifetimes of solar arrays, and they provide the Light Board and CMLP staff a reasonable break after deploying one increment before preparing for the next increment.

Five megawatts per increment is large enough to amortize the staff and committee effort of preparing Requests for Proposals, evaluating bids, and negotiating contracts. A smaller increment would require the same amount of effort but would produce correspondingly less electrical energy and capacity for that effort. Larger

increments would require larger blocks of financing at one time and would tend to reduce the benefits of incremental development.

Financial Considerations

Almost the entire cost of electricity from solar panels is in the capital cost of the installation. Operating costs are estimated to be negligible. In late 2010, the installed cost per watt of large-scale solar arrays is just under $5 per watt, but this is mitigated by government subsidies and by Solar Renewable Energy Credits (S-RECs) funded by fossil fuel customers of investor owned utilities. Subsidies come and go with politics, legislation establishing the S-REC market is currently valid for ten years, and the S-REC market could easily become quite volatile and could expand to public power utilities. Therefore, it is recommended that *for the time being*

> UTILITY-SCALE SOLAR ARRAYS BE FINANCED BY LEASING AND POWER PURCHASE AGREEMENTS SIMILAR TO THOSE PROPOSED FOR ARTICLE 64.

This puts all of the risk and uncertainty of subsidies and S-RECs onto the vendor in exchange for the ability to profit by their upside potential.

When the price of solar panels drops below a certain threshold — say, $2 per watt — it becomes financially attractive for Concord to own and operate its own solar arrays with little risk. In Concord's climate and latitude, each watt of capacity produces about 1¼ kilowatt-hours (kWh) of electrical energy per year. Assuming a 25-year life, depreciation would cost about 6.4¢ per kWh and interest on debt service would add about 2.5¢ per kWh to the average cost over the life of the array. This cost is unsubsidized and is well within what CMLP currently pays for electrical energy.

Therefore, it is recommended that when the capital cost of solar arrays drops below a threshold to be established by the Light Board

> FUTURE UTILITY-SCALE SOLAR ARRAYS MAY BE OWNED AND OPERATED BY CMLP AND BE FINANCED BY BONDS AUTHORIZED BY TOWN MEETING.

S-RECs AND OTHER SUBSIDIES ACCRUING FROM IN-TOWN SOLAR GENERATION SHOULD BE USED TO PAY DOWN THE DEBT, THEREBY REDUCING INTEREST COSTS AND THE AVERAGE COST PER KILOWATT-HOUR.

It should be noted that solar generation within Concord will reduce transmission charges paid to ISO New England and will also reduce Concord's obligation to make forward capacity purchases. These reductions are *not* figured into the cost of owning and operating our own arrays, but they will benefit the Town when CMLP rates are established.

Finally, when we start implementing Town-owned solar generation, depreciation should be set up in order provide for the renewal and replacement of arrays as they reach the ends of their useful lives. Until more experience is obtained, the depreciation rate should be set at 4%, representing a 25-year useful life per panel. By collecting depreciation every year and by accelerated payments of bonded debt, Concord will gradually build up an asset base of solar generation capability that will eventually fund its own replacement from its depreciation charges.

Land Requirements

Solar arrays currently require about five acres per megawatt of capacity. This might drop slightly with improved technology, but it will not change dramatically. Therefore, twenty-five megawatts of solar capacity will require about 125 acres of land, preferably not all in one location. Currently, there seem to be two immediate options:–

The W. R. Grace land in the southwestern end of Town. This former Superfund site is particularly attractive because it is large and flat, and there are few, if any, others in Concord interested in this land.

The Massport land located in the eastern end of Town. Massport has a priority of keeping residential developments away from flights path of aircraft, but they seems to be open to considering other low-level uses of the land.

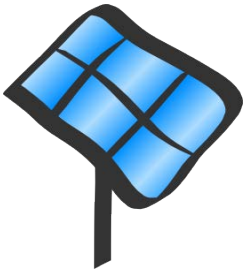
The Town Manager, the Board of Selectmen, the Light Board, and other committees need to collaborate on acquiring or gaining access to these sites and/or identifying other suitable properties. Some longer term options include:–

The Landfill. While attractive, this is located close to Walden Pond and would interact with the Walden Woods group's long-term vision for the area. Even if agreement could be reached with the Walden Woods interests, permitting would require 1-5 years.

The Starmet Superfund site in the southwestern end of Town. The cleanup of this site is not nearly so far along as that of the W. R. Grace property. Also, the property is more hilly.

Town well sites. We should pursue the question of dual-use of these sites with the state. If they eventually allow passive solar arrays in combination with well use, we might consider it. However, the study and analysis would take years before a reasonable conclusion could be reached, and state regulators are understandably cautious about drinking water supplies.

Appendix 4 CMLP Renewable Energy Strategy (January 2011)



Concord Municipal Light Plant
Renewable Energy Strategy

January 2011
Version 1.1

Purpose of this Document

The purpose of this document is to present the Light Board's current understanding of renewable energy opportunities and considerations and to recommend a strategy for increasing renewable energy sources within Concord's energy supply. This document is not intended to present a detailed set of action plans, but rather an overall set of strategies (see page 3) that will be prioritized and further developed with associated goals, plans and policies. The Light Board welcomes comments from the Concord community. Please send your comments to LBchair@concordma.gov.

Renewable Energy Strategy Overview

This section is a summary of the Concord Municipal Light Plant (CMLP) long-term strategy for sourcing renewable energy. The full-length document provides more details about each of the subjects mentioned here. Here, the focus is on power *supply;* other sustainable energy topics such as energy conservation and efficiency efforts are part of CMLP's *demand* strategy.

Current Power Supply

The following table displays Concord's current energy purchases by fuel source for the 12-month period ending August 31, 2010.

Fuel Type	Contract	Expires	Annual MWh	% of Supply
Natural Gas	Morgan Stanley	2013	130,000	74%
	Braintree	2029	10,000	6%
	Spot Market	Ongoing	16,000	10%
Landfill Gas	Granby LFG	2013	7,500	4%*
Hydropower	Miller (Maine)	2013	5,500	3%*
	NY Power Authority	Ongoing	6,000	3%*
Total			175,000	100%
*renewable				

CMLP's current renewable energy portfolio is about 10%, including hydropower facilities, and increases to 13% in 2011 if both the Spruce Mountain (Maine) wind contract and the Concord Wastewater Treatment Plant solar contract come to pass.

The current Massachusetts Renewable Portfolio Standard (RPS) is 5% in 2010, increasing 1% per year to 15% in 2020. Existing hydropower facilities are not included in MA's measure of renewable energy. While CMLP is not currently obligated by law to meet the MA RPS, our general objective is to obtain as much of our electricity as possible from renewable, sustainable, or environmentally-friendly sources as possible. Our particular objective is to consistently meet or exceed the Massachusetts Renewable Portfolio Standard.

Future Power Supply

The Light Board recommends that CMLP commit to increase the renewable energy portion of its energy supply portfolio from 10% in 2010 to 20% by 2015 and 30% by 2020. Each 10% increase in renewable energy will reduce CO2 emissions by 15 million pounds (7,500 tons) annually.

Renewable energy sources generally have several positive attributes, including the following:

- Essential environmental benefits – fewer CO2 emissions and less air pollution
- Predictable and stable cost structures – less exposure to fossil fuel price fluctuations
- Immediate cost reductions – reduced transmission costs when energy is produced locally, and reduced forward capacity charges when peak consumption is reduced by local power generation
- Low long-term costs – renewable energy sources are becoming increasingly cost-effective when viewed over the life of the energy source

Renewable Energy Strategies

Specific strategies to achieve the goal stated above include the following:

1. Move rapidly to implement in-town solar power generation at all levels: residential, municipal, commercial and utility-scale.
2. Research, evaluate, and take an active role in developing wind power sources in New England.
3. Work with Energy New England (ENE) to aggressively pursue other cost-effective renewable energy contracts.
4. Monitor emerging technologies and assess potential for use by CMLP.
5. Develop and implement a formal Energy Conservation strategy.
6. Develop a financial strategy that supports energy conservation and renewable energy plans. A key activity is to determine whether CMLP should purchase power or own renewable energy facilities – "buy vs. own", and how CMLP will increase its renewable energy supply and promote conservation while continuing to provide reliable and affordable power to its customers.
7. Monitor developments in plug-in electric vehicles.
8. Update the CMLP Power Supply Manual as appropriate.

It is expected that each of these strategies will be further analyzed in detail and associated tactics, plans and policy implications identified.

Definition and Benefits of Renewable Energy

Renewable energy is energy which comes from natural resources such as sunlight, wind, water flow, waves, tides and geothermal heat, which are renewable (naturally replenished). Biomass (plant material) is also a renewable energy source because the energy it contains comes from the sun through the process of photosynthesis and plant material can be replenished every growing season.

Fossil fuel-based energy sources such as coal and oil and natural gas (methane), while also natural resources, are considered to be finite in supply and therefore not renewable. Also, the burning of fossil fuel-based energy sources adds carbon dioxide and other emissions to the Earth's atmosphere, contributing to climate change and its impacts, whereas the use of renewable energy sources does not.

Landfill gas is considered to be a renewable resource, because its use prevents the emission of methane, a potent greenhouse gas, into the atmosphere.

Renewable energy sources have several positive attributes, including the following:

- Essential environmental benefits – particularly, fewer CO2 emissions and less air pollution
- Predictable and stable cost structures – less exposure to fossil fuel price fluctuations
- Immediate cost reductions – reduced transmission costs when energy is produced locally, and reduced forward capacity charges when peak consumption is reduced by local solar power generation
- Low long-term costs – renewable energy sources are becoming increasingly cost-effective when viewed over the life of the energy source

Current Power Supply Mix

CMLP is required to contract for both energy and capacity. *Energy* is what we think of to light our lights, heat or cool our buildings, and make our appliances and machinery go. *Capacity* is the amount of energy that can be delivered during any particular instant — especially the amount that can be delivered during the hottest hour of the hottest day of the year. Under the current market rules for electricity supplies in New England, CMLP is required to purchase capacity amounting to 1.5 times the peak demand for the year.

In 2010, CMLP is paying about 8¢ per kilowatt-hour (kWh) for energy. We also pay an average of about $6.07 per month per kilowatt of capacity through 6/1/11, for a total of about 63,500 kW. The capacity charges work out to about 2.2¢ per kWh when averaged over the entire year.

The following chart displays Concord's current Energy purchases by fuel source for the 12-month period ending August 31, 2010.

Fuel Type	Contract	Expires	$/kWh	Annual kWhs (000s)	% of Supply
Natural Gas	Morgan Stanley	2013	$0.08	130,000	74%
	Braintree	2029	$0.06	10,000	6%
	Spot Market	Ongoing	$0.05	16,000	10%
Landfill Gas	Granby LFG	2013	$0.065	7,500	4%*
Hydropower	Miller (Maine)	2013	$0.0635	5,500	3%*
	NY Power Authority	Ongoing	$0.03	6,000	3%*
Total				175,000	
*renewable					

Currently renewable energy sources provide 10% of Concord's energy supply. Two additional renewable sources are currently in progress:–

- A contract with Spruce Mountain Power of Maine has just been signed that would add 5,000,000 kWhs of wind power to CMLP's portfolio at a fixed price of 9.9¢ per kWh (less renewable energy credits) for 15 years for energy and capacity. The facility is expected to become operational in the fall of 2011.
- Additionally, a utility-scale solar installation at the Concord Wastewater Treatment Plant is being negotiated. If completed in 2011, this would deliver about 800,000 kWh per year at 11¢/kWh, and it would offset transmission and capacity charges of about 8¢/kWh, arriving at a net cost of 3¢/kWh..

The addition of these two sources would increase the renewable energy portion of Concord's energy supply to roughly 13%.

The following chart displays Concord's current Capacity purchases by fuel source for the month of July 2010. This chart is for informational purposes only. Calculation of the portfolio's renewable energy percentage is based on Energy purchases (above).

Fuel Type	Contract	Expires	Monthly kWs	% of Requirement
Natural Gas	Braintree	2029	9,200	16%
	Dominion	2015	8,100	14%
	Spot Market	Ongoing	36,195	64%
Landfill Gas	Granby LFG	2013	1,000	2%
Hydropower	HydroQuebec	Ongoing	1,025	2%
	NY Power Authority	Ongoing	1,300	2%
Total			56,820	

The total annual carbon dioxide emission from this portfolio is roughly 150 million pounds (75,000 tons) based on an emissions rate of .952 lbs CO2/kWh (the on-peak marginal emission rate for the Northeast electric grid) multiplied by the annual non-renewable kilowatt hours of CMLP's current power supply (156,000,000).

Most of the fossil fuel power supplies in New England burn natural gas (methane), although some burn oil during the winter months when natural gas supplies are restricted. Natural gas is a fossil fuel producing carbon emissions, albeit less than coal or oil, and it is a non-renewable energy source. New deposits of natural gas are being found, but some predictions are that natural gas supplies will peak in 2040 and decline thereafter. Moreover, new natural gas fields (such as the Marcellus Shale of Pennsylvania and New York) have severe environmental and pollution impacts of their own. Natural gas has been described as a "transition fuel" with near-term use until an infrastructure of renewable energy sources can be established.

Natural gas prices are very low at present but have been very volatile in recent years. We believe that prices will increase over time; just how much is hard to estimate. In 2008, natural gas prices were 11¢/kWh, double today's price. Renewable energy prices have historically been higher than fossil fuel energy prices, but they are becoming competitive with fossil fuels due to market forces, federal and state incentives, and improvements in technology. When viewed in a long-term perspective, renewables tend to be more stable and predictable in cost than fossil fuels.

Currently, renewables represent a small percentage of CMLP's energy portfolio. The price of CMLP's current renewable energy contracts is very competitive with that of its current fossil fuel energy contracts.

Other Considerations

Energy Transmission: The electricity grid in the New England must be (and is being) modernized to handle renewable energy sources. Transmission costs to Concord have already increased significantly, and we expect them to continue to increase in the future. Energy production within Concord eliminates the transmission charges associated with energy generated outside Concord. Both transmission charges and forward capacity charges are based on peak energy consumption. Reductions in peak energy consumption will generate direct savings to CMLP and its customers.

Energy Consumption: Several factors will influence electricity consumption in the future, some increasing consumption and others decreasing consumption. Concord's population has remained stable over the past 30 years, and a significant increase in population appears unlikely. There has been a discernible trend toward decreasing energy usage due to conservation.

A planned large housing development in West Concord will increase demand in the near term. The move to electric (plug-in) cars will increase consumption, primarily during the evening hours as cars are plugged in to charge overnight. Likewise, if Electric Thermal Storage heating becomes more popular, it will also increase consumption, primarily at night. Energy conservation and local generation of solar power by residential, commercial, institutional and municipal customers will reduce demand for CMLP-supplied electricity. On the whole, we do not expect a significant reduction in electricity use in the future.

Peak Demand: The transformers at the Forest Ridge facility are sized to handle 50 MVA each at peak demand. Current peak demand is running 44 MW. With a power factor of .92, this usage translates to 47.8 MVA, which is very close to the current Forest Ridge capacity. The two transformers serve as backups for each other, so one can carry the entire load if the other is out of service. Once the peak demand goes over 50 MVA, there is no backup, and Concord would suffer a loss of capacity if one transformer goes down. The same thing is true of the transmission lines from Sudbury, which are shared by three communities, namely Concord, Acton, and Maynard. There are two lines capable of carrying 90 MVA each, but the combined demand is already over 100 MVA. Therefore, there is currently no backup if one line goes out of service during a peak period.

It is essential and urgent to address both issues. There several possible non-exclusive approaches:–

- Increase the capacity of the Forest Ridge substation to handle more than 50 MVA with appropriate backup, and later increase the capacity of the transmission lines from Sudbury to provide adequate backup. Both of these would be investments in the infrastructure but would represent pure overhead expenses.
- Reduce demand at peak times through conservation and peak management with Smart Grid.
- Provide some kind of electricity generation within Concord to provide a portion of the peak power that does not need to pass through the transformers and transmission lines.

The first of these approaches would be purely an overhead expenditure (although the transmissions lines would have to be shared with NStar, the utility for Acton and Maynard). The second should be undertaken, regardless of other efforts. However, it involves changing people's behaviors, and therefore it is likely to take a long time. The third would be a revenue-producing investment and represents the best option. Among the in-town generation options, solar energy is particularly attractive. If implemented aggressively enough, it would delay the need to upgrade the transformers, perhaps indefinitely.

Energy Conservation: Energy conservation is a very important part of an overall strategy to manage electricity consumption. There are many efforts underway to promote energy conservation, including rebates for compact fluorescent light bulbs

and energy-efficient appliances, special programs for home energy audits and weatherization (e.g., National Grid and CMLP), and state and federal tax credits for energy efficiency improvements and renewable energy. In October 2009 CMLP implemented a new tiered rate structure with higher rates for higher levels of electricity use. The Smart Grid implementation within Concord will enable time-of-use billing and the installation of smart meters on home appliances such as pool pumps to reduce electricity use during peak periods. Energy conservation is the "first fuel," and will continue to be an important focus of CMLP's efforts.

Renewable Energy Technologies and Opportunities

Wind Power

The areas of highest potential in Massachusetts include coastline and off-shore areas, and the Berkshire mountain ridge in western Massachusetts. Wind power is currently not feasible in Concord due to low wind speeds. Transmission of energy over long distances (e.g., outside New England) is limited due to energy losses and the high cost of power transmission from or through New York State. Therefore, potential sources of wind power for Concord are New England-based wind facilities or facilities in eastern Canada. For a wind facility to be considered economically viable, it should have at least 2200-2500 wind-equivalent hours per year. That is, the wind should blow hard enough and often enough that a 1-MW turbine generates 2200-2500 megawatt-hours of energy per year.

Wind energy tends to peak in the early morning and early evening, which is not aligned with peak usage. Wind turbines can be placed on farmland, supporting dual land use and providing another source of income for farmers. Wind power efforts suffer from resistance by neighbors who complain about noise and the disruption of their view.

The State recently changed its regulations to allow the investor-owned utilities (IOUs) to meet State targets by purchasing wind power from outside Massachusetts. In general, competition for renewable energy from the IOUs can be expected to increase as they strive to meet State mandates for renewable energy.

As noted above, CMLP has signed its first wind power contract with Spruce Mountain Power of Bethel, Maine. Opportunities to add wind power to Concord's portfolio include more contracts through Energy New England, and pursuing opportunities to partner with other communities to develop modest-sized wind power facilities. For example, the town of Princeton, MA has installed two wind turbines behind Mount Wachusett which are generating 40% of that town's annual electricity needs at about 7¢/kWh. It may be possible to approach Princeton about installing a CMLP-owned turbine in Princeton.

In general, Concord should look for small or medium-scale wind facilities where we would have access to 7-12 megawatts of capacity at one site at costs of about $2.00-

2.50 per watt. By contrast, most wind farms that make the news are large investor-owned installations that are measured in the hundreds of megawatts.

Hydropower

CMLP currently purchases power from a large-scale river-based hydropower facility in Maine and intends to purchase power from a (very) small-scale power facility in Acton, MA. Hydropower facilities, especially small ones, are affected by dry periods that drive down water levels and limit energy production. Climate change in the Northeast will result in more rainfall in heavy downpours and then periods of little rain, exacerbating issues at small hydropower facilities. Hydropower facilities alter river and stream ecosystems, creating concerns about negative impacts on plants and animals.

It is generally regarded in the power industry that all river-based hydropower opportunities in New England have been exploited. The most promising supplier is Hydro Quebec, who has publicly expressed an interest in selling more hydropower to New England over an existing high-voltage transmission line. Concord should continue to purchase hydropower from vendors who are willing to sell at appropriate prices.

An emerging area in hydropower is marine (ocean-based) power, which is the use of waves or ocean tides to generate power. Maine has begun developing tide-based power facilities. Massachusetts is seeking to establish a "wetlab" off shore south of Cape Cod and The Islands for the testing of tidal generators, wave power generators, and offshore wind turbines. Marine power is an emerging technology and opportunities to purchase this type of power, when available, should be examined.

Solar Power

Solar photovoltaic (PV) technology is fairly straightforward and has remained relatively the same over the past 30 years, with modest improvements in efficiency and big reductions in cost. New developments include thin film technology which may in the future allow solar PV cells to be imbedded in roof tiles and other construction materials. While one thinks of the sunny Southwest as the best place for solar energy generation, the Northeast still has good solar potential. At Concord's latitude and in Concord's climate, a 1-kW solar array would generate about 1200-1300 kWh of energy per year. (Some solar arrays increase the number of solar-equivalent hours by mechanically controlling the tilt of the panels to track the sun.) Although solar energy is generated only during the day, it is generated at its highest levels during hot summer days when electricity usage and cost is highest and when peak capacity and transmission charges are calculated.

Solar power has historically been much more expensive than other power sources. Many factors are combining to significantly reduce the cost of solar energy, including the economic slowdown, an oversupply of panels from manufacturers in

China and Germany, and state and federal incentives for solar power facilities. Current installed prices are running less than $5/watt, a decrease of 50% since 1998.

Local solar facilities, whether large-scale or located on residential or non-residential roofs, will reduce transmission costs and forward capacity market charges that are associated with peak consumption. A CMLP analysis prepared in August 2010 for a 1 megawatt array estimated that transmission cost savings would be approximately 2¢/kWh and forward capacity market savings approximately 6.5¢/kWh. With recent bids for utility-scale solar on Town-owned land at 11¢–14¢ per kWh, the transmission cost savings makes the price of solar energy very attractive in comparison with other power purchased by CMLP.

Residential Solar: Solar panel providers generally estimate that 25% of a community's homes could support solar panels, which in Concord would be 1,500 homes. An average installation of 4 kilowatts on 1,500 homes would translate to 6,000 kW, or 6 megawatts of solar energy potential. CMLP is currently developing a power purchase program for residential and small commercial customers to remove the financial barriers to these installations. However, given the current Federal, State and CMLP incentives, and the current CMLP net metering policies for residential solar, a homeowner who purchases a PV system outright can do well financially, recovering the initial investment within 8 - 10 years and then generating positive return.

Under the CMLP Net Metering policy effective until 12/31/10, residential solar energy offsets electricity costs at the prevailing residential rate, and any excess is sold back to CMLP at the same rate. The financial viability of this practice on CMLP's operation has been reviewed. It has been decided that as of January 1, 2011, CMLP customers with PV systems on their property will be credited for energy delivered to the CMLP system at the previous month's average cost of the Day Ahead energy as purchased by CMLP from the Integrated System Operator (ISO).

Municipal, Commercial, and Institutional Solar: Non-residential buildings are also good sites for solar, due to generally large and flat roofs. A 48 kW system on the roof of the Willard Elementary School recently went live and is expected to provide about 9% of Willard's annual electricity needs. The Department of Corrections has installed a 60 kW system at the Concord Reformatory and is installing another system (100 kW) at the Northeast Correctional Institute (on the north side of Route 2). Commercial investment in solar will reduce purchases of power from CMLP, affecting the ability to cover CMLP operating costs, but will also reduce CMLP's transmission and forward capacity costs. An estimate of the potential size of commercial solar facilities has not been made. The commercial sector may not be aware of the potential for solar facilities.

CMLP does not currently have a tariff for non-residential solar energy. An in-depth study and analysis is required to balance the benefits against the costs and to develop appropriate incentives.

Utility-Scale Solar: Utility-scale facilities offer a good way to achieve significant amounts of solar energy relatively quickly, and with the current State incentives, at a very competitive cost. The drawback of utility-scale facilities is that they require a lot of space, generally about 5 acres per megawatt and there are always existing uses of the land that must be considered. There are a number of utility-scale solar vendors who will own, install, operate and maintain solar facilities, and enter into a long-term power purchase agreement with the local electrical utility.

The Light Board has recently voted to approve a Utility-Scale Solar Strategy. In summary, this calls for about 25 megawatts of solar capacity within Concord, to be deployed in increments of about 5 megawatts each and about 5 years apart. 25 megawatts would represent about as much power as CMLP could accommodate on normal (non-peak) days and more than 50% of the Town's total peak demand. When fully deployed, it would generate about 20% of the Town's annual electrical energy requirements at reasonable and predictable costs. Incremental deployment over time would help to manage the financing and to enable us to take advantage of technological improvements as they emerge.

In-town solar helps CMLP manage its costs by reducing forward capacity and transmission costs, and long-term utility-scale solar contracts at competitive rates provide rate stability. Solar power is the energy source with the greatest potential in Concord and should be aggressively pursued at all levels – residential, municipal, commercial, institutional and utility-scale.

Biomass

Biomass is plant matter grown to generate electricity or produce heat generally through direct incineration. Forest residues (such as dead trees, branches and tree stumps), yard clippings, wood chips and garbage are often used for this. Industrial biomass can be grown from numerous types of plants, including miscanthus, switchgrass, hemp, corn, poplar, willow, sorghum, sugarcane, and a variety of tree species, ranging from eucalyptus to oil palm. The issues with the use of biomass have to do with competition with other uses of the land (e.g., raising crops to burn versus raising crops to eat), the true "sustainability" of the feedstock (the ability to keep feeding the incinerator), and the need to allow crop residues to remain to nourish the soil.

CMLP has been in conversation with the developers of a wood-burning facility in mid-state, but it appears that the facility will not be built. Massachusetts has recently restricted its definition of what qualifies as biomass, which will probably limit the opportunities for power generation in this area. Biomass is an emerging technology and should be monitored to see if opportunities develop.

One possible application for biomass energy involves cogeneration. Cogeneration involves generating electricity through combustion of fuel (fossil or biomass), and using the "waste" heat for water and space heating applications. Cogeneration is very energy efficient, but must be located near the site(s) where the excess heat is utilized. Examples of biomass cogeneration systems include systems at Mt. Wachusett Community College and Middlebury College. The magnitude of locally available, sustainably-produced biomass feedstock has not been assessed, so it is not yet known if biomass cogeneration could contribute significantly to the Town's power supply.

Energy Storage

There are many emerging energy storage technologies, including ice storage, water storage, fly wheels, batteries and fuel cells. These technologies help the grid handle intermittent generation by renewable energy sources. The ISO (grid operator) generally manages the inflow of electricity to the grid to meet demand. For the time being, additional storage at the local level is not critical. A pilot of ice storage technology in a municipal building is currently being considered as a peak-shaving option. CMLP's current ETS (Electric Thermal Storage) program goals and results should be evaluated as part of CMLP's Energy Conservation/Demand Management Strategy. The field of energy storage technology and Concord's needs can be monitored to see if anything of potential use develops.

Financial Considerations

CMLP Mission: CMLP's mission is to provide reliable electricity at a reasonable cost to its customers. According to a residential customer survey completed in 2008, CMLP's residential customers consider reliability, cost and environmental sensitivity to be equally important. An informal survey of selected commercial customers indicates a bias toward reliability and cost but with concern for the environment. CMLP's challenge is to incorporate renewable energy sources into its portfolio at a cost that does not result in an unreasonable price to customers and at the same time provides enough revenue to fund CMLP operations.

Conservation and Renewable Energy Budget: CMLP currently collects a surcharge of 0.52% on its electricity bills for energy conservation and renewable energy incentives, amounting to about $100,000 per year. CMLP's current solar rebate is $1/watt. At this incentive level and given the current budget, only 20 5kW installations could be supported annually. Beginning 1/1/11, CMLP's solar PV rebate will be $.625 per watt AC with a maximum rebate per installation of $3,125. The revised rebate amount is calculated based upon 10 years of savings realized by CMLP due to the installation of local solar capacity, minus the revenue lost by CMLP when customers with solar PV facilities generate their own electricity. It is an open question as to whether or not the annual budget for energy conservation and solar PV rebates is adequate, given CMLP's interest in promoting conservation and renewable energy.

Federal and State Financial Incentives: The Light Board recognizes that federal and state subsidies and Renewable Energy Credit programs are intended to stimulate the renewable energy market and that as those markets mature, the subsidies will no longer be needed. The Light Board also recognizes that the "externalities" cost of the use of fossil fuels (e.g., the cost of war in the Middle East, the cost of pollution cleanup, the cost of black lung disease and other public health problems) is disregarded when these costs are compared to the cost of renewable energy. In addition, special tax breaks are awarded to the oil, gas and coal industries. Government subsidies have been used when the market itself has been dysfunctional in promoting "the right kind of activity." The subsidies for renewable energy are helping to create a green energy economy and jobs. The Light Board believes that we have a responsibility to participate in moving the market forward.

Nevertheless, the Light Board also believes that financial decisions should only be made with subsidies actually in hand or guaranteed to be available. It should not count on future subsidies that may change or evaporate as a result of legislative action or on renewable energy credits whose price is determined by market forces. Instead, any such future subsidies or credits that are earned by CMLP renewable energy facilities should be used to retire debt and/or to build up funds to pay for future facilities.

Renewable Energy Portfolio Goal

The current Massachusetts Renewable Energy goal is 5% in 2010, increasing 1% per year to 15% in 2020. Existing hydropower facilities are not included in MA's measure of renewable energy. CMLP's current renewable energy portfolio is about 10%, including hydropower facilities, and increases to 13% in 2011 if both the Spruce Mountain wind contract and the Wastewater Treatment Plant solar contract come to pass.

The potential for future wind power contracts is unknown at this time. The potential for utility-scale solar power in town is based on the amount of land that can be acquired or made available. Under the Utility-Scale Solar Strategy adopted by the Light Board, ten megawatts should be deployed in the next ten years. Several potential sites have been identified, and options are being explored.

The Light Board recommends that CMLP commit to increase the renewable energy portion of its energy supply portfolio from 10% in 2010 to 20% by 2015 and 30% by 2020. Each 10% increase in renewable energy will reduce CO2 emissions by 15 million pounds (7,500 tons) annually. It appears that this goal is achievable with the addition of 10 MW of solar energy and 7MW of wind energy over a 10-year period.

Renewable Energy Strategy

The following strategic initiatives are recommended to achieve the Renewable Energy Portfolio goal stated above. It is expected that each of these strategies will be further analyzed in detail and associated goals, plans and policy implications identified.

1. **Move rapidly to implement in-town solar power generation at all levels: residential, municipal, commercial, institutional and utility-scale.**

   Communications: Develop a communications plan to educate the community about solar energy potential and CMLP's strategy.

   Residential Solar
   - Implement a PPA (power purchase agreement) option for residents.
   - Develop a financial comparison between an outright purchase and a PPA to inform residents of their options.
   - Develop a system to submit solar energy generated from resident-owned systems to the State for SRECs (solar renewable energy credits) and give dollars earned back to the residents.

   Municipal, Commercial, and Institutional Solar
   - Develop policies, tariffs, and incentives for solar energy on non-residential buildings and properties.
   - Determine the potential for solar facilities on municipal and commercial rooftops and land (e.g., parking lots).
   - Inform business/building owners of the potential for solar energy, including financial savings.
   - Facilitate the process between owners and PV system providers.

   Utility-Scale Solar
   - Proceed with the Article 64 project as under recommendations suggested by the Board of Selectmen. Consider if additions to capacity for the Wastewater Treatment Plant site are possible to achieve a meaningful-size installation.
   - Identify all potential sites within Concord, including those not currently owned by the Town.
   - Prepare warrant articles for Town Meeting 2011 or 2012 as needed.
   - Prepare a detailed plan for making a multi-year investment in utility-scale solar based on potential sites and financial feasibility.
   - Consider if it makes sense for CMLP to own and operate such facilities, given its ability to issue long-term bonds at favorable rates and the opportunity to own SRECs.

2. **Research and evaluate opportunities to develop modest scale wind power facilities in New England.** Understand the details of the Princeton facility and

explore options for siting a CMLP-owned wind turbine or turbines in one or more locations in New England.

3. **Work through ENE to aggressively pursue other renewable energy contracts that make sense financially.** Inform ENE of CMLP's Renewable Energy Strategy and Goal. Discuss options, including multi-municipal opportunities to own renewable energy facilities, much like some of the current fossil fuel-based facilities.
4. **Develop and implement a formal Energy Conservation strategy.** Review the effectiveness of the current programs and adjust as required to maximize impact.
5. **Monitor emerging technologies and assess potential for use in Concord.** These include, but are not limited to, the following: local wind power, biomass, energy storage, marine-based power.
6. **Develop a financial strategy that supports energy conservation and renewable energy plans.** Consider increasing annual funding for energy conservation and renewable energy, while reviewing and adjusting incentive levels as appropriate. Understand the potential impact of energy conservation and local residential and commercial solar facilities on CMLP revenues and adjust incentives as needed. Research other sources of funding for renewable energy and conservation (e.g., RGGI – Regional Greenhouse Gas Initiative $$$). Understand CMLP's overall financial strengths and debt capacity to help determine whether CMLP should in the future purchase power or own renewable energy facilities.
7. **Monitor developments in plug-in electric vehicles.** Not only must the impact on rates be considered, but also on the electrical system and the ability to deliver renewable energy to them.
8. **Review contract policy implications and update the CMLP Power Supply Manual as appropriate.**

Policy Considerations

Power supply contracting efforts will need to take the renewable energy portfolio goal into account to ensure that contracts are structured to achieve the goal. For example, CMLP should not commit to fossil fuel contract timeframes that would not leave enough consumption to be met by renewable energy contracts. Also, CMLP's position on purchasing coal-fueled energy should be stated, as coal is the biggest contributor to climate change and has many other deleterious environmental and public health effects. CMLP's position on the purchase of nuclear power should also be stated, given the safety and other issues associated with nuclear power.

Next Steps

It is not realistic to expect that CMLP staff will be able to perform all of this work, so priorities for efforts will need to be established. It is possible that teams of people could be put together to work on each of these projects, with a Light Board member or CMLP staff member as lead for each project. The Solar initiatives could be split into 3 projects – residential, municipal/commercial/institutional, and utility-scale – with separate teams to address. Team members can come from the Light Board, the Comprehensive Sustainable Energy Committee, CMLP staff and the community at large.

Appendix 5 Conservation Designations for Land Use

Land conservation comes in many forms. All Town-owned conservation lands, parklands, and other lands purchased for a public benefit are protected by Article 97 of the state constitution. Some lands may be protected by Conservation Restrictions (held by another entity such as the Concord Land Conservation Trust); others are deed restricted for open space, recreation, etc. Article 97, a constitutional amendment dating back to 1972, protects lands purchased for a public benefit from disposition for other purposes, which includes any change of use (for example, solar), by requiring approval of a change of use by two-thirds of both houses of the legislature. Private conservation lands may also have a Conservation Restriction held by the Town or other entity. Lands with a Conservation Restriction in perpetuity are not eligible for utility-scale solar or other development.

Conservation Restriction - MGL Chapter 184 Section 31

A conservation restriction means a right, either in perpetuity or for a specified number of years, whether or not stated in the form of a restriction, easement, covenant or condition, in any deed, will or other instrument executed by or on behalf of the owner of the land or in any order of taking, appropriate to retaining land or water areas predominantly in their natural, scenic or open condition or in agricultural, farming or forest use, to permit public recreational use, or to forbid or limit any or all (a) construction or placing of buildings, roads, signs, billboards or other advertising, utilities or other structures on or above the ground, (b) dumping or placing of soil or other substance or material as landfill, or dumping or placing of trash, waste or unsightly or offensive materials, (c) removal or destruction of trees, shrubs or other vegetation, (d) excavation, dredging or removal of loam, peat, gravel, soil, rock or other mineral substance in such manner as to affect the surface, (e) surface use except for agricultural, farming, forest or outdoor recreational purposes or purposes permitting the land or water area to remain predominantly in its natural condition, (f) activities detrimental to drainage, flood control, water conservation,

erosion control or soil conservation, or (g) other acts or uses detrimental to such retention of land or water areas.

(http://www.mass.gov/Eoeea/docs/eea/dcs/crhandbook08.pdf)

Conservation Restrictions (aka Conservation Easements) are interests in land acquired through gift, purchase or regulatory exaction which are designed to preserve natural resources from adverse future change. The unique features of conservation restrictions are that they leave land on the tax rolls (though sometimes much reduced in value), preserve land without public ownership, and allow, in many instances, for public access. Conservation restrictions can be for a period of years or in perpetuity.

Preservation Restriction - MGL Chapter 184 Section 31

A preservation restriction means a right, whether or not stated in the form of a restriction, easement, covenant or condition, in any deed, will or other instrument executed by or on behalf of the owner of the land or in any order of taking, appropriate to preservation of a structure or site historically significant for its architecture, archeology or associations, to forbid or limit any or all (a) alterations in exterior or interior features of the structure, (b) changes in appearance or condition of the site, (c) uses not historically appropriate, (d) field investigation, as defined in section twenty-six A of chapter nine, without a permit as provided by section twenty-seven C of said chapter, or (e) other acts or uses detrimental to appropriate preservation of the structure or site.

Agricultural Preservation Restriction - MGL Chapter 184 Section 31

An agricultural preservation restriction means a right, whether or not stated in the form of a restriction, easement, covenant or condition, in any deed, will or other instrument executed by or on behalf of the owner of the land appropriate to retaining land or water areas predominately in their agricultural farming or forest use, to forbid or limit any or all (a) construction or placing of buildings except for those used for agricultural purposes or for dwellings used for family living by the land owner, his immediate family or employees; (b) excavation, dredging or removal of loam, peat, gravel, soil, rock or other mineral substance in such a manner as to adversely affect the land's overall future agricultural potential; and (c) other acts or uses detrimental to such retention of the land

for agricultural use. Such agricultural preservation restrictions shall be in perpetuity except as released under the provisions of section thirty-two. All other customary rights and privileges of ownership shall be retained by the owner including the right to privacy and to carry out all regular farming practices.

Appendix 6 Well site regulations

Parcels Researched:

1. **Parcel 3008-1 (97A Old Marlboro Road) – Jenny Dugan Well**
2. **Parcel 1374-1 (26A Balls Hill Road) – Benson Well Site**
    a. *Can TM vote change use restriction?* According to Alan Cathcart, Zone 1 areas are challenging due to the requirement for a 400-foot radius around the well. Furthermore, there are DEP Drinking Water supply concerns on these sites:

310 CMR 22.00 Drinking Water – DEP Regulations

22.24: Sale, Transfer of Property Interest, or Change in Use of Water Supply Land

(1) No supplier of water may sell, lease, assign, or otherwise dispose of, or change the use of, any lands used for water supply purposes without the prior written approval of the Department. The Department will not approve any such disposition or change in use unless the supplier of water demonstrates to the Department's satisfaction that *such action will have no significant adverse impact upon the supplier of water's present and future ability to provide continuous adequate service to consumers under routine and emergency operating conditions, including emergencies concerning the contamination of sources of supply, failure of the distribution system and shortage of supply.*

(2) Land Transfers Any sale, transfer of property interest *or change in use of land acquired for water supply purposes may also require approval by a _ vote of the Legislature*, in addition to Department approval. (Massachusetts Constitution Amend. Art. XCVII, Section 243)

(3) Easements The Department will not approve any grant of easement for pipelines, or other conduit, carrying liquid petroleum products within the Zone I of a PWS. For other public utility easements within Zone I, the Department may require as a condition of any grant of such easement an express perpetual prohibition on the use of fertilizers, pesticides, herbicides, and other non-mechanical means of vegetation control within the area subject to the easement.

(4) The owner/operator of any public water system shall notify the Department in writing at least 30 days in advance of any:

(a) proposed sale, change of system ownership, or transfer of the system; and or of the system and/or change in the type of facility served by the system.

(b) changes that impact the classification of the system. Changes in system classification are subject to Department review and approval. For non-community systems, changes that impact the classification include changes in the type of facilities, service connections, population served or operating hours that may result

in a change of transient use to non-transient use, or non-community use to community use according to the definition of a public water system pursuant to 310 CMR 22.02 and the Guidelines and Policies for Public Water Systems.

Appendix 7 Model Solar Bylaw

Model As-of-Right Zoning Bylaw:

Allowing Use of Large-Scale Ground-Mounted Solar Photovoltaic Installations

Prepared by:
Department of Energy Resources
Massachusetts Executive Office of Environmental Affairs

December 2010

This Model Bylaw was prepared to assist cities and towns in establishing reasonable standards to facilitate development of large-scale ground-mounted solar photovoltaic installations. The bylaw was developed as a model and is not intended for adoption without specific review by municipal counsel.

1.0 Purpose

The purpose of this bylaw is to promote the creation of new large-scale ground-mounted solar photovoltaic installations by providing standards for the placement, design, construction, operation, monitoring, modification and removal of such installations that address public safety, minimize impacts on scenic, natural and historic resources and to provide adequate financial assurance for the eventual decommissioning of such installations.

The provisions set forth in this section shall apply to the construction, operation, and/or repair of large-scale ground-mounted solar photovoltaic installations.

1.1 Applicability

This section applies to large-scale ground-mounted solar photovoltaic installations proposed to be constructed after the effective date of this section. This section also pertains to physical modifications that materially alter the type, configuration, or size of these installations or related equipment.

Qualifying as a Green Community: *In order to satisfy the Green Communities Act as-of-right zoning requirement a community's zoning must allow solar photovoltaic installations that utilize ground-mounted systems which individually have a rated name plate capacity of 250 kW (DC) or more.*

Approximate size of installation: *A solar photovoltaic array with a rated name plate capacity of 250 kW (DC) occupies approximately one acre of land.*

Smaller installations (under 250 kW): *The above requirement for qualification as a Green Community is not intended to discourage construction of solar photovoltaic installations that are smaller than 250 kW, but rather to ensure that in designated locations local regulatory barriers that may adversely affect large-scale ground-mounted*

Educational Note: *Existing Massachusetts law largely exempts solar photovoltaic installations from local zoning restrictions. Massachusetts General Laws Chapter 40A, Section 3, provides, in relevant part, that:*

> *No zoning ordinance or by-law shall prohibit or unreasonably regulate the installation of solar energy systems or the building of structures that facilitate the collection of solar energy, except where necessary to protect the public health, safety or welfare.*

In view of M.G.L. ch. 40A § 3, local zoning provisions specifically allowing for the as-of-right construction of smaller solar energy systems – such as those commonly installed on top of or on the lot of a home or business—are unnecessary. However, it is not clear whether M.G.L. ch. 40A § 3 applies to the construction of large scale ground-mounted systems. Therefore, to qualify as a green community, a municipality may adopt a solar photovoltaic bylaw for as-of-right siting of large scale ground-mounted systems in a designated location(s). An existing example of a large scale ground-mounted solar photovoltaic system is the Brockton Brightfields Project

2.0 Definitions

As-of-Right Siting: As-of-Right Siting shall mean that development may proceed without the need for a special permit, variance, amendment, waiver, or other discretionary approval. As-of-right development may be subject to site plan review to determine conformance with local zoning ordinances or bylaws. Projects cannot be prohibited, but can be reasonably regulated by the inspector of buildings, building commissioner or local inspector, or if there is none in a town, the board of selectmen, or person or board designated by local ordinance or bylaw.

Building Inspector: The inspector of buildings, building commissioner, or local inspector, or person or board designated by local ordinance or bylaw charged with the enforcement of the zoning ordinance.

Building Permit: A construction permit issued by an authorized building inspector; the building permit evidences that the project is consistent with the state and federal building codes as well as local zoning bylaws, including those governing ground- mounted large-scale solar photovoltaic installations.

Designated Location: The location[s] designated by [the community's local legislative body], in accordance with Massachusetts General Laws Chapter 40A, section 5, where ground - mounted large scale solar photovoltaic installations may be sited as-of right. Said location[s] [is/are] shown on a Zoning Map [insert title of map] pursuant to Massachusetts General Laws Chapter 40A Section 4. This map is hereby made a part of this Zoning Bylaw and is on file in the Office of the [Town/City] Clerk.

Note: *The term "designated location" refers to the location within a community where solar photovoltaic installations are permitted as-of-right. Establishment of a designated location for such installations is an integral part of the process of adopting an as-of-right solar photovoltaic bylaw.*

Legal Requirements: *The process of designating the location must comport with the requirements of Massachusetts General Laws Chapter 40A, Section 5, which sets out the requirements for adopting and amending zoning bylaws.*

Methods of Designating a Location: *Communities may designate locations by reference to geographically specific districts. In the alternative, communities may create an overlay district consisting of all or portions of multiple preexisting zoning districts, where large scale solar photovoltaic power generation is permitted by right. Because solar photovoltaic power generation produces neither noise nor harmful emissions, use of land for the purpose of solar photovoltaic power generation should be compatible with most other types of land usage.*

Green Communities Program Requirements: *To qualify for designation as a Green Community, the designated location must provide a realistic and practical opportunity for development of a large scale solar photovoltaic power generation facility. In designating a location, it is important for the community implementing the as-of right zoning bylaw to consider the availability of sunlight and particular characteristics of the local community. It is not practical to site solar photovoltaic installations in areas that are surrounded by tall structures. The size of available lots is also a relevant consideration, though aggregation of parcels within a designated district in order to create a parcel of sufficient size to construct a qualifying facility will be considered. As previously mentioned, a solar photovoltaic array with a rated name plate capacity of 250 kW occupies approximately*

Large-Scale Ground-Mounted Solar Photovoltaic Installation: A solar photovoltaic system that is structurally mounted on the ground and is not roof-mounted, and has a minimum nameplate capacity of 250 kW DC.

On-Site Solar Photovoltaic Installation: A solar photovoltaic installation that is constructed at a location where other uses of the underlying property occur.

Rated Nameplate Capacity: The maximum rated output of electric power production of the Photovoltaic system in Direct Current (DC).

Site Plan Review: review by the Site Plan Review Authority to determine

Note: *In some communities this is known as Site Plan Approval rather than Site Plan Review. Regardless of which term is used by a community, the following excerpt from Lowe's Home Centers, Inc. v. Town of Auburn Planning Board provides an excellent judicial explanation of the nature of site plan review as applied to as-of-right uses:*

Site plan approval acts as a method for regulating as-of-right uses rather than prohibiting them as per Y.D. Dugout, Inc. v. Bd. Of Appeals of Canton, 357 Mass. 25, 31, 255 N.E.2d 732 (1970). When evaluating the Site Plan Applications, the Planning Board may not unconditionally deny the Site Plan Applications, but rather, it may impose reasonable conditions upon them. See Prudential, 23 Mass.App.Ct. at 281-82, 502 N.E.2d 137; Quincy, 39 Mass.App.Ct. at 21-22, 652 N.E.2d 901 ("[W]here the proposed use is one permitted by right the planning board may only apply substantive criteria ... i.e., it may impose reasonable terms and conditions on the proposed use, but it does not have the discretionary power to deny the use."). Thus, when a site plan application is submitted for an as-of-right use, a planning board is obligated to grant an approval with reasonable conditions unless, "despite best efforts, no form of reasonable conditions [can] be devised to satisfy the problem with the plan...." Prudential, 23 Mass.App.Ct. at 283n. 9, 502 N.E.2d 137; Castle Hill Apartments Ltd.P'ship v. Planning Bd. Of Holoyke, 65 Mass.App.Ct. 840, 845-45, 844 N.E.2d 1098 (2006).

conformance with local zoning ordinances or bylaws.

Site Plan Review Authority: For purposes of this bylaw, Site Plan Review Authority refers to the body of local government designated as such by the municipality

Note: *The Site Plan Review Authority can be the Board of Selectman, City Council, Board of Appeals, Planning Board or Zoning Administrator. However, the Planning Board is typically the best group to serve in this capacity as it is usually the most familiar with the municipality's zoning bylaws/ordinances as well as its Master Plan or other plans for future conservation/development.*

Zoning Enforcement Authority: The person or board charged with enforcing the zoning ordinances or bylaws.

Note: *By state statute, the Zoning Enforcement Authority may be the "inspector of buildings, building commissioner or local inspector, or if there are none, in a town, the board of selectmen, or person or board designated by local ordinance or by-law". M.G.L. ch. 40A § 7. In many communities, the building inspector is the person charged with enforcing both the state's building code and local zoning ordinances or bylaws.*

3.0 General Requirements for all Large Scale Solar Power Generation Installations

The following requirements are common to all solar photovoltaic installations to be sited in designated locations.

3.1 Compliance with Laws, Ordinances and Regulations

The construction and operation of all large scale solar photovoltaic installations shall be consistent with all applicable local, state and federal requirements, including but not limited to all applicable safety, construction, electrical, and communications requirements. All buildings and fixtures forming part of a solar photovoltaic installation shall be constructed in accordance with the State Building Code.

3.2 Building Permit and Building Inspection

No large scale solar photovoltaic installation shall be constructed, installed or modified as provided in this section without first obtaining a building permit.

Note: *Under the state building code, work must commence within six (6) months from the date a building permit is issued; however, a project proponent may request an extension of the permit and more than one extension may be granted.*

3.3 Fees

The application for a building permit for a large scale solar photovoltaic installation must be accompanied by the fee required for a building permit.

3.4 Site Plan Review

Ground-mounted large scale solar photovoltaic installations with 250 kW or larger of rated nameplate capacity shall undergo site plan review by the Site Plan Review Authority prior to construction, installation or modification as provided in this section.

Purpose: *The purpose of the site plan review is to determine that the use complies with all requirements set forth in this zoning bylaw and that the site design conforms to established standards regarding landscaping, access, and other zoning provisions.*

Additional Considerations: *As part of the implementation of an as-of-right large-scale ground-mounted solar photovoltaic bylaw, communities should consider amending their existing site plan review provisions in order to incorporate site plan review conditions that apply specifically to such installations.*

3.4.1 General

All plans and maps shall be prepared, stamped and signed by a Professional Engineer licensed to practice in Massachusetts.

3.4.2 Required Documents

Pursuant to the site plan review process, the project proponent shall provide the following documents:

(a) A site plan showing:

- **i.** Property lines and physical features, including roads, for the project site;
- **ii.** Proposed changes to the landscape of the site, grading, vegetation clearing and planting, exterior lighting, screening vegetation or structures;
- **iii.** Blueprints or drawings of the solar photovoltaic installation signed by a Professional Engineer licensed to practice in the Commonwealth of Massachusetts showing the proposed layout of the system and any potential shading from nearby structures
- **iv.** One or three line electrical diagram detailing the solar photovoltaic installation, associated components, and electrical interconnection methods, with all National Electrical Code compliant disconnects and overcurrent devices;
- **v.** Documentation of the major system components to be used, including the PV panels, mounting system, and inverter;
- **vi.** Name, address, and contact information for proposed system installer;
- **vii.** Name, address, phone number and signature of the project proponent, as well as all co-proponents or property owners, if any;
- **viii.** The name, contact information and signature of any agents representing the project proponent; and

(b) Documentation of actual or prospective access and control of the project site (see also Section 3.5);

(c) An operation and maintenance plan (see also Section 3.6);

(d) Zoning district designation for the parcel(s) of land comprising the project site (submission of a copy of a zoning map with the parcel(s) identified is suitable for this purpose);
(e) Proof of liability insurance; and
(f) Description of financial surety that satisfies Section 3.12.3.

The Site Plan Review Authority may waive documentary requirements as it deems appropriate.

Additional Consideration for Smaller Solar Photovoltaic Installations: *The extensive site plan review documentation set forth in Section 3.4.2 of this model bylaw is not intended to apply to smaller solar photovoltaic installations. One of the key goals underpinning the Green Communities Program is the development of renewable and alternative energy capacity. Communities should shape their bylaws to enable both large and small projects to proceed without undue delay.*

3.5 Site Control
The project proponent shall submit documentation of actual or prospective access and control of the project site sufficient to allow for construction and operation of the proposed solar photovoltaic installation.

3.6 Operation & Maintenance Plan
The project proponent shall submit a plan for the operation and maintenance of the large- scale ground-mounted solar photovoltaic installation, which shall include measures for maintaining safe access to the installation, storm water controls, as well as general procedures for operational maintenance of the installation.

3.7 Utility Notification
No large- scale ground –mounted solar photovoltaic installation shall be constructed until evidence has been given to the Site Plan Review Authority that the utility company that operates the electrical grid where the installation is to be located has been informed of the solar photovoltaic installation owner or operator's intent to install an interconnected customer-owned generator. Off-grid systems shall be exempt from this requirement.

3.8 Dimension and Density Requirements

3.8.1 Setbacks
For large - scale ground-mounted solar photovoltaic installations, front, side and rear setbacks shall be as follows:
(a) Front yard: The front yard depth shall be at least 10 feet; provided, however, that where the lot abuts a Conservation-Recreation or Residential district, the front yard shall not be less than 50 feet.

(b) Side yard. Each side yard shall have a depth at least 15 feet; provided, however, that where the lot abuts a Conservation-Recreation or Residential district, the side yard shall not be less than 50 feet.

(c) Rear yard. The rear yard depth shall be at least 25 feet; provided, however, that where the lot abuts a Conservation-Recreation or Residential district, the rear yard shall not be less than 50 feet.

Note: *These setback distances are suggested values. Decreased setback distances may be appropriate. The municipality should evaluate what is appropriate for its designated*

3.8.2 Appurtenant Structures

All appurtenant structures to large- scale ground-mounted solar photovoltaic installations shall be subject to reasonable regulations concerning the bulk and height of structures, lot area, setbacks, open space, parking and building coverage requirements. All such appurtenant structures, including but not limited to, equipment shelters, storage facilities, transformers, and substations, shall be architecturally compatible with each other. Whenever reasonable, structures should be shaded from view by vegetation and/or joined or clustered to avoid adverse visual impacts.

Note: *Regulations governing appurtenant structures are typically contained in a town's zoning ordinance or bylaw.*

3.9 Design Standards

3.9.1 Lighting

Lighting of solar photovoltaic installations shall be consistent with local, state and federal law. Lighting of other parts of the installation, such as appurtenant structures, shall be limited to that required for safety and operational purposes, and shall be reasonably shielded from abutting properties. Where feasible, lighting of the solar photovoltaic installation shall be directed downward and shall incorporate full cut-off fixtures to reduce light pollution.

3.9.2 Signage

Signs on large- scale ground-mounted solar photovoltaic installations shall comply with a municipality's sign bylaw. A sign consistent with a municipality's sign bylaw shall be required to identify the owner and provide a 24-hour emergency contact phone number.

Solar photovoltaic installations shall not be used for displaying any advertising except for reasonable identification of the manufacturer or operator of the solar photovoltaic installation.

3.9.3 Utility Connections

Reasonable efforts, as determined by the Site Plan Review Authority, shall be made to place all utility connections from the solar photovoltaic installation underground, depending on appropriate soil conditions, shape, and topography of the site and any requirements of the utility provider. Electrical transformers for utility interconnections may be above ground if required by the utility provider.

3.10 Safety and Environmental Standards

3.10.1 Emergency Services

The large scale solar photovoltaic installation owner or operator shall provide a copy of the project summary, electrical schematic, and site plan to the local fire chief. Upon request the owner or operator shall cooperate with local emergency services in developing an emergency response plan. All means of shutting down the solar photovoltaic installation shall be clearly marked. The owner or operator shall identify a responsible person for public inquiries throughout the life of the installation.

3.10.2 Land Clearing, Soil Erosion and Habitat Impacts

Clearing of natural vegetation shall be limited to what is necessary for the construction, operation and maintenance of the large – scale ground-mounted solar photovoltaic installation or otherwise prescribed by applicable laws, regulations, and bylaws.

3.11 Monitoring and Maintenance

3.11.1 Solar Photovoltaic Installation Conditions

The large - scale ground-mounted solar photovoltaic installation owner or operator shall maintain the facility in good condition. Maintenance shall include, but not be limited to, painting, structural repairs, and integrity of security measures. Site access shall be maintained to a level acceptable to the local Fire Chief and Emergency Medical Services. The owner or operator shall be responsible for the cost of maintaining the solar photovoltaic installation and any access road(s), unless accepted as a public way.

3.11.2 Modifications

All material modifications to a solar photovoltaic installation made after issuance of the required building permit shall require approval by the Site Plan Review Authority.

3.12 Abandonment or Decommissioning

3.12.1 Removal Requirements

Any large- scale ground-mounted solar photovoltaic installation which has reached the end of its useful life or has been abandoned consistent with Section 3.12.2 of this bylaw shall be removed. The owner or operator shall physically remove the installation no more than 150 days after the date of discontinued operations. The owner or operator shall notify the Site Plan Review Authority by certified mail of the proposed date of discontinued operations and plans for removal.
Decommissioning shall consist of:

(a) Physical removal of all large- scale ground-mounted solar photovoltaic installations, structures, equipment, security barriers and transmission lines from the site.
(b) Disposal of all solid and hazardous waste in accordance with local, state, and federal waste disposal regulations.
(c) Stabilization or re-vegetation of the site as necessary to minimize erosion. The Site Plan Review Authority may allow the owner or operator to leave landscaping or designated below-grade foundations in order to minimize erosion and disruption to vegetation.

3.12.2 Abandonment

Absent notice of a proposed date of decommissioning or written notice of extenuating circumstances, the solar photovoltaic installation shall be considered abandoned when it fails to operate for more than one year without the written consent of the Site Plan Review Authority. If the owner or operator of the large- scale ground-mounted solar photovoltaic installation fails to remove the installation in accordance with the requirements of this section within 150 days of abandonment or the proposed date of decommissioning, the town may enter the property and physically remove the installation.

3.12.3 Financial Surety

Proponents of large-scale ground-mounted solar photovoltaic projects shall provide a form of surety, either through escrow account, bond or otherwise, to cover the cost of removal in the event the town must remove the installation and remediate the landscape, in an amount and form determined to be reasonable by the Site Plan Review Authority, but in no event to exceed more than 125 percent of the cost of removal and compliance with the additional requirements set forth herein, as determined by the project proponent. Such surety will not be required for municipally- or state-owned facilities. The project proponent shall submit a fully inclusive estimate of the costs associated with removal, prepared by a qualified engineer. The amount shall include a mechanism for calculating increased removal costs due to inflation.

6.2.9 Landscape buffer: Side yards, rear yards and the other lot lines noted in Table III shall be suitably landscaped. Such landscaping shall be designed to reduce the visual impact of the principal use upon adjacent property by the use of trees, shrubs, walls, fences, or other landscape elements. Where the developed area adjoins land developed for residential use, suitable landscaping shall consist of a substantially sight-impervious screen of evergreen foliage at least eight (8) feet in height or planting of shrubs and trees complemented by a sight-impervious fence of at least five (5) feet, but not more than eight (8) feet, in height, or such other type of landscaping as may be required under site plan approval. In all developments, to the extent practicable, existing trees shall be retained and used to satisfy the provisions of this Section 6.

Appendix 9 Summary of Municipal and Public Comment

Concord Solar Siting Committee Open House, September 14, 2011

Committee member Mark Myles greeted the audience, provided a brief overview of the purpose of the evening, and encouraged everyone to participate.

There were 6 stations presenting maps of each of the primary sites identified by the Solar Siting Committee.

Written comments from attendees submitted during the event were recorded via a prepared form. The comment forms were available at each map station, and committee members were available to answer questions and provide background for the entire two- hour duration.

Sample form:

Concord Solar Siting Committee - Feedback Form

Thank you for attending the discussion on Sept 14 at the Harvey Wheeler Center. Please Please take a moment to provide the committee your thoughts / reaction to the sites under consideration, and / or about including solar in the mix of Concord's energy sources.

Check below to indicate which topic(s) you are commenting on:

- ☐ Concord Carlisle High School
- ☐ White Pond Reservation
- ☒ Former Landfill
- ☐ Solar Power in general
- ☐ Sanborn School
- ☐ Concord Municipal Light Plant
- ☐ Sleepy Hollow & Wastewater Plant
- ☐ Other

HARRY BARTLETT
Name

Address

GREAT USE FOR A LANDFILL

Attendance was estimated at 60 people.

A group unrelated to the committee had a station offering information on alternative non-solar energy sources. A solar panel vendor attended with a display solar panel. Members of the Concord Board of Selectmen and the Town Manager stopped by to visit.

54 individual comments were received and tabulated as follows.

Concord–Carlisle High School	6 comments	Supportive	100%
Sanborn School	5 comments	Supportive	60%
		Neutral	20%
		Opposed	20%
White Pond Reservation	6 comments	Opposed	100%
Concord Municipal Light Plant	5 comments	Supportive	80%
		Opposed	20%
Former Landfill	12 comments	Supportive	83.3%
		Neutral	16.6%
Sleepy Hollow & WWTP	6 comments	Supportive	33.3%
		Neutral	16.6%
		Opposed	50%
Solar Power in General	12 comments		
Other	2 comments		

Transcribed comments received at Open House

In some instances comment cards with input on multiple subjects received minor editing for clarity.

Concord–Carlisle High School

6 comments Supportive 100%

- Obvious winner(s): Concord High School (perfect timing, fantastic specimen for science class)
- The High School is a good site, but I don't want to look at solar panels from my living room, I have a full view of the football field, and that's fine. It's too bad you can't use all the school roofs.
- Put panels on the roof, over the parking and as a barrier to Rte 2 and the RR tracks, so the kids can't access the RR tracks!
- I encourage strong deployment of solar power in general, with minimal ecological disruption, the high school seems to be a good candidate, but other sites should be considered as well.
- Solar panels at CCHS would be a good idea if incorporated into the new school design such as in roof panels.
- My priorities are CCHS, CMLP, Sanborn, Landfill, go, go, go!

Sanborn School

5 comments Supportive 60% Neutral 20% Opposed 20%

- My priorities are CCHS, CMLP, Sanborn. Landfill, go, go, go!
- We are so excited about Concord solar siting work. As abutters to one of the proposed sites, we recognize that we are only one family and want Concord to pursue green energies. A well-placed array in the SW of the Sanborn area looks terrific. The smaller northern parcel raises serious concerns for us. Even if that array were set back, that ridge is steep and sandy and removing trees would lead to serious storm water runoff, erosion and flooding. Our home would probably be flooded in the spring. Uncontrolled runoff could also jeopardize our source of drinking water (S well) because we cannot access town water.
- Why cut down trees? Put it on top of the schools and other buildings.

- The Sanborn School site should only be used if incorporated in a new middle school design sometime in the future.
- Sanborn School access problems exist, better to avoid if there are options.

White Pond Reservation

6 comments Opposed 100%

- Why use forested land for solar arrays? Use land that cannot be otherwise used, e.g., rooftops, the area over parking lots, the air over the sewage treatment plants. Preserve trees, preserve farmland.
- White Pond access problems exist, better to avoid if there are options.
- The Trails committee opposes any taking of land in the WPR for solar panels. This is recreation land with many trails and the land also buffers runoff into White Pond, a kettle pond. My personal opinion is any productive land – forest, agricultural, recreational, should not be taken out of service by solar panels. Look at large parking lots and flat roof buildings!! This is already unproductive except for parking and both can be accommodated.
- I support alternative energy, but I cringe at the thought of losing any trails at this site. I use all the trails in this land all year round with my wife and kids. It is a valuable recreation area. If it must be used for solar panels, please do NOT infringe on the existing trails. This site is inferior to sites that are not presently used for recreation. Any plans for this site should also be held up until the WP management plan is completed. On future meetings, please show existing trails and the White Pond Conservancy District lines.
- I'd stay away from this one. The areas seem small and not contiguous. Consider relationship to BFRT issue, this is a nice area with trails, I wouldn't disturb.
- While I support the cause of solar generation of electric power, I do not think it should occur at the cost of endangering an irreplaceable natural

resource area such as White Pond & the adjoining well field. Clear cutting in this area would increase runoff into the pond. The cleared areas would likely attract geese and other wildlife, increasing nitrogen runoff into the pond. In addition, the loss of woodlands would reduce the recreational usefulness of the area.

Concord Municipal Light Plant

5 comments Supportive 80% Opposed 20%

- I encourage strong deployment of solar power in general, with minimal ecological disruption.
- My priorities are CCHS, CMLP, Sanborn. Landfill, go, go, go!
- This site would be very convenient and would have minimal impact on neighbors.
- The municipal light plant appears suitable.
- Why use forested land for solar arrays? Use land that cannot be otherwise used, e.g., rooftops, the area over parking lots, the air over the sewage treatment plants. Preserve trees, preserve farmland.

Former Landfill

12 comments Supportive 83.3% Neutral 16.6%

- I favor this site above the others as the land is already damaged and has limited alternative uses. It is a good size so it could make a significant contribution. It could be adequately screened with perimeter vegetation. Need to investigate design details in relation to landfill cover, access, settling, etc. Open talks with the Walden Woods/Conservation lobby.
- I like this one the best. No current agricultural use, no trees to cut down, lots of towns are doing solar on landfill, large area for solar.
- Great use for a landfill.
- This parcel appears to be the best choice of all those presented tonight.

- I like the idea of the former landfill.
- Obvious winner(s): Former landfill (trees already removed, nice for "entering Concord" sign).
- Landfill appears to be ideal based on its present lack of use.
- I encourage strong deployment of solar power in general, with minimal ecological disruption, the landfill (and others) seems to be a good candidate, but other sites should be considered as well.
- My priorities are CCHS, CMLP, Sanborn. Landfill, go, go, go!
- The former landfill would be ideal if such construction is possible on the covered fill.
- Can this (Landfill) land be used for playing fields or other uses on its surface? If not, use it for a solar array, but first exhaust all other choices, rooftops, over parking lots, etc.
- Since this field is "reclaimed" and now nice wildlife habitat, please keep that impact in mind.

Sleepy Hollow & Wastewater Treatment Plant

6 comments Supportive 33.3% Neutral 16.6 % Opposed 50%

- I encourage strong deployment of solar power in general, with minimal ecological disruption, the WWTP seems to be a good candidate, but other sites should be considered as well.
- WWTP, the existing "ag" field is a terrific start, why not?
- Why not research which crops do best in partial shade, then cover the field with a solar panel array and growing something underneath that is amenable to shade? Are there any studies of productivity of crops at varying sun /shade levels?
- The waste water treatment plant appears suitable but Sleepy Hollow needs to be reserved for future burial plots in the future. The WWTP area would be suitable, in my view, only if the cleared land near the plant were used instead of the agricultural fields indicated. Agricultural land should not be

converted to power generation use. Concord can replace the power, it cannot replace farmland.

- Not clear what you are proposing at WWTP. If it intervenes with Hutchins Ag lease, this is the wrong place for a solar array and the Ag Committee will oppose it.
- Blandings turtles and current agricultural use seem to be big barriers.

Solar Power in General

12 comments

- I'm wondering if there are factors to consider relating to the grid connection (trench, etc) for each site. Such as: ownership easement along line to existing grid, can it connect at any point or are there line voltage capacity issues, wetland constraints. The White Pond sites made me wonder as they are rather isolated.
- Why do you assume that taking land is the solution to power arrays? 2) Have you considered rooftop arrays, schools, hospital, parking structures, etc.? 3) Have you considered micro level alternatives, 1 panel per phone pole, roof tops if residential homes? 4) None of the materials I have seen show analysis of trends. Is consumption trending up or down? Are there factors that will increase demand and conversely those that will decrease it? How do I know you won't be asking for big chunks of land every few years? 5) Have you considered partnerships with land rich communities that don't have the $ to develop solar or wind power?
- I believe that before cutting down any woods, the town should use all of the parking lots +flat roofs that are appropriate. I urge you to consider "solar canopies" (attached photocopies). Note that such canopies are not restricted to southern states but are being built in states that have snow and ice, like us!

  The Cincinnati zoo in fact claims to be building "the largest publicly accessible array in the country". Also, consider providing incentives to the

owners of private parking lots to permit the installation of "solar canopies", lots like the huge one on Baker Avenue.

- Why not rent the roof of Crosby's or other centers? Long term leases, use parking areas, the land over them.
- Why not buy Nuclear Metals site for this use? Why such an ambitious solar goal? 125 acres of this is not going to happen. Maybe it should not.
- Site solar arrays in town if possible for reasons of social justice, perhaps practicality as well if the electricity needs to travel far to get to Concord.
- I suggest prioritizing dual-use sites such as parking lots and animal grazing land. And putting cleared or damaged land before woodland. I have heard that agricultural land further west is attracting commercial solar companies' interest, so there may be an increase in supply – but a regional strategy to apply priorities as above would be ideal.
- Solar power in general? Absolutely. But tree removal, absolutely not (carbon dioxide wise).
- Providing a lease option is also a good idea for individual homes. Will Concord own their own systems? Owning is preferable.
- My preference is not to use agricultural or conservation & recreation lands. What about using large parking lots in town?
- We are so excited about Concord's solar siting work.

- Multiple questions submitted via document from 1 party:

  1) Has aging at a rate of 1% per year been considered in 25 year goal? 20% at 20 years. Data beyond 20 years very uncertain. This would be plus 5 megawatts over nominal or 30 megawatts.

  2) Has customer requirement of deliverable commitment considered annual fluctuations in solar energy? Estimate is +- 17% 07 25 megawatts nominal is 29,5 megawatts. Adding the above two paragraphs and actual capacity for nominal 25 megawatts would be about 34 megawatts or a

requirement of 34 megawatts or 170 acres for a guaranteed 25 megawatts in year 25.

3) Is the landfill soil sufficiently stabile and free from settling? Agricultural land will probably require payback of exemption taxes. Co-use with agriculture seems dubious. Most uses require sunlight even if "low lying" Consider mushroom farming.

4) What is the real cost per megawatt of power capacity or per KWH of solar if all subsidies and/or tax breaks are considered?

5) What are current costs per KWH of coal and gas?

6) Security costs. Solar panel thefts a significant problem in California.

7) Recent bids may have been different by a factor or two. Tioga low ball? Packaging. Willard School vendor was other bidder. two x. What is the basic stability of vendors and who is really liable? Unsettled state of U.S. panel mfr, - FBI raid. Will Chinese vendor cost subsidies maintain?

Other

2 comments

- All proposals to the town, WWTP, Amendolia were for Chinese panels. Why not spec American made panels, even if a little more expensive?
- Open space now used for active nature space should be avoided. The presence of nature of hiking trails is evidence of nature land. Goal of 25MW seems excessive without the use of non-Concord Land.

Transcribed by Coleman Hoyt.

Comments received on draft Executive Summary (June 2011)

Nick Pappas, Member, Public Works Commission

A. In section V, p. 37, the argument is made that "PV arrays have the most power on sunny days - just when power peaks are most likely due to the need for air conditioning". The term "most likely" is very important. There is no certainty that the peak load will occur during a sunny day, and the peak load will set our demand rate for the entire year. Not having enough power on the peak usage day is a major problem.

This also raises the issue of how energy will be stored, how long it can be stored, and the cost of the storage facility. This is a major cost in a project like this and must be part of the discussion since it affects our ability to meet that goal of assuring we have power to reduce the Peak Demand on the hottest day of the year.

B. The wooded lands of Concord, and the plants and animals living on them are one of the most important attributes of Concord, in my opinion. Concord will be a far different place if any significant reduction in our forested area occurs. I am strongly against reduction in wooded areas without MUCH more study and quantification of benefits and without seeing specific proposed changes.

C. I find the CMLP Renewable Energy Strategy to be unconvincing in some areas. It does not present a solid quantitative analysis. For instance, take the following statement on page 61,

> "Renewable energy prices have historically been higher than fossil fuel energy prices, but they are becoming competitive with fossil fuels due to market forces, federal and state incentives, and improvements in technology. When viewed in a long-term perspective, renewables tend to be more stable and predictable in cost than fossil fuels."

I do not know what "market forces" are being referred to, or the slope of the implied curve. I see no certainty that federal or state incentives will last or that existing ones will not be terminated - perhaps abruptly and after we make commitments to suppliers. And although fossil fuel prices may be unpredictable, there is no case made that their overall hedged price is not predicable. What specific prices are being assumed?

D. The same document offers some convincing reasons to generate power locally, but I would like to see a more rigorous financial analysis of the benefits and risks. I think it is especially important to identify the risks. Perhaps this analysis has been done, in which case, I would like it to be publicly available.

E. Couldn't peak demand be shaved by implementing Energy Storage alone? It would entail some risk, but I see no indication that any analysis has been done.

Brian Crounse, Member Concord Municipal Light Board

I think the Committee should make as a basic requirement of any solar project that we won't install anything, anywhere in town, that leaches pollutants (that exceed whatever standards are relevant).

Division of Public Works

The Public Works Commission, Public Works Director and staff welcome the opportunity to comment on the Solar Siting Committee's Draft Executive Summary and appreciate the efforts and hard work of the Committee in their development of this site evaluation.

Recognizing that Concord Public Works is a large consumer of energy in the delivery of its critical water, wastewater and public services, we support the

initiative to explore an alternative energy strategy in an effort to reduce the reliance on fossil fuels and promote sustainable public works practices.
After reviewing the draft executive summary received on June 27th, 2011 we provide the following comments.

A primary interest of the Commission and the Department is to ensure that any solar array facilities proposed to be sited at Concord Public Works facilities are compatible with, and do not preclude the use of the site for, the delivery of Concord Public Works core services. Applying this criterion, for example, Public Works has supported the use of portion of the filter beds at the wastewater treatment facility for a utility scale solar array anticipated to be constructed soon. In the case of any other potential solar project at the Wastewater Treatment site our concern will be whether, like the filter bed project, compatibility can be achieved or whether, given the current status of planning efforts underway to create increased wastewater treatment capacity, conflicts might arise. Until we gain a full understanding of treatment plant needs at the Site, any additional solar project will be a cause for concern and likely would not be able to achieve our unqualified support.

With regards to the potential use of the Landfill site for a PV system, we are fully supportive of this concept. Indeed, solar projects are a post closure use for landfills that is becoming quite common at many sites in the New England area following extensive regulatory permitting and engineering. The proposed use as a PV facility should be compatible with the current site use as a residential drop-off for leaves, brush, paint, etc. along with its critical municipal use for winter snow storage and storm debris staging. In addition, the PV facility should be compatible with the site's current function as a primary staging area for inert materials such as stone, sand and fill along with logs and brush. However, we would note that it is imperative that any final plan for the proposed use of the landfill site for solar arrays is done so with these critical operations, needs and overall Town interests in mind.

Finally, the Solar Committee is undoubtedly aware of (and clearly suggested in the executive summary) the significant legislative and regulatory hurdles associated with many of the public works sites identified in the study. Of particular note are the well sites that are subject to the "public trust" doctrine, which specifies that all land acquired for the purpose of water supply cannot be used for other purposes or diverted to another inconsistent public use, except by laws enacted by a two-thirds vote of each branch of the general court. This Article 97 provision would apply to many of the sites which have been identified in the study including the Benson well site and Jennie Dugan well site among others. Thus, while we are generally supportive in concept of PV projects we will all need to keep these regulatory constraints in mind as we proceed to the next stage of the process.

Harry Beyer, 52 Authors Road, Concord

A California son points out that his town is installing solar cells over their large parking lots. See
Los Altos High School parking lot: http://www.cei.com/projects/mountain-view-los-altos-high-school-district/

Has the committee considered this possibility?

Thomas Piper

Discussions of siting alternatives need to be accompanied by discussions of the economics of alternative energy sources today and in 20 years. One hears very different and, therefore, confusing views on relative costs. Also, the criteria adopted by the Siting Committee seem to ignore the "best alternative uses" of the various possible sites. I believe that this is a serious omission.

Chris Sgarzi, Chair, Planning Board

The Town owns plans for expanding the Sanborn School resulting in a single middle school. If this project (or an updated version of it) were to occur it might use up some of the land considered available in this report, but it might also

make more land available on the Peabody School site. This design was part of the Master Plan (10 years ago?) which included the three elementary schools and the middle school. There was never a determination about what the Peabody School site would be used for if the middle school became one building at Sanborn. Some of the discussions mentioned kindergarten, pre-k, administrative offices, sold to private developer, etc. as possibilities. It, in conjunction with the Ripley school site, should be considered for highest and best future use. These are both inefficient and outdated buildings.

The Master Plan failed and now each project has been picked off one by one, except the middle school. I suspect that once the high school project is completed, eyes will turn to the middle school needs.

Letters received after the September 2011 public Open House

TOWN OF CONCORD
NATURAL RESOURCES COMMISSION
141 KEYES ROAD, CONCORD, MASSACHUSETTS 01742
TEL. (978) 318-3285 FAX (978) 318-3291

September 21, 2011

Hugh Lauer, Chair
Solar Siting Committee
Town of Concord

Dear Hugh,

The Natural Resources Commission (NRC) applauds the Town's ambitious goal of developing 25 megawatts of utility scale solar generation capability over the next 25 years. We appreciate the difficulty of locating appropriately-sized sites and the balances that must be struck with other specific long-range goals including the preservation of open space and natural resources and protection of our agricultural resources. Furthermore, we note that each of the sites identified by the Solar Siting Committee may require permitting under the Massachusetts Wetlands Protection Act (WPA) and the Town Wetlands Bylaw. With the responsibility for stewardship of the natural resources of the Town and administration of the WPA and the Town Wetlands Bylaw in mind, the NRC offers the following comments on the draft Solar Siting Committee Report.

Of the A- and B-ranked sites, the NRC groups the sites into three categories (preferred, less preferred, and least preferred) based on their potential impacts to existing natural and agricultural resources:

Preferred: These sites are currently disturbed. Although wetlands permitting may be required, distance to the wetlands resource is great, separated by other development, and/or would require minimal or no tree clearing.

- Former Landfill – This site appears to present the least number of competing interests for other town uses. In addition to being currently disturbed, it is adjacent to existing infrastructure and requires no vegetation removal. Installation of a solar array at this site offers exceptional educational opportunities and could be coupled with an interpretive trail system highlighting the use of the solar array.
- Concord Carlisle High School (CCHS) – While some tree removal appears necessary to install panels at this site, the site presents good opportunities to combine the existing school use with solar use. In addition, much of the infrastructure is already in place. This site also offers excellent opportunities for interpretive education. Rooftop and parking lot panel installation is recommended for further consideration at this site.

Less Preferred – These sites are currently wooded, however they have only moderate value for habitat or recreational use because of adjacent development. Wetlands permits will be required, but the projects are likely permittable with appropriate controls. The NRC notes that the substantial tree removal required for solar installation at these sites diminishes their value for solar installation.

- Sanborn School –Substantial tree removal presents challenges for solar installation at this site. The NRC recommends that panels be constructed on the school rooftops and parking lots, perhaps combining this with an additional site to achieve utility scale solar. This site offers excellent opportunities for interpretive education.
- Concord Municipal Light Plant – Although the light plant occupies a sizable footprint, substantial tree removal near wetlands and two Certified Vernal Pools presents challenges for solar installation at this site. The NRC recommends that panels be constructed on the rooftops of the light plant buildings at this site, and parking lot, perhaps combining this with an additional site to achieve utility scale solar.

Least Preferred – Wooded sites with significant natural resources/open space issues.

- Sleepy Hollow Cemetery – Substantial tree removal presents challenges for solar installation at this site. It is also within rare species habitat and state NHESP approval may be difficult to obtain. There is an existing trail network in this area that would be lost, and infrastructure is not currently in place.
- Wastewater Treatment Plant Agricultural Fields – These fields have recently been returned to organic agricultural use, and represent a significant resource to the Town. The northern end of the field is specifically managed for nesting Blanding's turtles, and is frequently used for nesting sites. Placement of solar panels would have a significant impact on hatchling turtle development and would not likely be permitted under the state Natural Heritage and Endangered Species Program.
- White Pond Reservation – The White Pond Reservation is a heavily used open space adjacent to one of Concord's most sensitive natural resources. Development of this site, with required utility access, will have significant environmental impacts on the pond and its habitat.

In addition to these sites, development of portions of the two municipal well sites listed (the Benson Well Site and Jennie Dugan Well Site) are recommended for further analysis. It should be noted that installing solar on lands acquired for public water supply might require legislative approval under Article 97 of the state constitution, a time-consuming but not insurmountable hurdle. In addition, the Committee may wish to consider installation on the former Nuclear Metals site at 2229 Main Street. Though not currently owned by the Town, this 46-acre site is in the remediation process and is intended to be sold.

We appreciate the opportunity to comment on the draft plan and look forward to working with the Solar Siting Committee in the future to assist in increasing the Town's renewable energy resources.

Sincerely,

George Lewis
Chair

September 30, 2011

Dear Members of the Concord Solar Siting Committee,

I am writing at the request of Committee member, Emily Wheeler, to comment on your consideration of the Sleepy Hollow and Wastewater treatment Plant area as a site for a proposed photovoltaic array.

I believe that constructing a solar power generating facility in the town-owned field bordering Peter Spring Road and the Concord Wastewater Treatment Plant is ill advised. Rather than adding a new "use to this area, I believe that constructing a large-scale solar power array on the field would greatly diminish the area's existing utility, especially as critical nesting habitat for the threatened Blanding's turtle, *Emydoidea blandingii*. I explain my reasoning below.

I am a consulting ecologist, specializing in the conservation and management of rare reptile and amphibian species. I have a Ph.D. in biology and an M.A.in environmental policy, both from Tufts University. I am the initiator and the ongoing coordinator of a long-term effort to protect the Great Meadows population of Blanding's turtles and have worked in that capacity since 2003. For more than 20 years, I have also worked as a consultant on numerous development projects in which I have worked to find solutions that have both allowed planned development activities and safeguarded the status of rare wildlife populations. Additionally, I have lived with my family on Arrowhead Road, on the corner of Peter Spring Road, for the past 19 years and am a near-daily user of the open space provided by the Peter Spring Road field and surrounding woods.

Blanding's turtles are a rare and threatened species throughout their range in the United States and Canada, especially in the New England area. There are currently only three populations of Blanding's turtles thought to contain more than 50 adults in all of New England, one of those being the Great Meadows population of Concord, MA.

Since 2003, I have worked in collaboration with the Town of Concord, U.S. Fish and Wildlife Service, Mass. Division of Fisheries and Wildlife, Zoo New England, the New England Aquarium, and the Concord Land Conservation Trust to describe the status of the Great Meadows Blanding's turtle population. Having demonstrated that the number of adult turtles has declined by about 60% since previous research in the early 1970's, I have worked with my collaborators to manage the population in a way that would both likely result in a long-term increase in the population back to at least the level observed in the 1970s and to do so in a way that engaged people and minimized the constraints on human use of the habitats upon which the turtles depend.

For nine nesting seasons, my colleagues and I have radiotracked and searched for nesting female Blanding's turtles and have found that the Peter Spring Road field is the single most commonly used nesting site. The importance of this field as a Blanding's turtle nesting site has been known for decades and is cited in a peer-reviewed publication cited

below[1] The importance of the Peter Spring Road field area also formed the basis of the lease that the Town of Concord negotiated with Hutchins Farm to farm the area, stipulating that the northern approximately ¼ of the field be managed in a way specifically intended to maximize its value as Blanding's turtle nesting habitat.

I have found that Blanding's turtle nest throughout the entirety of the Peter Spring Road field area, with some preference for the area managed as turtle nesting habitat. I work with Hutchins Farm personnel to guarantee that their agricultural operations can be conducted in a manner that minimizes any inconvenience to the farmers yet helps protect the turtle nests. Typically, I place small enclosures around the nests that we find and report their locations to the farmers, who are able to work around them without difficulty.

During my work with the Great Meadows Blanding's turtle population, I have learned that the likely cause of their precipitous decline in numbers since the 1970's has been high levels of mortality among Blanding's turtle eggs and young juveniles. Our management efforts are therefore specifically focused towards protecting as many nests and hatchlings as possible so that they may, over the course of the coming decades, grow in to adults that can replace the mostly very old (50+ years of age) adults currently inhabiting the Great Meadows area. Currently, all 4th graders in Concord, 5thgraders in Carlisle, and CCHS students assist by raising (headstarting) young Blanding's turtles during their critical first 9 months prior to release back into the Great Meadows area.

One constant observation of ours has been that the successful production of nestlings from Blanding's turtle nests in the Concord area is directly tied to the amount of exposure that the nests have to the sun. In our area, near the northern edge of the turtle's range, any shading of the nests or relatively cloudy conditions during the 70-90- day incubation period, can result in eggs that fail to develop before cold autumn weather sets in killing the embryos. Moreover, even when the eggs hatch, females are produced only when the eggs are exposed the very warmest temperatures experienced in Concord area nests. (Blanding's turtle gender is determined by nest temperatures.) Our headstarted turtles are brought to either the New England Aquarium or Zoo New England where their genders are determined by surgical laparoscopy (the only method to do so). Among 25 headstarted turtles raised during the first two years of the program and surgically examined, *all 25 were males*. We have thus learned to manage some of the nests with care by cutting shading vegetation and even covering some with black plastic to produce warmer nest temperatures and a more even gender ration among hatchlings.

Since the efficiency of a photovoltaic array is dependent upon the amount of the sun's energy captured in the panels, the area under and directly surrounding the proposed industrial scale solar generation facility would deeply shade critical nesting habitat for the Blanding's turtle and result in an outright loss of suitable and crucial nesting habitat.

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[1] Linck, M.H., J.A. DePari, B.O. Butler, and T.E. Graham. 1989. Nesting behavior of the turtle, *Emydoidea blandingii*, in Massachusetts. Journal of Herpetology 23: 442-444.

Such a facility would compromise the work that many people, including many teachers and students in the Concord Public School system have worked towards over nine years.

The Peter Spring Road field area currently is a successful example of a multiple use area, it rather harmoniously supports wildlife conservation, agriculture, and recreational uses. Rather than adding a "use" to the town-owned Peter Spring Road field area, siting the solar array there would:

- destroy existing Blanding's turtle habitat,
- remove critical agricultural land from the Town,
- impair the enjoyment of the many residents that currently use the area for walking, skiing, bicycling, and other recreational purposes.

I am a supporter or "greener" forms of energy generation. Indeed, I volunteered my time to meet with both the original proponents of a solar generating facility at the Wastewater Treatment Plan and the state Division of Fisheries and Wildlife. At that meeting, I expressed my opinion that a solar array located atop unused settling ponds at the Wastewater Treatment Plant could be designed in a way that minimized any harm to Blanding's turtles. When it comes to any proposal to locate the arrays *on the critical nesting habitat of the Peter Spring Road field itself*, I am adamantly opposed and will communicate my opposition to the Division of Fisheries and Wildlife.

Thank you for the opportunity to provide these comments.

Yours Sincerely,

Bryan Windmiller, Ph.D.
Consulting Ecologist
65 Arrowhead Road
Concord, MA 01742
bwindmiller@gmail.com

sent via email to Emily Wheeler

I'm out of town for the week (and away from the few notes I wrote down about the sites) so will write what I remember. I think I wanted to note that the Benson well site on Ball's Hill was in one of the Natural Vegetation Areas of the Open Space Plan, and that clearing woodlands there for solar panels would affect the integrity of that 'patch'. At the sewage treatment plant, it wasn't clear where the panels might go, but as I'm sure you've heard, there are Blanding's turtles nesting in that area and I would guess that solar panels would negatively impact their sites, which need to be sunny. Both the town and the land trust have invested in Bryan Windmiller's research and management over the last 6-7 years. Possibly the intent was to clear the woods there instead?

Joan Ferguson

To: Julie Vaughan & Members of Solar Siting Committee
Cc: Comprehensive Sustainable Energy Committee
Subject: Feedback on Solar Siting Report
From: Charlie Parker
Date: September 20th, 2011

Hello All,

I attended the review meeting at the Harvey Wheeler Center and have read the report. I think the committee did an outstanding and professional job against a well-written and thoughtful committee charge. While I wish to provide comments, please do not construe any of this as critical of the committee or its work. My feedback is specific to 'what's next' as we pursue our 25 MW goal.

Near-Term Priorities: There are three high quality sites identified in the report for near-term action:

- #1 – CMLP: My sense is that it would be prudent to move ahead at Town Meeting next year with at least one of the parcels and my recommendation would be the CMLP site. This parcel is not next to any neighbors, it's of sufficient size to get us started in a substantive way, and it's in an area with other solar facilities (prison solar farm). As important, it's a CMLP site and that makes it a good functional fit. Of all the identified parcels, this should be the least controversial and has the best overall fit to our objectives.
- #2 – CCHS: The second priority should be the CCHS site. For CCHS, we'd want the interconnect for the power on the CCHS side of the meter which would enable CCHS to take advantage of 100% of power produced to offset it's bills. Our baseline shows annual CCHS consumption of 2.5MW. That's as much as $400,000 annually. Enabling CCHS to gain direct budget offset for some or all of this expense would be an incentive to both towns to agree on establishing a major solar facility. While the timing of solar at CCHS is dependent on many other design and project phasing factors, it's not too early to begin the work of establishing consensus on CCHS as our Number 2 Site.
- #3: The third priority should be the Land Fill site.

Immediate-Term Priority (A) -- Brownfield Development:

While I understand fully the reasons why the purchase of 'brownfield' properties was not included in the report or in the Committee's charge, I think it will be extremely difficult for the Town to proceed with the other identified parcels until we've completed our pursuit of at least one of the prime 'brownfield' sites. Before we move beyond the near-term priorities (lasted above) to the other identified sites, we should complete our pursuit of brownfield (and lease) sites in a way that either (a) rules-out or (b) enables us to proceed with utility scale solar on one of more of these areas.

Immediate-Term Priority (B) – Legal/Legislative Clearance to Use Well Sites:

The report identifies a number of sites that are possibly viable but which would require legislative action. Again, until this avenue is fully explored, all but the Near Term Priorities will be ruled-out by people who will claim that these other alternatives are better suited to solar.

Waste Water Treatment Site – Protected Habitat and Agriculture Fields:

The land that's currently being farmed by the Beemis Family and the adjacent unfarmed wildlife habitat (turtles) should be reconsidered. I do not agree that this area should be included in the list of 'ideal sites for utility scale solar'. First, this land was set aside for wastewater treatment. It would be prudent to retain it for that purpose. Second, we should consider agriculture as the absolute highest and best use for our property in Concord. This is not a battle we should be fighting, at least not at the very start of the discussion. The Town's firm policy on this property should be 'agricultural use' until required for waste water discharge or some other wastewater purpose. (We should take a similar approach on the wildlife habitat area. The same logic applies. This is not a battle we should be fighting now. While a mixed use could be considered for the land currently used by the turtles, why complicate our proposal unnecessarily.)

Conclusion:

The Solar Siting Committee's report proves one very important point: there aren't a lot of sites that we can consider as 'low hanging fruit'. We should pursue the few clear-cut cases now and concurrently move ahead with investigation of brownfield/lease and well sites. Once we're finished with this effort, we'll be in a position to finish establishing priorities for parcels that are more ambiguous than the three 'Near Term' sites noted above.

Hi folks -
I completely second Charlie's summary and recommendations. The only caveat is that the CCHS project presents significant ownership issues given the Regional School District interface, the largely treed nature of the site, and of course the design and implementation cost structure. I think all of these could be addressed with a comprehensive effort.

Peter Nobile

In case these are useful, here are a couple of links to examples of solar power installations in parking lots, with pictures.
http://www.igdnt.com/2009/10/dell-installs-solar-panel-in-hq.html
http://cybernetnews.com/googleplex-solar-power-project-in-3d/

I haven't found any examples of large arrays on grazing land, only smaller installations for farm water pumps etc. - although my guess is that it could be done, at a suitably low density.

Good luck with your investigations.

Cathy Perry

September 20, 2011

To: The Solar Siting Committee

From: The White Pond Advisory Committee

The purpose of this letter is to communicate the concerns of the White Pond Advisory Committee (WPAC) regarding the inclusion of the White Pond Reservation as one of the six sites recommend as suitable to develop 25 megawatts of utility-scale solar generation within the Town borders. As Town–appointed stewards of White Pond, we strongly object to the inclusion of the White Pond Reservation, and request that the Town remove this land from consideration for this use.

White Pond and the surrounding Conservation and Reservation Lands are irreplaceable natural gems, a resource used by many Town residents for multiple recreational uses, home to a wide variety of wildlife, and as much a part of the cultural legacy of Concord as neighboring Walden Pond. A solar installation on this site, including the array of panels, maintenance roads, and connecting wiring, would significantly degrade the quality and experience of any of these current complementary and popular uses.

Furthermore, as a kettle pond, with no outlets, the White Pond ecosystem is especially fragile and already burdened by surrounding development. The White Pond Reservation is entirely within the watershed of White Pond, and therefore any change in use of this land, both during construction and in operation, will surely change and negatively impact the Pond. Just this past year, The Community Preservation Act allocations included funding for the preparation of a White Pond Watershed Management Plan, which is now underway. It would be premature to commit to any proposal such as this, which could have such a significant impact on the Pond, before this plan is completed.

Despite this strong objection, the WPAC congratulates the Solar Siting Committee for developing such a thoughtful draft report and acknowledges the work that goes into such an endeavor. Furthermore, we also acknowledge that reducing pollution by generating power from renewable sources is indirectly good for the Pond.

For those reasons, and in support of the greater goal to develop 25 megawatts of utility-scale solar generation within the Town borders, rather than suggesting the sacrifice an irreplaceable natural resource such as the White Pond Reservation, we suggest that the town expand the potential options for how to achieve the goal by considering acquisition of more suitable property not currently owned by the town, such as the current stock of acres of paved parking lots and rooftops, or even better by investing in conservation and reduction in power demand.

While the Town could certainly find alternate options to reach the solar generation goals, the town can not acquire another property as rich and important as the White Pond Reservation or later undo any damage to the Pond that would result from altering the White Pond view shed and watershed.

The White Pond Advisory Committee

Chris Leary, Chair
Arra Avakian
Jerry Frenkil
James Lyon

James Lyon
51 Mitchell Road
Concord, MA 01742

September 15, 2011

Solar Site Feedback

I found last night's presentation to be most helpful. Your committee did a nice job laying it all out for the public to see. Thank you to the committee for your hard work

These are my concerns regarding the White Pond Parcels:

There is only so much land in Concord and I feel it is wrong to locate the solar installations in such pristine Town Reservation Land.

The parcels are larger than most other sites.

The site closest to White Pond at Sachem's Cove is much too close to the pond. It would clearly be seen from many directions and with illegal swim usage in that part of the pond security or vandalism could be an issue. Run-off, erosion, invasive species are all a concern as well.

The Town of Concord is currently funding a Watershed Management Plan for White Pond. That study must be implemented and completed before even considering this land.

The Trails Committee has recently finalized their blazes and map of the Conservation and Reservation land. These sites would all interfere with that system and change forever this pristine area.

I swim and or hike around White Pond almost every single day. It is an incredible resource and I see many people enjoying it to its fullest. Why would anyone want to destroy or change such valuable Town asset?

Thank you.

James E. Lyon

Good morning,

I am writing in agreement with the points made by the White Pond Advisory Committee in a recent letter to the Solar Siting Committee concerning the installation of solar arrays on the White Pond Reservation. I hope the Solar Siting Committee will give the White Pond Advisory Committee's letter careful attention.

I would like to add that I am concerned that the uses of that area of land south of White Pond, even before it became the White Pond Reservation, include dumping, night time recreation, the occasional fire and other activities supported by its size, "privacy", and relative inaccessibility to law enforcement. The Reservation seems to me to have a high potential for vandalism of the solar arrays and that should be a consideration in evaluating its use for that purpose.

Sincerely,

Judith Sprott

I and my wife Pat strongly agree with the concerns expressed by the White Pond Advisory Committee (WPAC) regarding the inclusion of the White Pond Reservation as one of the six sites recommend as suitable to develop 25 megawatts of utility-scale solar generation within the Town borders.

White Pond and the surrounding Conservation and Reservation Lands are irreplaceable natural gems, a resource used by many Town residents for multiple recreational uses, home to a wide variety of wildlife, and as much a part of the cultural legacy of Concord as neighboring Walden Pond. A solar installation on this site, including the array of panels, maintenance roads, and connecting wiring, would significantly degrade the quality and experience of any of these current complementary and popular uses.

The White Pond Reservation is entirely within the watershed of White Pond, and therefore any change in use of this land, both during construction and in operation, will surely change and negatively impact the Pond.

Thanks in advance for considering our objections and concerns. We hope that you'll remove the WP Reservation from the list of recommended locations.

George and Pat Barnard

Dear Solar Siting Committee,

I am writing to convey my thoughts on your draft report and presentation on Tuesday, Sept 12 at the Harvey Wheeler Center. By way of full disclosure, I should mention that I am an electrical engineer with deep interests in power issues. I am also an active user of White Pond and its environs as well as a member of the White Pond Advisory Committee, however I speak for only myself in this letter.

Overall, I very much support the goal of local energy production and am pleased that the town has embarked on an effort to add substantial amounts of alternative energy to the town's energy portfolio. Furthermore, I appreciate the tremendous effort contributed by the Solar Siting Committee in surveying town properties and in explaining and communicating the committee's conclusions. However, I have some concerns about the committee's charge and some of the report's conclusions. My concern over the charge is that a narrow definition - utility scale only, 5 acre site minimum, parcels only currently owned by the town - can lead to sub-optimal conclusions. I also have concerns regarding the conclusions regarding the White Pond parcel with respect to the conversion of a multi-use property into a single use property. I will elaborate below.

Certainly, locally generating a significant portion of Concord's power consumption is a tall yet admirable order, and the draft report clearly notes that - it seems that the goal of 25MW is a major challenge, at best, given the committee's specific charge. Thus, I would argue that the charge is excessively constrained. From an engineering perspective over constraining the problem definition is known produce sub-optimal results. In this case, I believe that the sub-optimality will manifest as the conversion of properties to PV power that are better suited to other purposes along with not converting some of the best suited properties. For example, in the report I saw little discussion of municipal parking areas (other than at the high school). Other areas in town would appear to be suitable (parking lots at Concord elementary and middle schools as well as parking areas downtown and on Baker Ave) but perhaps were ruled out because of the 5 acre minimum or the requirement that the parcels be currently owned by the town.

Of further concern is the issue of converting multi-use properties to single use (PV only). While the report noted that converting any property to PV production would require balancing competing requirements, I saw no discussion addressing those competing requirements. For example, converting the CCHS parking area to PV production *adds* an additional use to the original use of parking. Converting the Wastewater treatment parcel to PV production *replaces* the original use. And in the case of the White Pond Reservation parcel, the PV production would replace *multiple* uses - recreation, wildlife habitat, and watershed buffering. I submit that single use properties should be considered for PV installation in all cases prior to consideration of multi-use properties, and that this consideration be specifically added to the report.

The issue of multiple uses is particularly pertinent to the consideration of the White Pond Reservation parcel. One of the uses, watershed buffering, is an essential mechanism for aquifer protection and is especially important in this case as White Pond is part of Concord's aquifer. In addition, as White Pond is a spring fed kettle pond with no outlet, whatever contaminants find their way into the pond have no way of flushing out.

As one particular example of a specific concern, the leading American producer of PV cells - First Solar - manufactures their cells using a compound semiconductor, CdTe or Cadmium Telluride. Cadmium is

extremely toxic. Any damage to PV arrays built with CdTe cells presents a real danger of releasing Cadmium into the environment, a completely unacceptable risk in the White Pond watershed.

The case of Barton Springs in Austin, Texas is unfortunately instructive. Barton Springs is a much beloved and widely supported natural spring in a creek bed in central Austin. In the mid 1980s a controversial development was built upstream of the springs, the controversy centering on the potential impact to the springs. To make a long story short, the development occurred and now, after rains, the springs are closed due to contamination from runoff. Fortunately, the springs usually flush the contaminants out a number of days after the rains (unlike White Pond, which has no outflow). Recalling this situation, which bears some similarities to the proposed PV installation around White Pond, I cannot support a large scale (multi-acre) development within the White Pond watershed.

In conclusion, while I support CMLP's efforts to increase renewable energy production, I can support only some of the committee's recommendations for appropriate PV sites in town. I am completely opposed, for the multiple reasons described above, to converting the White Pond parcel to PV production. I instead suggest identifying other parcels that may not been considered, especially various parking areas, due to the constraints placed on the committee's charge.

Respectfully,

Jerry Frenkil