Climate & Climate Change –The climate of Albuquerque, NM is ASHRAE Climate Zone 4B – Mixed and Arid at an elevation of approximately 5,000 ft. Winters are cold and summers are hot. The daily diurnal range is typically more than 30 degrees. The historical average annual rainfall is 8.1" per year. Climate change is impacting Albuquerque significantly: the average annual temperature has increased rapidly (0.6 F per decade since 1970 on average) and average annual rainfall reduced. These trends are expected to continue; Albuquerque is forecast to get still hotter and even drier in the coming years.

Site Selection & Program – The site was chosen based on our research into Albuquerque Public School District's strategic plans to build shared campuses that support students from elementary to middle school and even through high school. Located in district five, we discovered Jimmy Carter Middle School which is currently utilizing modular classrooms. Locating our project North of Los Volcanes Road NW, alleviates the Middle School's limited space and enables the sharing of educational resources for both the Middle School and surrounding neighborhood to use. Through research, the team reduced the total square footage to 72,700 SF (from 75,000 SF) while still satisfying the requirements of the Albuquerque Public Schools Design Standards and exemplifying STEM-based programming.

Building Systems – Multiple envelope strategies were studied. Ultimately, a high thermal mass wall was selected for the exterior with an R-38 insulated roof. This was selected to minimize the embodied carbon of the envelope materials and maximize the use of the large daily diurnal range available from using a high thermal mass construction. Earth berms and plantings were placed to reduce the wind's convective cooling effect – enabling further optimization of the high mass construction for use as a "thermal battery". Initial studies concluded the current climate of Albuquerque was conducive to a fully passive design using only an earth tube coupled with thermal mass and night flush to achieve comfort for about 90% of the occupied hours of the school. However, subsequent analysis of projected warming due to climate change showed those strategies to be ineffective as the temperature climbed. In addition, the passive-only design would have limited the usability of the building as a shelter for "climate refuges" and reduced the comfort for community members who may have needed to seek shelter here from power outages, wildfires, or other climate change "enhanced" disasters. Thus, the team decided to pursue a ground-source heat pump system with airside energy recovery in lieu of the all passive approach to enhance adaptability and durability to the building and building systems for future generations and the broader community.

Energy – The systems selected to minimize operational energy include GSHP, night flush during warm months, IAQP-based ASRHAE 62.1 compliance to reduce peak OA, solar hot water is used to pre-heat OA and DHW, the WWR, glazing specs, and fixed exterior building shades are optimized to balance daylight with minimizing heating and cooling loads and energy.

Indoor Air Quality & Thermal Comfort – A DOAS system with MERV 13 primary filters is augmented by IAQ monitoring and sorbent air cleaning to continuously monitor CO2, formaldehyde, and other contaminants. The system removes or kills 99.99% of airborne viruses. Comfort is enhanced with ceiling fans in classrooms and common spaces.

Water – Based on the available literature for climate change impacts in the area, conserving water is a critical strategy. Roof rainwater harvesting, 70,000-gallon cistern, and low-flow fixtures reduce the building water demand by 74%. Parking lot rainwater harvesting enables irrigation of the outdoor playfield which was sized based on the available rainwater harvesting. Below-grade drip irrigation system for the playfield reduces water evaporation by 90%. Native drought resistant plants were selected for the earth berms that shelter the building from the wind and reduce convective losses/gains.

Operational Carbon – The building reduces operational carbon by 68% by using a 1 Mwh battery system with PV. The battery is charged most of the year through the building PV system and charges from the grid during the day when the grid is cleaner. The battery also "peak shaves" to reduce utility demand charges, functions as a source of clean power for the onsite electric vehicle chargers and provides 4-8 hours (depending on season) of emergency power for the building.

Embodied Carbon and Materials – Embodied carbon calculations played a role in materials selection and was weighed against operational carbon savings. Environmental Product Declarations (EPD's) were also a preferred criteria in materials selection; products/materials with EPD's were given preference over products/materials without them. Phase Change Materials (PCM) were not selected, in part, because EPD's are not available for the products studied – even though they would save operational energy and carbon.

Adaptability & Durability– The design supports educational adaptability through movable partitions and walls. The flexible classrooms not only benefit the longevity of the spaces needed over time but also increases everyday students' engagement. Classrooms are encouraged to collaborate by opening their adjoining folding walls. In addition, the building is sited adjacent to an existing middle school which supports an adaptive campus. The building is intended to be used by the community as needed: for community events including elections and in times of emergency – e.g. a temporary "home" for climate refugees seeking shelter from natural disasters like wildfires. The operational performance and systems selections were also based on an analysis of a hotter climate and the building features adaptable systems that perform well in both today's climate and the hotter climate of the future. For example, the GSHP system design includes solar hot water pre-heat setpoint that can be adjusted as the climate warms to keep the loop in balance.