SYNERGY
DIEGO BAZZOTTI

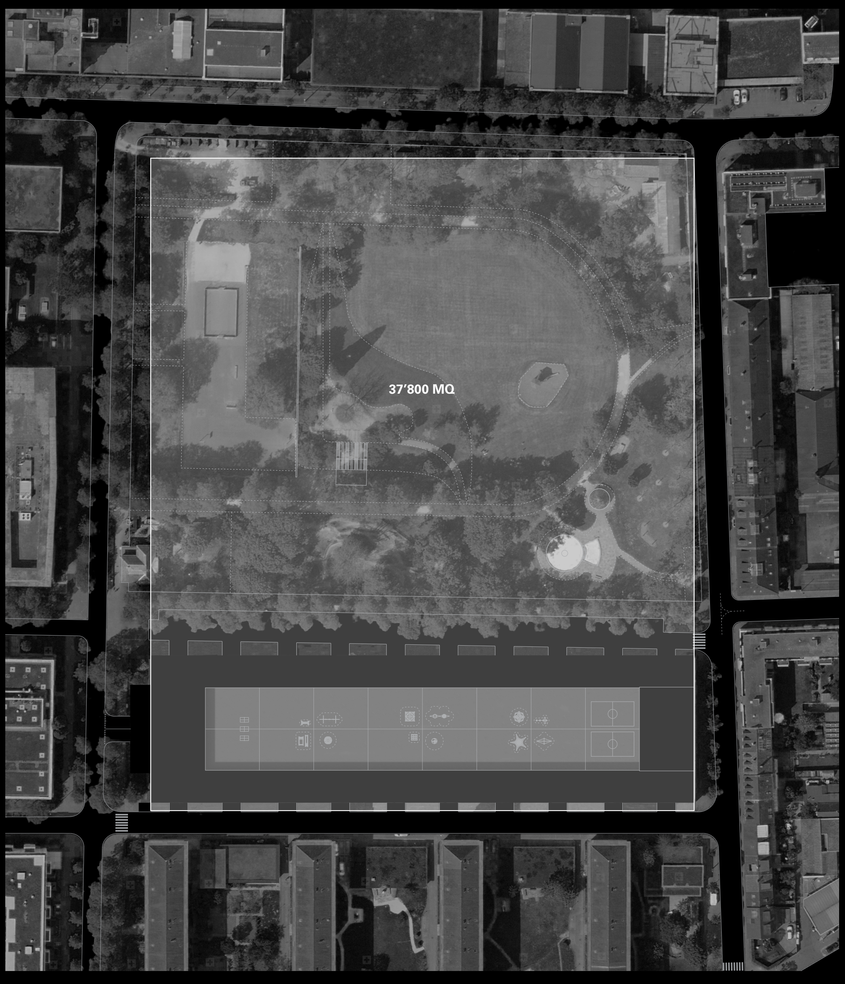
Part of the project involved the designing of a solar canopy that can shelter a school situated over a parking and the neighbouring park, while producing the necessary energy to recharge the parked cars and power the school.

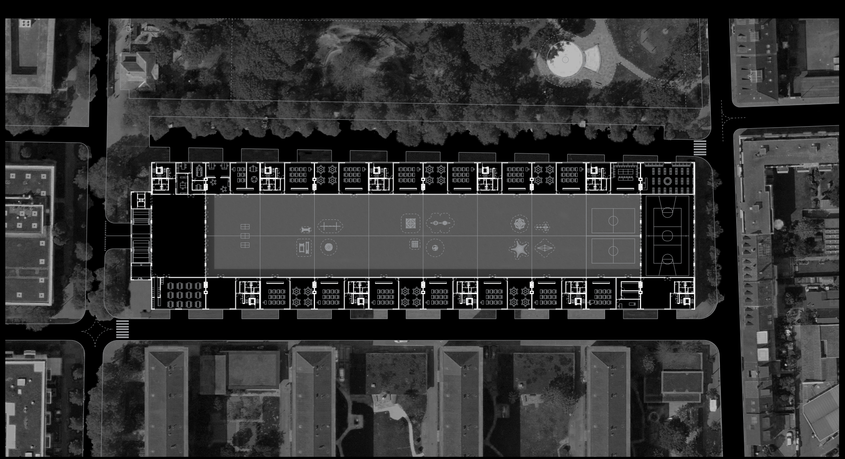
The roofing consists of concentrated photovoltaic panels, which use lenses to focus sunlight on tiny but efficient solar cells (29% yield). Alignment with the sun is ensured through the horizontal movement of the lens array. The coverage also ensures that the physiological needs of the plants are respected. For a few hours of the day, the panels decrease their energy performance to redirect the light onto the vegetation below.

The access at the roof for maintening and cleaning the panels is done through mobiles platforms that slide on rails above the panels.

The heat produced by the cells, which leads to a decrease in efficiency, is removed and stored under the parking lot, to be used for heating the school and the surrounding homes. A borehole seasonal storage system ensures that the thermal energy needs of the projects and of part of the surrounding buildings is met all year round. This system is model after a similar project located in Okotoks, Canada,

Rainwater is captured and stored in tanks placed above the vertical supports, and is used to water the park at night. The drainage starts from the rails that supports the panels, which have an integrated gutter in their profile. The tank are also connected to the city water system, in order to ensure that the water needs of the plants are met also in dry periods.





DEVICES	SURFACE AREA	*UNIT VALUE	ENERGY NEEDS
CLASSROOM	1’941 M2	4 KWH/M2	7’764 KWH
ADMINISTRATIVE	272 M2	3 KWH/M2	816 KWH
LIBRARY	175 M2	2 KWH/M2	350 KWH
CANTEEN	175 M2	2 KWH/M2	350 KWH
GYM	665 M2		4’270 KWH
TOT			13’550 KWH

LIGHTING	SURFACE AREA	*UNIT VALUE	ENERGY NEEDS
CLASSROOM	1’941 M2	6 KWH/M2	11’646 KWH
ADMINISTRATIVE	272 M2	3 KWH/M2	816 KWH
LIBRARY	175 M2	3 KWH/M2	525 KWH
CANTEEN	175 M2	4 KWH/M2	700 KWH
GYM	665 M2	9 KWH/M2	5’985 KWH
CIRCULATION	510 M2	5 KWH/M2	2’550 KWH
STAIRWELL	2’520 M2	2KWH/M2	5’040 KWH
WC	225 M2	5 KWH/M2	1’125 KWH
TOT			28’387 KWH

VENTILATION	SURFACE AREA	*UNIT VALUE	ENERGY NEEDS
CLASSROOM	1’941 M2	2.5 KWH/M2	4’852 KWH
ADMINISTRATIVE	272 M2	2.5 KWH/M2	680 KWH
LIBRARY	175 M2	1.5 KWH/M2	263 KWH
CANTEEN	175 M2	4.7 KWH/M2	823 KWH
GYM	665 M2	2.5 KWH/M2	1’663 KWH
CIRCULATION	510 M2	0.7 KWH/M2	357 KWH
WC	225 M2	1.5 KWH/M2	338 KWH
TOT			8’976 KWH

COOLING	SURFACE AREA	*UNIT VALUE	ENERGY NEEDS
CLASSROOM	1’941 M2	16.9 KWH/M2	32’803 KWH
ADMINISTRATIVE	272 M2	13.3 KWH/M2	3’617 KWH
LIBRARY	175 M2	7.9 KWH/M2	1’383 KWH
CANTEEN	175 M2	12.2 KWH/M2	2’135 KWH
TOT			39’938 KWH

HEATING	SURFACE AREA	*UNIT VALUE	ENERGY NEEDS
CLASSROOM	1’941 M2	15.4 KWH/M2	29’891 KWH
ADMINISTRATIVE	272 M2	21.9 KWH/M2	5’957 KWH
LIBRARY	175 M2	10 KWH/M2	1’750 KWH
CANTEEN	175 M2	5.3 KWH/M2	928 KWH
GYM	665 M2	11.1 KWH/M2	7’382 KWH
CIRCULATION	510 M2	4.6 KWH/M2	2’346 KWH
STAIRWELL	420 M2	9.2 KWH/M2	3’864 KWH
WC	225 M2	29.7 KWH/M2	6’683 KWH
TOT			58’801 KWH

HOT WATER	SURFACE AREA	*UNIT VALUE	ENERGY NEEDS
CLASSROOM	1’941 M2	5.3 KWH/M2	10’287 KWH
CANTEEN	175 M2	108.9 KWH/M2	19’058 KWH
LIBRARY	175 M2	10 KWH/M2	1’750 KWH
GYM	665 M2	5.3 KWH/M2	32’245 KWH
TOT			63’340 KWH

LIFTS	UNITS	**UNIT VALUE	ENERGY NEEDS
PEOPLE	12	4’350 KWH	52’200 KWH
GOODS	1	1’850 KWH	1’850 KWH
TOT			54’050 KWH

PARKING	UNITS	***UNIT VALUE	ENERGY NEEDS
CARS	1’753	3’650 KWH	6’398’450 KWH

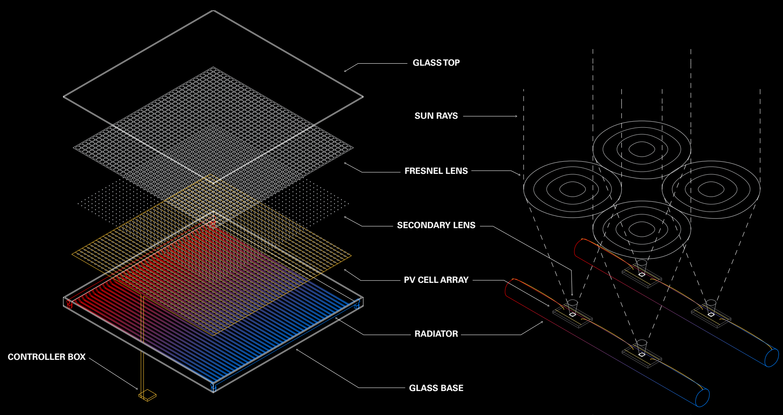
TOTAL ELECTRICITY DEMAND 6’543’351 KWH

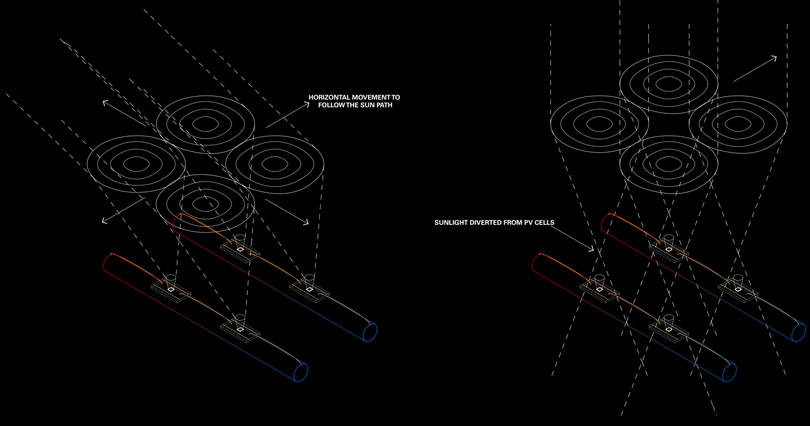
TOTAL HEAT DEMAND 122’141 KWH

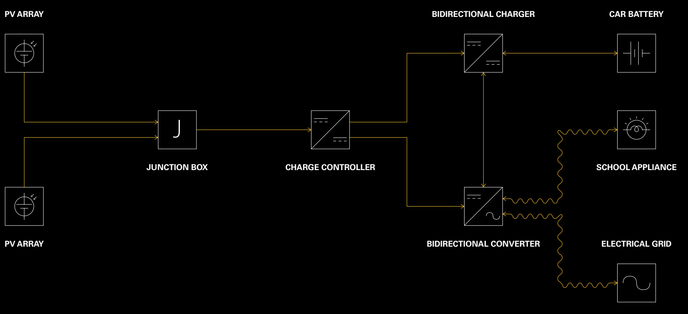
*For this calculation, the target values proposed by the SIA standard 2014/15 were used.

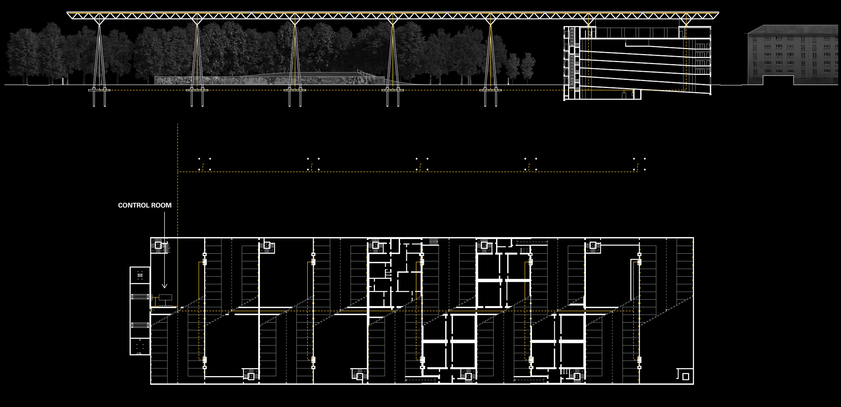
**These values are an average of the energy consumption of swiss elevators.

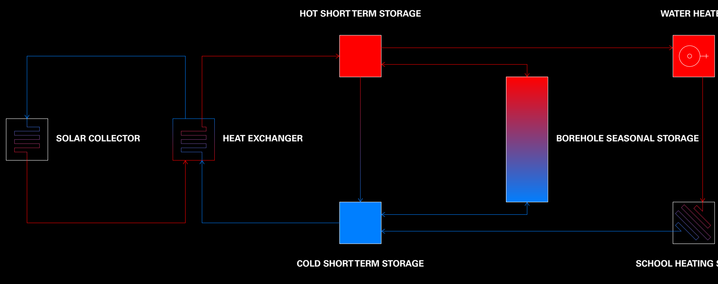
***The average trip lenght of commuters is 50 km a day, which translate to a daily consume of 10 kWh.

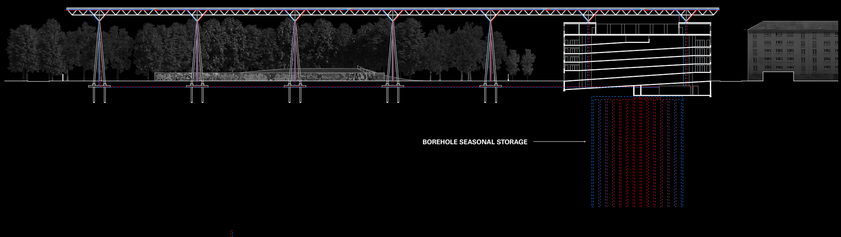

GLASS TOP
SUN RAYS
FRESNEL LENS
SECONDARY LENS
PV CELL ARRAY
RADIATOR
CONTROLLER BOX
GLASS BASE

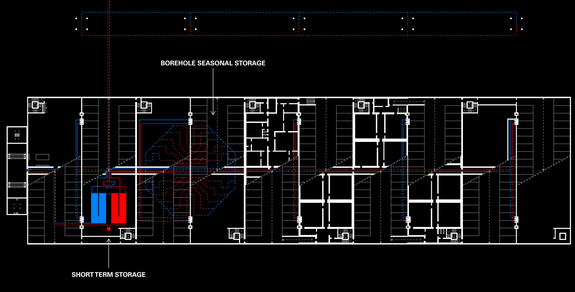

HORIZONTAL MOVEMENT TO FOLLOW THE SUN PATH
SUNLIGHT DIVERTED FROM PV CELLS

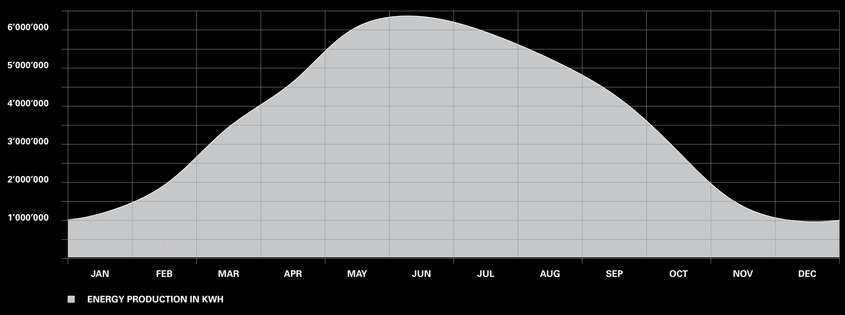

PV ARRAY
BIDIRECTIONAL CHARGER
CAR BATTERY
JUNCTION BOX
CHARGE CONTROLLER
SCHOOL APPLIANCE
PV ARRAY
BIDIRECTIONAL CONVERTER
ELECTRICAL GRID
DIRECT CURRENT
ALTERNATE CURRENT

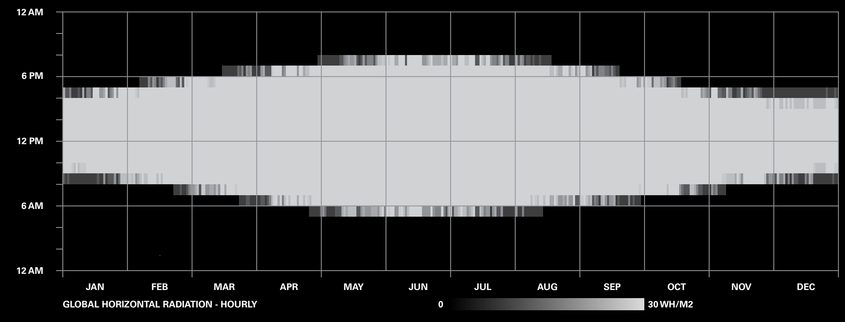

CONTROL ROOM


HOT SHORT TERM STORAGE
WATER HEATER
SOLAR COLLECTOR
HEAT EXCHANGER
BOREHOLE SEASONAL STORAGE
COLD SHORT TERM STORAGE
SCHOOL HEATING SYSTEM


BOREHOLE SEASONAL STORAGE

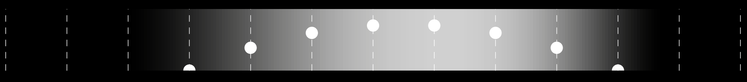

BOREHOLE SEASONAL STORAGE
SHORT TERM STORAGE



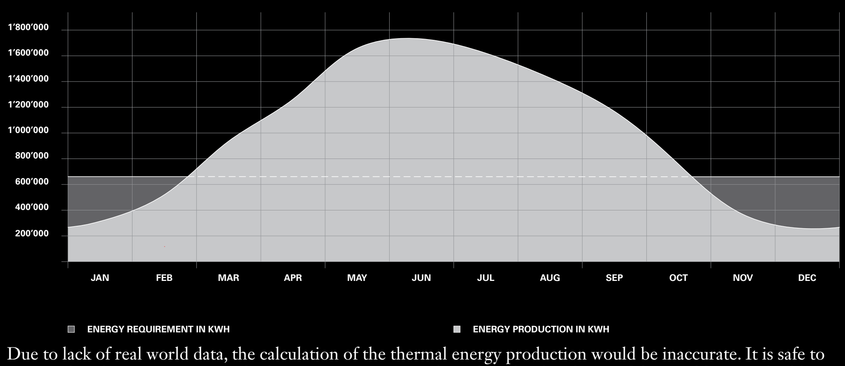


TOTAL IRRADIATION: 42'458'000 KWH

Around 20% of the panels are located on top of trees, these will need to partly redirect the sunlight to respond to the needs of the vegetation below. It is extimated a loss of about 10 % efficiency in the energy production,



TOTAL ELECTRICITY PRODUCTION: 11'081'500 KWH



Due to lack of real world data, the calculation of the thermal energy production would be inaccurate. It is safe to assume that the canopy can supply the necessary energy to heat the school and part of the neighbouring buildings. It is to be expected that the borehole seasonal storage system will take a few years to reach its maximum potential, given that it relies on the surrounding land to absorb heat and keep the water at a constant temperature.

In addition, pumps are needed to circulate the coolant and overcome the difference in height. A powerful pump will be installed at the base of each support, and 4 smaller additional units will push the water to and from the seasonal storage and school.

NUMBER OF PUMPS: 35
HEIGHT DIFFERENCE: 27 M
DIFFERENCE IN PRESSURE: 27 M * 997 KG/M3 * 9.81 N/KG = 2.64 BAR
RECOMMENDER FLOW RATE FOR SOLAR PANELS: 30 L/M2*H
SURFACE AREA FOR EACH PUMP: 1'080 M2
PUMP CAPACITY: 30 L/M2*H * 1'080 M2 = 32.4 M3/H
OVERALL PUMP EFFICIENCY: 90%
ELECTRICITY DEMAND FOR PUMPS: (2.64 BAR *32.4 M3/H) / (36*0.90) = 2.64 KW
AVERAGE DAILY HOUR OF USAGE: 10 H
ANNUAL ELECTRICITY DEMAND FOR PUMPS: 337'260 KWH

TOTAL ELECTRICITY SURPLUS: 4'200'889 KWH