Key Design Principles[1] (Final)
Middle School School Feasibility and Design Study

These Design Principles are a distillation of the key elements of the design approach that was referenced in the Town Meeting Amendment to the Feasibility and Design Study Article and was communicated to the Concord School Committee at Town Meeting. The purpose of these Principles is to provide a sustainability framework that should be followed in the design process.

Text of Amendment to Article 14 at Town Meeting and Implications for Design:

'The feasibility and resulting design specification shall be consistent with Concord's sustainability principles and with Concord's goals for reducing greenhouse gas emissions, requiring both an all-electric design and Zero Net Energy-ready building and site capabilities. While the Town urges the School Building Committee to conduct its feasibility study with all-electric/ZNE-ready as the preferred design, other alternatives may be considered. The third-party hired to perform this feasibility study and school design should have demonstrated competencies and experience in all-electric/ZNE building design.'

The implications are twofold: First, the new school building should be fossil-free (all electric). Second, the amount of energy consumed by the school building should be matched by an equivalent amount of energy produced on site ('Net Zero'). Annual kWh consumption on the site = annual PV production from the site (roof, parking lot canopies, etc.).

Best In Class Energy Efficiency:

Net Zero buildings meet the most stringent energy efficiency standards. As such, Net Zero buildings are in a class by themselves, performing significantly better than buildings that simply meet 'code' or which are designated as 'high-performance'. The Energy Use Index (EUI), which measures the energy consumption per square foot, should be used to establish metrics for the design process and distinguishes net zero from 'code' and high performance buildings.[2] The highest, best-in-class efficiency, *as measured by EUI*, is required in order to meet these fundamental Net Zero requirements in a cost effective way.

Efficiency Through Passive Solar Design:

While efficiency in the mechanical systems is important, efforts to reduce building energy requirements start with optimizing the building design to take advantage of the sun for day-lighting and passive heating/cooling. And, the building should be oriented and designed to maximize the exposure of the roof for PV.

High-End Building Envelop (Thermal Control Layer):

The envelope needs to incorporate the highest standards for doors, windows, slab, and roof. Minimizing heat loss is far less expensive than building additional PV capacity on-site to compensate for heat loss.

[1] Our Thanks to William Maclay, and Mcclay Architects, from whose concepts we have liberally borrowed.
[2] Maclay, William, *The New Net Zero*, Chelsea Green Publishing, 2014. Typical Existing 'pre-code' schools at 83 EUI, Code schools at 45-55 EUI, High-Performance at 25-45 EUI, and Net Zero at 10-25 EUI.

Heating:

In a fossil-free building, heating is accomplished though air-source and/or ground source heat pump technology.

Ventilation:

Given the high efficiency of the thermal control layer in a Net Zero building and the resulting lack of air infiltration, a ventilation system to provide fresh air to the building is required. In order to provide the desired fresh air while minimizing the heating load, the ventilation system needs to be separated from the heating system. This allows for the use of a heat/energy recovery system to conserve energy as air from the building is exchanged for outside air. This approach has the advantage of fine-grained control over the fresh air volume and allows for exceptional air quality, while conserving the energy in the building's heat.

Energy Loads:

In Net Zero design, energy loads (plug loads, heating/cooling, hot water heating, ventilation, and lighting) are modeled to achieve the EUI metric. This includes 100% reliance on outdoor light when it is available and sufficient control of fresh air ventilation to allow for adjustment to the level of occupancy expected for each room. As load increases, the PV requirement also increases.

Hot Water (and water in general):

Hot water is typically 4-5% of overall load for an educational facility. The best practices involve solar hot water collectors (i.e. roof-top Domestic Hot Water (DHW)) or electric resistance DHW with PV collector. But, as with many other of the Net Zero principles, reducing hot water demand is the first and most important requirement – high efficiency dishwasher, low flow faucets, and showers, and the use of heat recovery for gray water. Likewise, technology needs to be leveraged to reduce overall water consumption.

Site Design

The site design should allow for the reuse of storm-water runoff for irrigation.

Net Zero-Ready:

Net zero-ready allows for an end-to-end design of a 100% Net Zero building, including all of the PV capacity required for fully compliant net-zero building. However, this approach allows for a limited initial build-out of the PV system that includes roof-ready enhancements, conduits, and site improvements with a commitment to add the necessary capacity for 100% net-zero. Initial design and specification needs to include costing of both the PV infrastructure and the PV panels/arrays.

Embodied Energy

Embodied energy is the remaining energy required for the remaining elements of the lifecycle. Design should assume best practices in selecting use of low-carbon building materials (foundation, structural, windows, etc.). And, best low-carbon practices should be followed in disposing of the existing school buildings.