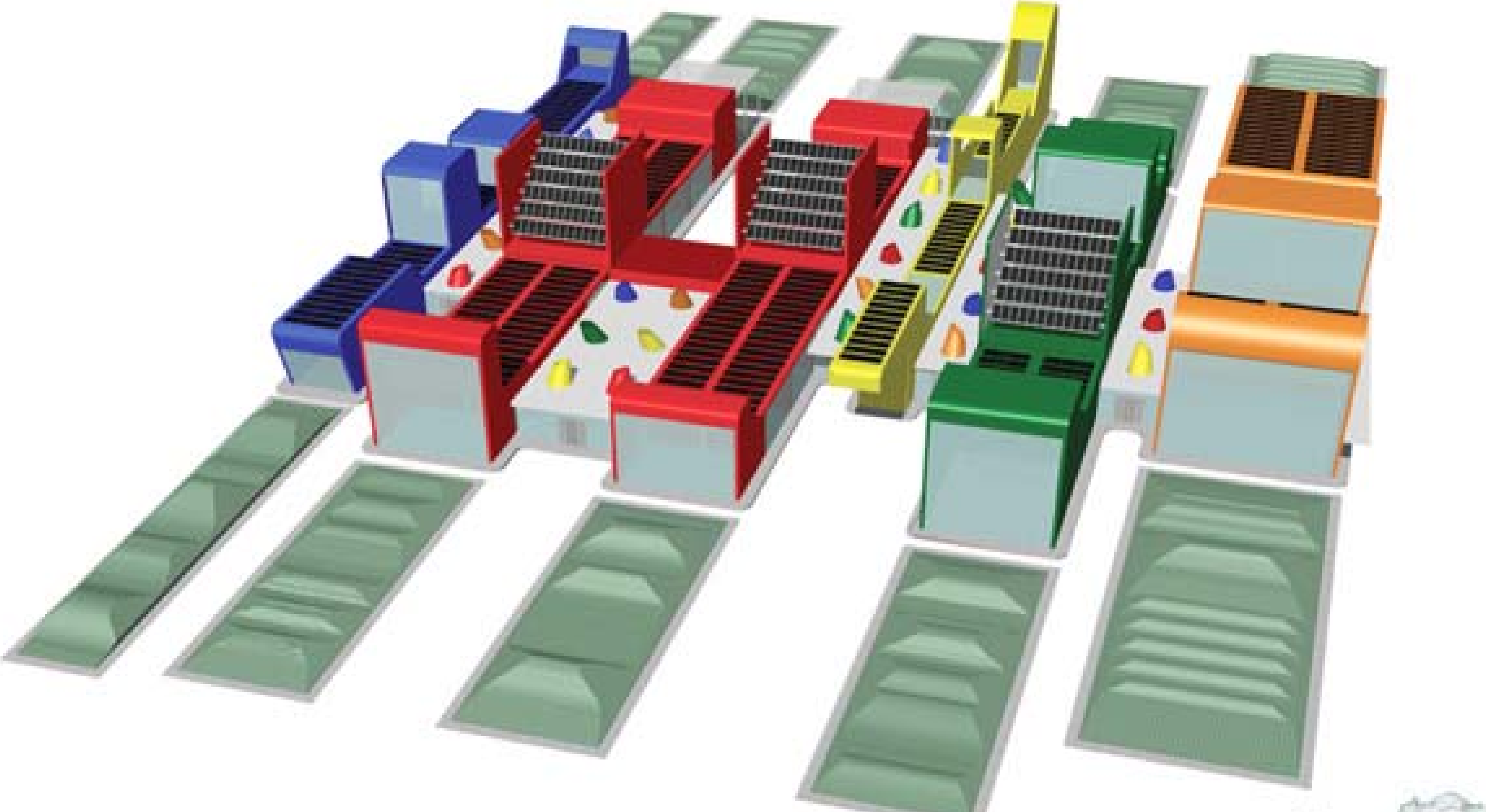


PLAYING ARCHITECTURE

old school

+	–	÷	x
growth	pollution	sharing	sunshine

=

sunshine primary school

running architecture -> buildings run on virtual railways toward the area. the length of each element depends on the lot dimensions. in fact PLAYING ARCHITECTURE is adaptable to:

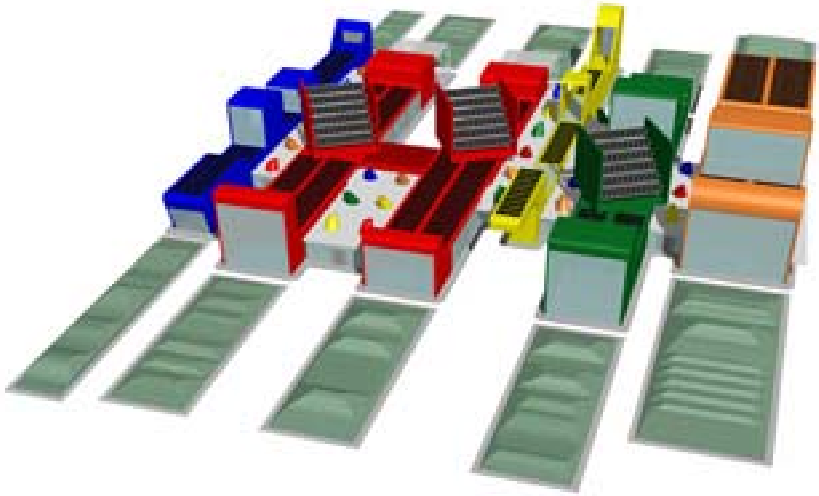
changeable areas -> buildings have different lengths and widths, and their mutual positions depend on logical necessity. among the linear buildings there are outdoor green passages, conditioning air and sight from inside.

recognizable functions -> colours identify functions inside the building spaces: blue=entry, red=classrooms, yellow=services, green=laboratory, orange=eating and reading. these are the school functions recognizable from colours, when people arrive or stay outdoor.

energy saving -> dual axis tracking photovoltaic solar panels on the building roofs to get the best results for power independence. production of sanitary water possible by hot air tank behind the solar collector.

sun + green -> sun is the real protagonist of the project. it lights and warms up the passages among buildings, it determines the microclimate around buildings and trees. sunlight beams the solar panels.

structure + HPL panels -> light steel frames of the buildings joint to self-supporting high pressure laminate panels create the colourful flexible facades.



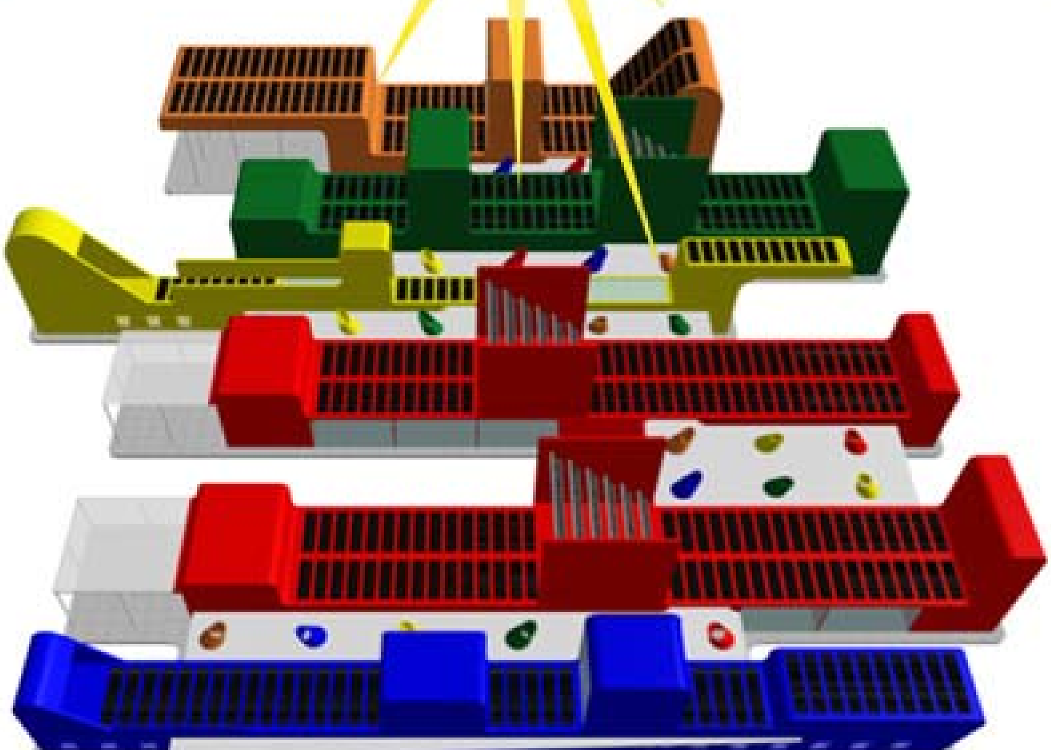
SERIAL NUMBER	ITEM	UNIT	QUANTITY
1	Total site area	ha	1.67
2	Total building area	m²	[illegible]
	Teaching area	m²	[illegible]
	Subsidiary building area	m²	[illegible]
3	Road & square area	m²	[illegible]
4	Sport field	m²	[illegible]
5	Greening area	m²	[illegible]
6	Floor area ratio (excluding sport field)	%	[illegible]
7	Greening rate (excluding sport field)	%	[illegible]
8	Building density	%	[illegible]

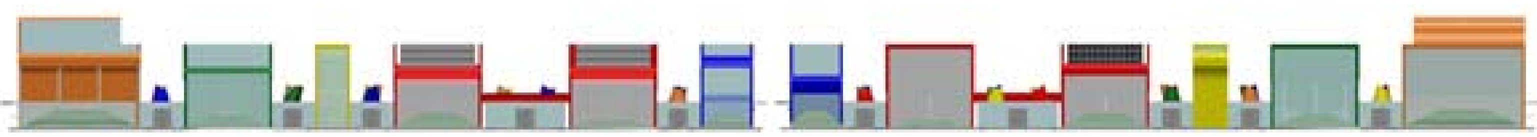
Green trees and grass among the architectures nature inside the buildings conditioning air and vision

1- Common classroom
2- Music classroom
3 - Instrument room
4 - Audio-visual room
5 - Audio-visual equipment room
6 - Laboratory

18 - Storage for general affairs
19 - Repairing room for woodworker
20 - Reception & duty room
21 - Hostel for single staff
22 - Canteen for teachers and other staffs
23 - Boiling water room

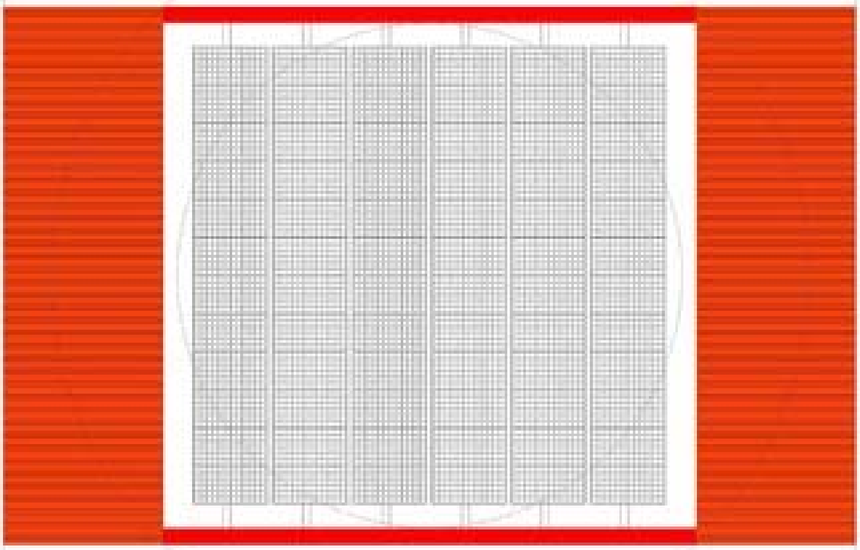
24 - Toilet for students
25 - Toilet for teachers and others staffs
26 - Bathroom



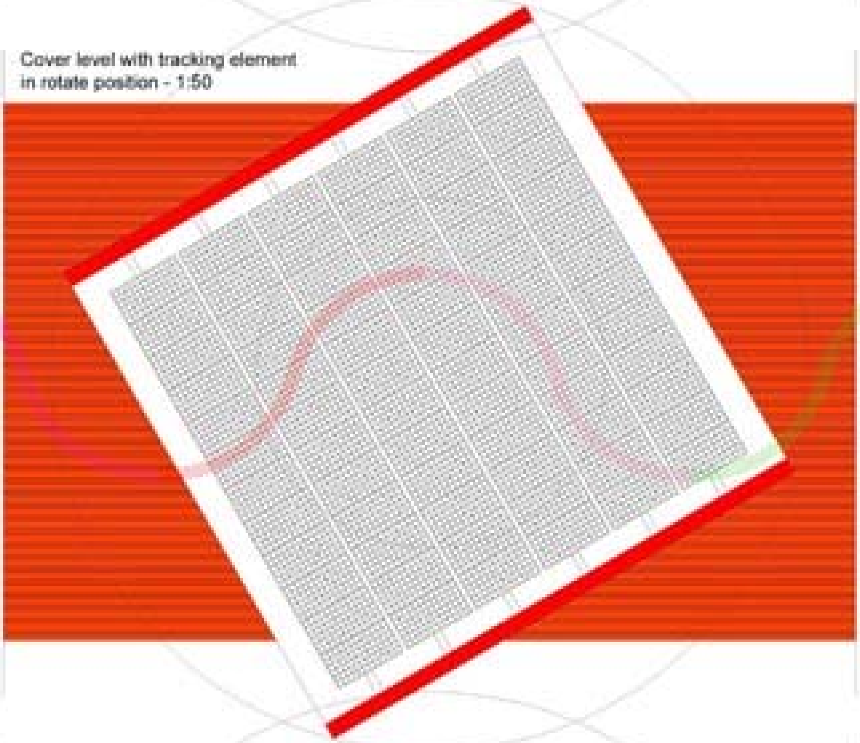



blue=entry
red=classrooms
yellow=services
green=laboratories
orange=eating and reading

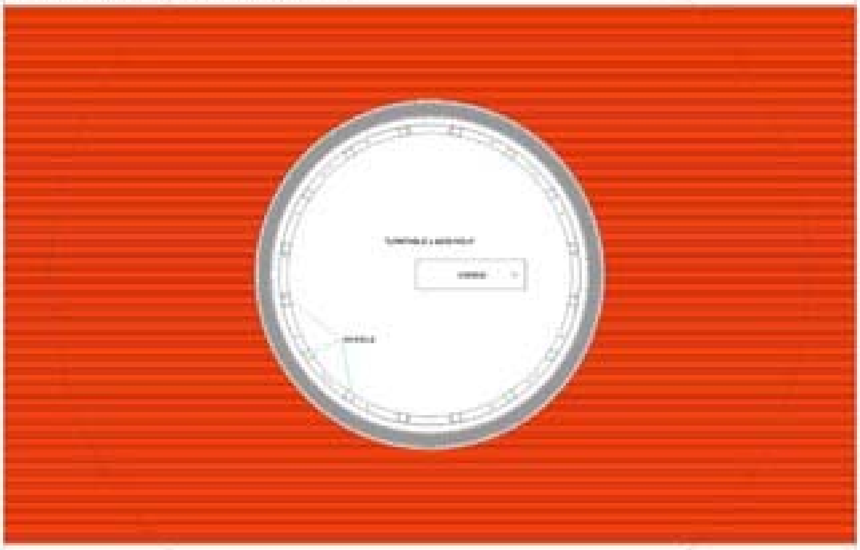
Cover level with tracking element in parallel position - 1:50



Cover level with tracking element in rotate position - 1:50



Cover level with turntable structure - 1:50

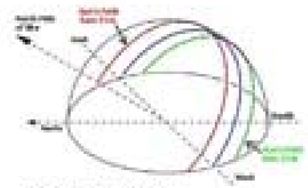


[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Engines for tracking

Example of zenithal rotation of the panels

Forces on a photovoltaic array

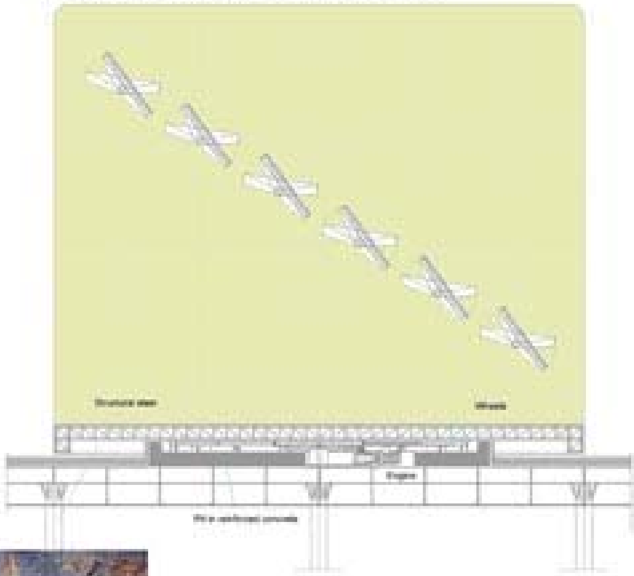


Main sun rotations

Photovoltaic cells used as solar orientation sensor

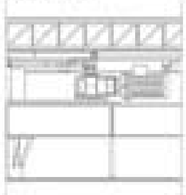
Detail model in 3 different positions

Section 1 - Zenithal rotation of the panels - 1:50

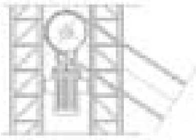


Dualaxis solar tracking
track-to-track time
delay circuit
helps maximize engine life

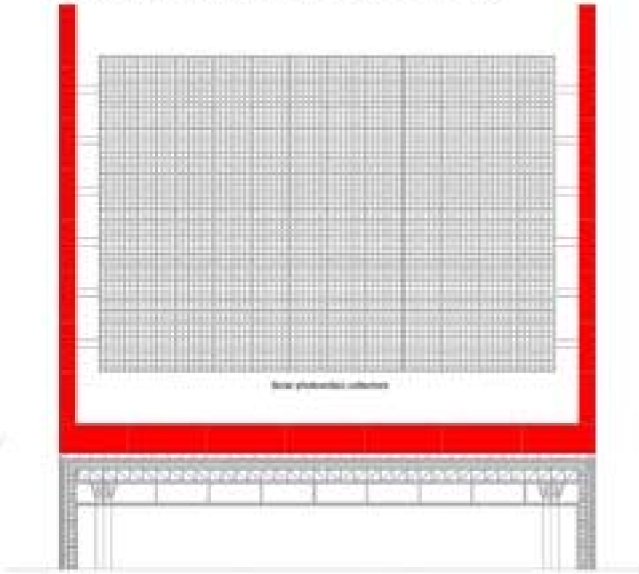
Detail of the engine for
orizontal rotation of the
panels - 1:25

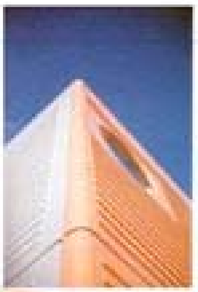


Detail of the engine for
zenithal rotation of the
panels - 1:25

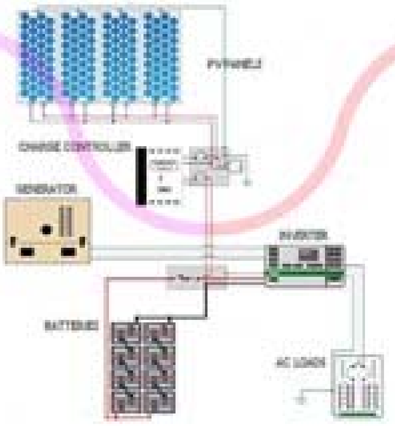


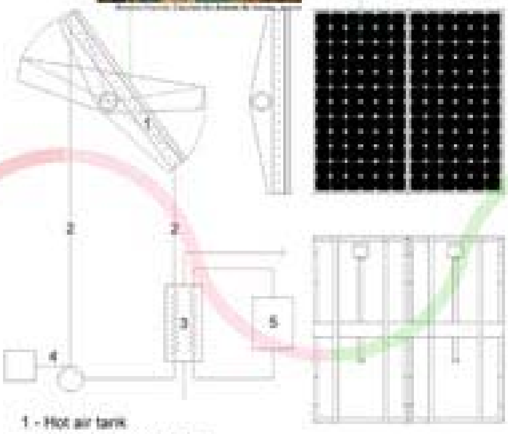
Section 3 - Front of the panels - parallel position - 1:50



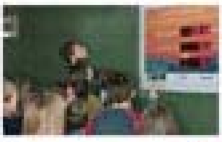


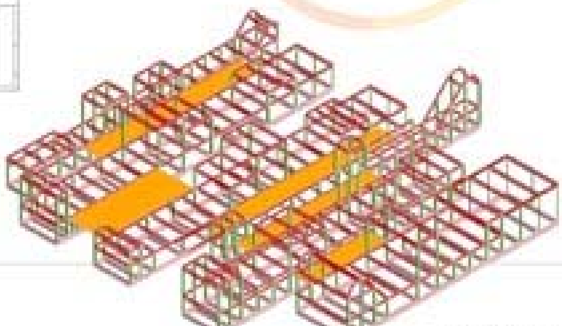
Photovoltaic collectors for electic power
+ hot air tank for sanitary water



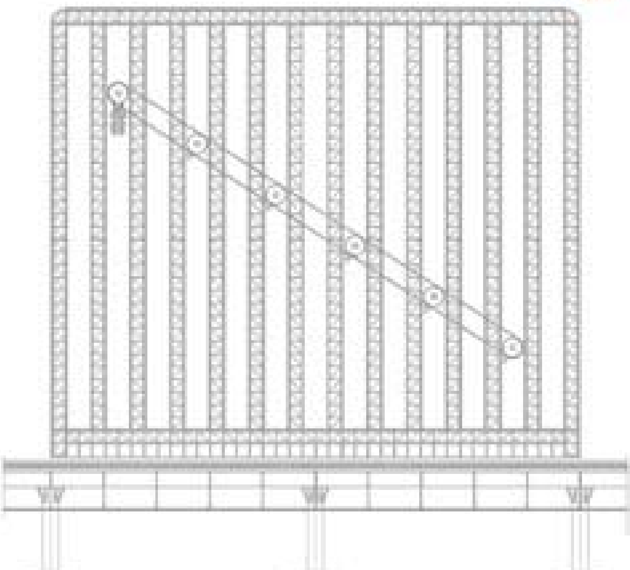


1 - Hot air tank
behind solar photovoltaic
collector for sanitary water
2 - Primary circuit
3 - Water storage tank
4 - Pump,actuator, controller and
other parts
5 - Water heater

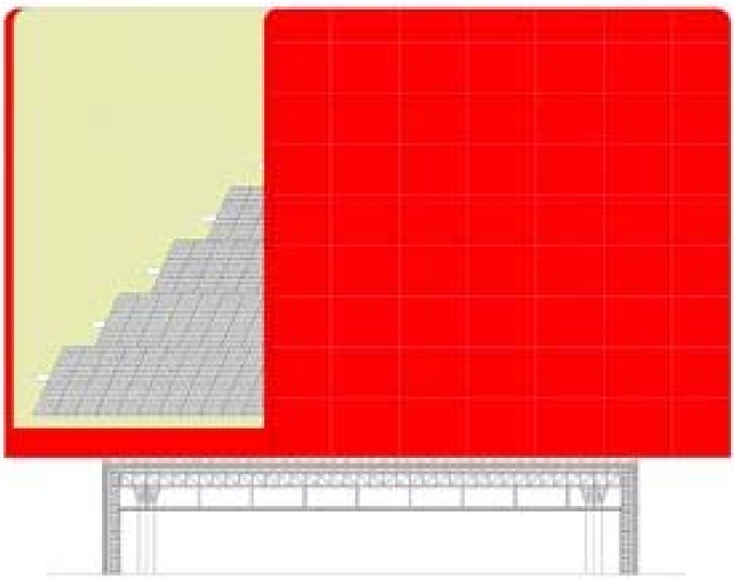




Steel structure



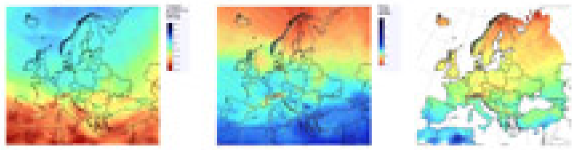
Section 2 - Engine and rack for zenithal rotation of the panels - 1:50



Section 4 - Front of the panels - oblique position - 1:50

Technical considerations on the sun-tracking PV units in the proposed design solution

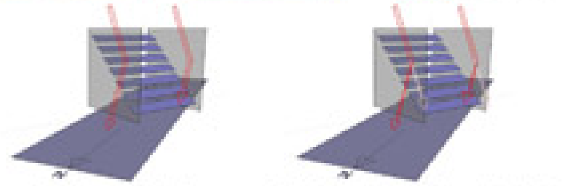
The tracking solutions adopted for the photovoltaic rotating units in the project allow for an increase in energy production relative to a fixed panels solution, ranging from about 25% to 50%, depending from climates and sun tracking strategy.
The increased efficiencies of the considered tracking systems are higher at lower latitudes in the case they are characterized by clearer skies (as generally is in the case of southern Europe), and at higher latitutes (as in northern Europe), due to the efficient tracking in the summer early mornings and late evenings, when the sun position is in the northern part of the sky vault. (See graphs - plotted with PVGIS.)



The construction solutions that have been taken into account for the side walls of the PV rotating units are conceived to make the shadowing effect of the side walls negligible even in case of clear sky (in which the direct radiation component is small and therefore the sun-tracking benefit is low) and prevalence of direct solar radiation. These solutions are:

1) Adoption of a clear, diffusively reflective, opaque metal finish for the interior face of the walls, aiming to reflect to the PV panels a radiation amount just slightly smaller (about 10%, depending from the finish reflectance) than that shadowed by the opposite wall.
2) Adoption of partially translucent and partially reflective sheets for the walls' surfaces, of the colored mirroring glass type, aiming to partially admit and partially reflect solar radiation to the panels.

The solution of choice may depend on the site's climatic conditions.

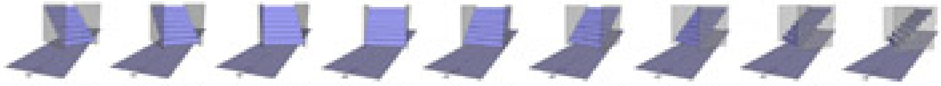


Diffuse beam reflection by the means of reflective walls   Diffuse beam reflection and transmission by the means of reflective and transmissive walls

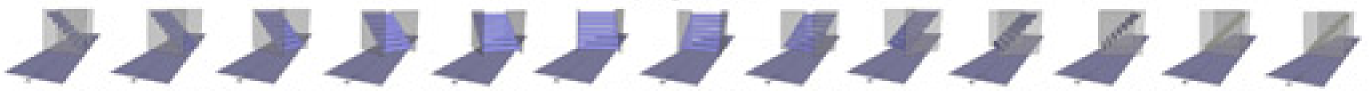
Solution 1: full dual axial solar tracking

The project has been optimized to possibly adopt two alternative sun tracking solutions for the adjustable PV units.
The **first considered solution** is characterized by a **full dual axial solar tracking strategy** requiring that the panels position is updated every quarter of an hour on both axes and controlled by a closed-loop sensor-based sun tracking control. This tracking and control strategy is more costly the the alternative ones, but produces the most efficient results, since it manages to always give the PV units an ideal position, depending from the proportions of direct and diffuse solar radiation, as monitored by real'time feedback, by increasing the horizontality of the panels when diffuse radiation is prevailing. It is therefore a particularly advantageous solution in the cases in which the diffuse radiation component is strong in the sky, as in the northern regions of Italy during winter for instance, or in the hot-humid climate in the world year-round. The simulations run for a number climates confirmed that this tracking solution is consistently the most efficient from the point of view of energy production. Here the tracking system's positions for a difficult (due to the high sky cloudness) climatic situations for the descibed system is represented: that of Milan (latitude: 45° N).

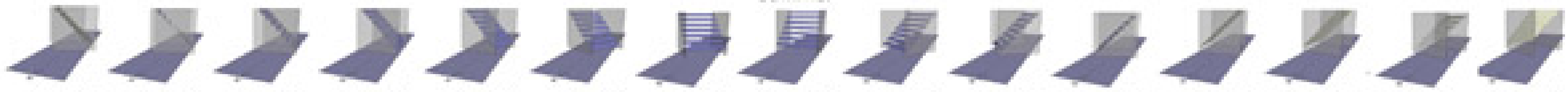
Winter



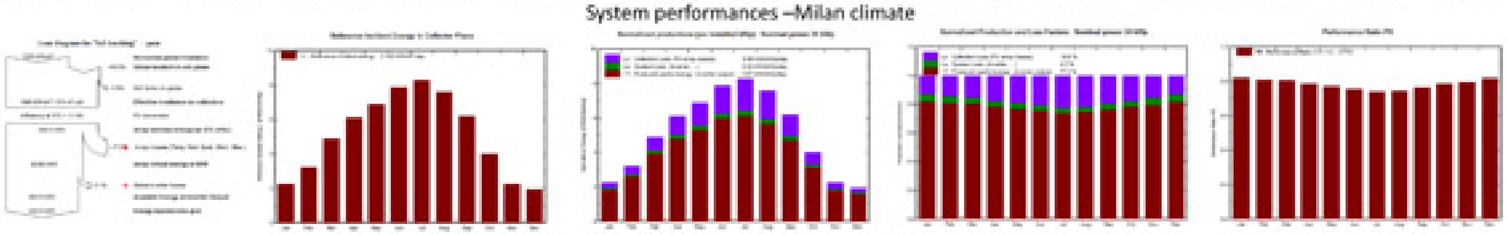
Spring and Fall



Summer



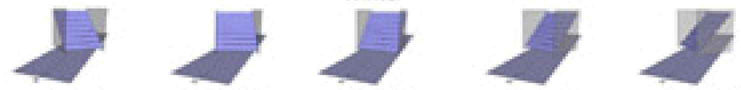
System performances –Milan climate



Solution 2: mixed mode (hourly + seasonal) dual axial solar tracking

The **second considered solution** is characterized by a **hybrid - hourly and seasonal - dual axial solar tracking strategy**. The movement is dual axial; but on the vertical plane (for azimuth variations) it is rarefied, happening every one hour and a half when the sun is up; while the movements of the horizontal axis are scheduled on a seasonal basis. Both movement types are scheduled on a chronological basis. This solution shows a certain (not dramatic: ranging from about 3% to 6% depending from climate types) decrease in efficiency if compared with the full-tracking solution; but it also comes at lower expenses, due to a reduced exploitation of the vertical axis movement system and expecially of the horizontal axis (seasonal) movement system. This is an important point because it opens more affordable solution for the mechanical durability of the movement system. This system's performance on the whole is very interesting.

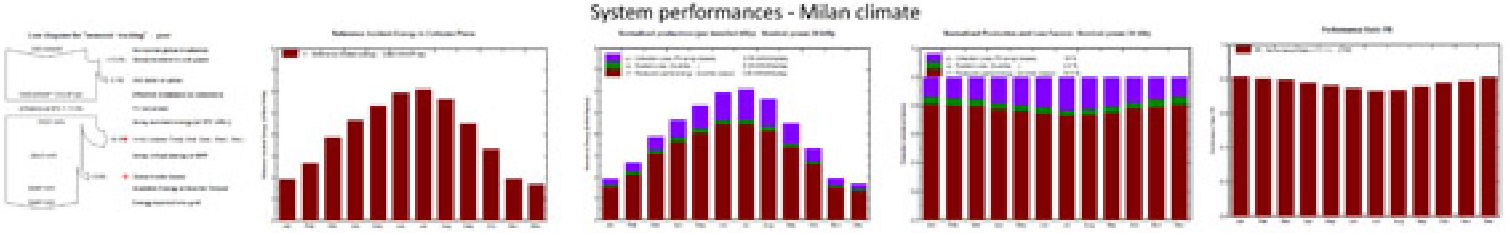
Winter



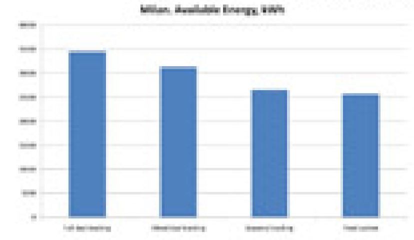
Spring and Fall

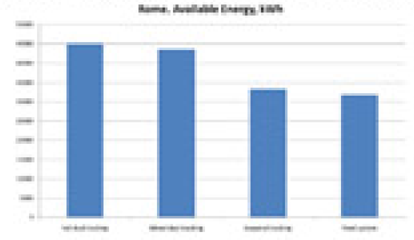
Summer

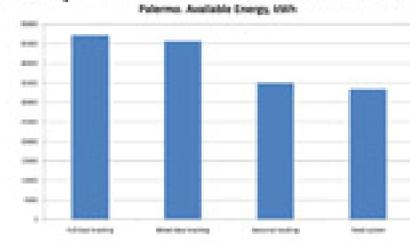
System performances - Milan climate



Performance comparisons with seasonal and fixed systems and other Italian location







Conclusion

The full-tracking system shows the best production performance at all the considered latitudes; and the performance of the considered mixed-mode (hourly and seasonal) tracking system comes close to this. While both the seasonal tracking system and the fixed system show a clearly lower energy production in all the tested climatic locations.