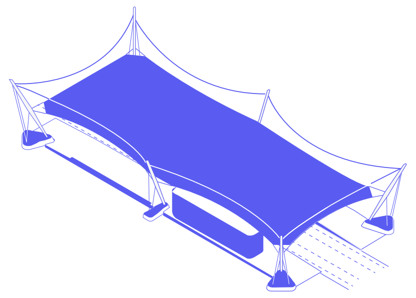
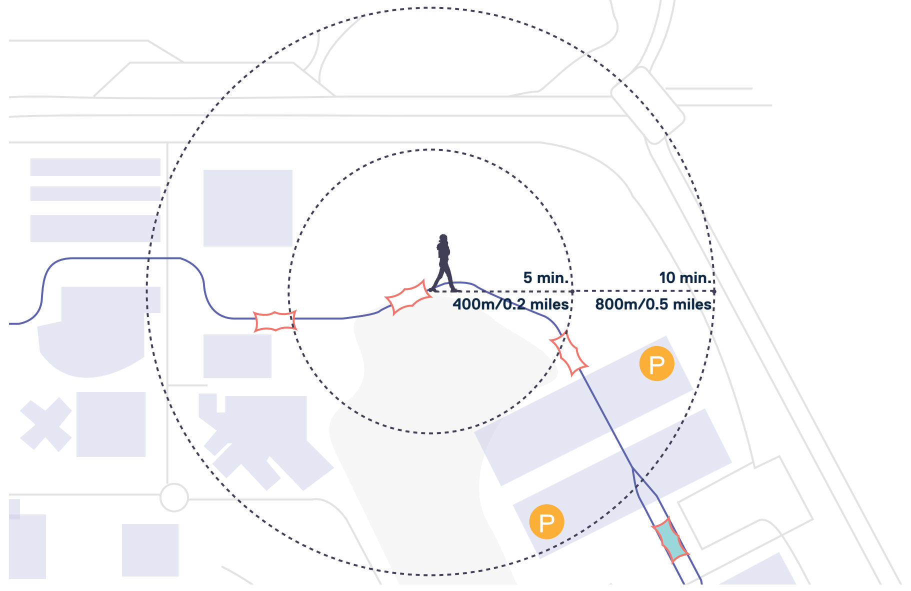
QATAR EDUCATION CITY TRAM STOPS



SUSTAINABILITY AND REGENERATIVE DESIGN CASE STUDY

The sustainability drivers for the Tram Stops at Education City were material reduction, ephemeralization through lightweight structural design and systems integration, and energy reduction through passive design optimization. The project brings a new form of transportation to Doha in the form of fast, efficient electric transit. Utilizing a first-of-its-kind catenary free system, the seventeen open-air stations are a model of efficient grace. A carefully articulated steel and glass canopy shades waiting areas below and hold quick-charge infrastructure that delivers power to trams at each stop. Small indoor waiting enclosures are joined by screens that mitigate sunlight to keep waiting passengers cool. The completed system provides key infrastructure on the campus that integrates the tram with other forms of access including walking, driving and cycling.

Location	Doha, Qatar
Completion	2019
Client	Qatar Foundation (Owner), ASTAD, Siemens and Habtoor Leighton Group
Project Partners/Lead	Juan Porral, Mark Husser/ Greg Haley, Iouyu Chen
Project team	Grimshaw, Schlaich Bergermann Partner, WSP, Front Inc, Arup, ECG



← Walkability
The completed system aims to allow for easy transit of the Education City campus, providing key infrastructure that integrates the tram with other forms of access including walking, driving and cycling. The stops are located 400m, or a five minute walking distance, from one another.

TRAM STOP
STATION
PARKING

The electrically-powered tram system, which uses a groundbreaking form of battery-charging (modular on board energy storage unit) technology, is open to the public and carries passengers around Qatar Foundation's 'Academic Loop' – where it's numerous schools and two universities are located, as well as the Green Spine and the Education City Stadium. The implementation of a hybrid energy storage solution allows for a catenary free tram to avoid the visual impacts of an overhead contact system. The tram operates by charging via pantograph contact to an overhead charging rail located at each station and stop. For tram operation between stops, the power is provided by super capacitors, and in the case of degraded modes or long distances between charging stations, by a battery. Depending on the topography of the line, charging times are expected to be between five and 22 seconds, and a calculated dwell time of 20 seconds covers the required charging time.

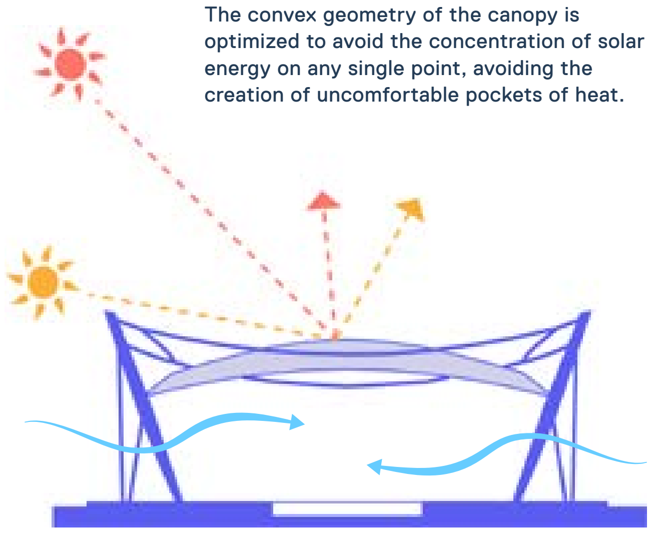
The design challenges lie in the structural design, climate responsiveness and user comfort. The original design concept for the tram stops is based on an integration of structure and enclosure in such a way that the architecture and the structure become essentially one and the same. The minimal enclosure that results, in the form of the mast supported canopy hovering above the platform, demands a careful integration of the myriad building services required to support the tram stops. To achieve a high level of integration, the support structure for the overhead charging rail is utilized as an armature for service routing resulting in a sort of central nervous system of power and data hovering between the canopy and the platforms.

Regarding the canopy, this structural configuration involves a cable net suspended above 6 columns, and allows for clear views into, out of, and through the stop. The configuration offers opportunities for enhanced daylighting, transparency and visibility. Further, the design of the whole cable net structure was developed to be prefabricated which not only offers added quality assurance. Moreover, constructing pieces quickly offsite result in reduced pollution and disturbance of jobsite. The controlled shop environment saves on water usage and enables the recycling of scraps and other materials. Additionally, the repetition of custom elements supports the concept of a line-wide identity while also enabling a more efficient fabrication and construction process. An economy of scale is achieved in the production of repeated elements, with further efficiencies realized in the erection of such structures, where the same erection process can be employed for multiple structures.

The extreme heat of the region posed a significant challenge regarding passenger comfort. The exterior under canopy waiting platforms as well as the interior waiting rooms included at each stop elevates the passenger comfort with both passive and active design measures.

Underneath the canopies, a glass-enclosed waiting room is situated on each platform to provide a conditioned place for waiting during extreme weather. The waiting areas are the only spaces being conditioned in the project. Two indoor units are provided for each waiting area each sized for 50% capacity. If one unit was to fail the remaining unit would provide 50% of the peak load. The client envisioned a state-of-the-art LRT system that set new precedents in sustainable design. This has been realized in part through an architecturally integrated battery-powered system that relies on 'recharging' at each station or stop. The project's innovative and ambitious charging stations and stops begin to realize the future of sustainable LRT travel.

Reflection angles ↓
The convex geometry of the canopy is optimized to avoid the concentration of solar energy on any single point, avoiding the creation of uncomfortable pockets of heat.



Alignment with UN Sustainable Development Goals

SDG 3 GOOD HEALTH AND WELL-BEING
Design encouraging of mass transit use and is integrated into pedestrian friendly public realm, designed/configured to provide convenient intermodal connections.

SDG 8 GOOD JOBS AND ECONOMIC GROWTH
New stations provide broader access within the metropolitan area between housing and places of work and education.

SDG 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE / SDG 11 SUSTAINABLE CITIES & COMMUNITIES
The state-of-the-art LRT system sets a new precedent in sustainable design through a battery powered system that relies on 'recharging' at each station or stop.

Key Sustainability Facts

PROJECT SITE
Greyfield

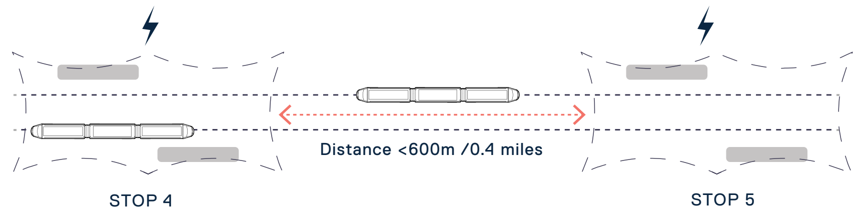
TRANSECT ZONE / CLIMATE ZONE
Campus zone / 1B

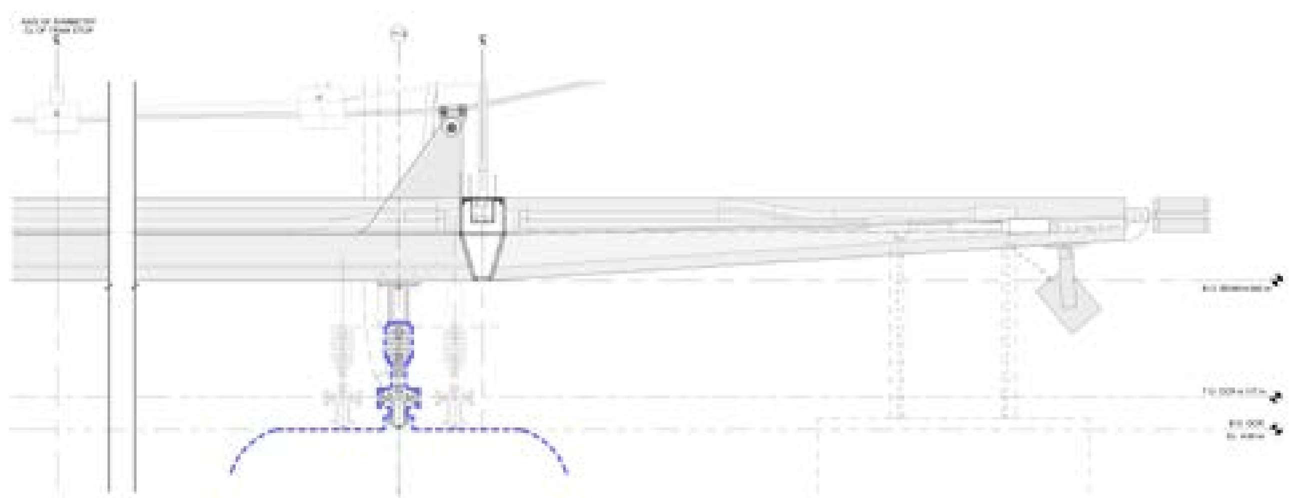
ECOREGION
Palearctic / The Arabian Desert and East Sahero-Arabian Xeric Shrublands

OPERATIONAL ENERGY/CARBON ENERGY USE INTENSITY
> Optimizations were focused on reducing the need for active systems
> The design provides for passive cooling at exterior, and active cooling at interior waiting areas with two DX split type fan coil units when occupied, each until with a total cooling capacity of 11.2kW.

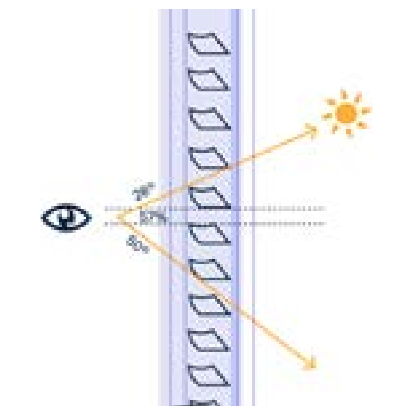
EMBODIED CARBON
> Optimizations were focused on design for durability, ephemeralization of structure, reducing materials and waste.
> The tram stops are constructed using a "kit of parts", a combination of prefabricated components, enabling a more efficient fabrication and construction process, including architecturally exposed structural steel, cut stone, laminated glass and machined hardware.

Charging Stations →
Trams run without any overhead contact lines between the stops. The trams are equipped with the Sitras HES energy storage system from Siemens, with energy being supplied at the tram stops via an overhead conductor rail system. The trams recharge at each station stop within 20 seconds.

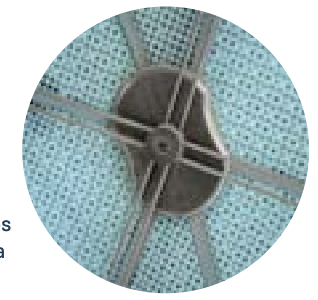


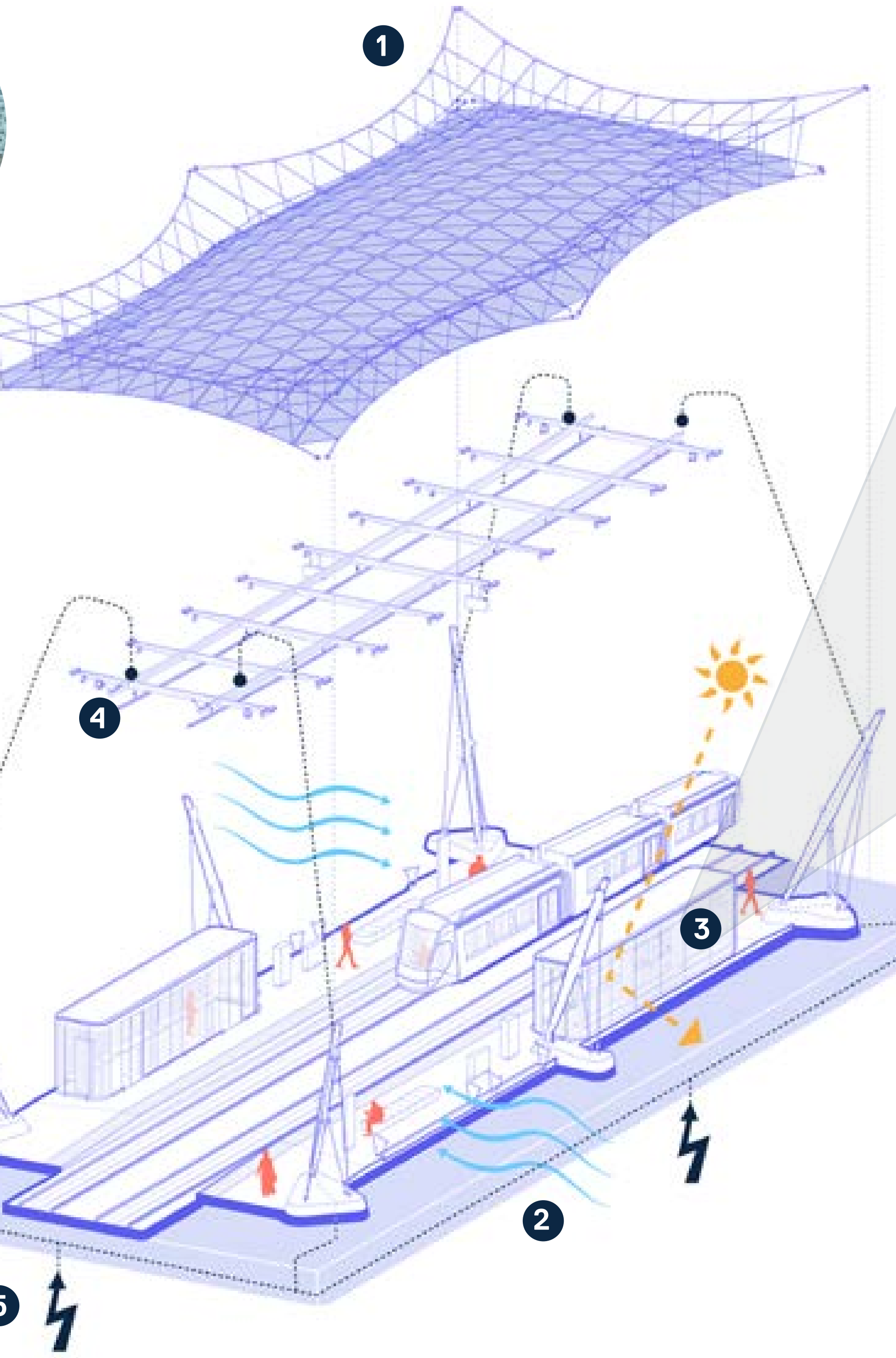


Louver system ↓
Louvers allow for transparency at eye level while shading or reflecting light above and below. The Okasolar F U Louver product reflects the majority of solar radiation back into the atmosphere. The extremely narrow cross section allows the horizontal transparency to be optimized at 57%.



Canopy integrated design detail ↑
The steel support frame is suspended from the canopy's cablenet which secures the overhead charging rails as this provides power to the tram's high capacity batteries only while at the stop. The support frame also distributes a network of concealed power and data cables to lights, signage and security devices hung above the waiting platforms.





Exploded axonometric diagram →

1. The arrangement of the glass panels that comprise the canopy is designed to provide shading during the day, and to reflect light and project the night sky in the evening. Canopy integrated PV systems were extensively studied. Available solar energy falling on an unshaded canopy is between 1550 and 1850 kWh/m^2 annually. Further review concluded that PV would not be appropriate for two reasons: (a) providing areas for canopy maintenance access would reduce the area available for the PV arrays which reduces the energy output considerably, and (b) shading for some stations that are located close to tall neighboring buildings would also have a significant reduction in output power production.
2. The open-air design allows for cross ventilation of the platforms.
3. To reduce cooling loads in the waiting shelters, the glass facades have an IGU integrated fixed louver system to optimize incidental light and shading. These glass facades selectively transmit daylight and protect against solar heat gain in order to create a comfortable waiting environment. A single waiting enclosure will be approximately 28,000 kWh annually for the HVAC system and lights.
4. The structure supports components for the tram's unique propulsion system, a hybrid energy storage solution that utilizes batteries that recharge via an overhead charging rail at each stop. This system eliminates the need for expensive and obtrusive overhead catenary wiring. The charging rail acts as a sort of central nervous system of power and data, hovering between the canopy and platform.
5. Power for the charging rails comes from an underground substation nearby and is routed up the corner columns. The high voltage system is completely contained/hidden within the structure.

↓ Transit choice
The safe, comfortable setting provided by the trams encourages people to select it as an alternative to car trips.