

# INTEGRATED ENVIRONMENTAL AND RENEWABLE POWER GENERATORS

## APPROACH

The project as a renewable power generator source propose an integrated system between power generation and environmental methods which benefits the project main culture concept and use. The construction system impeded indirectly the renewable power generators different methods equipment and a natural ventilation and daylight illumination system within the spatial scheme of the project.

### - The main factors of the integrated system :

**1- Wind Tunnel system** - The 2 towers located in the center of the main two entrances, one of them the major project landmark statue, act as a wind tunnels generator consists of vertical multi-system turbines from the bottom to the top which produce extremely highly efficient power harvest.

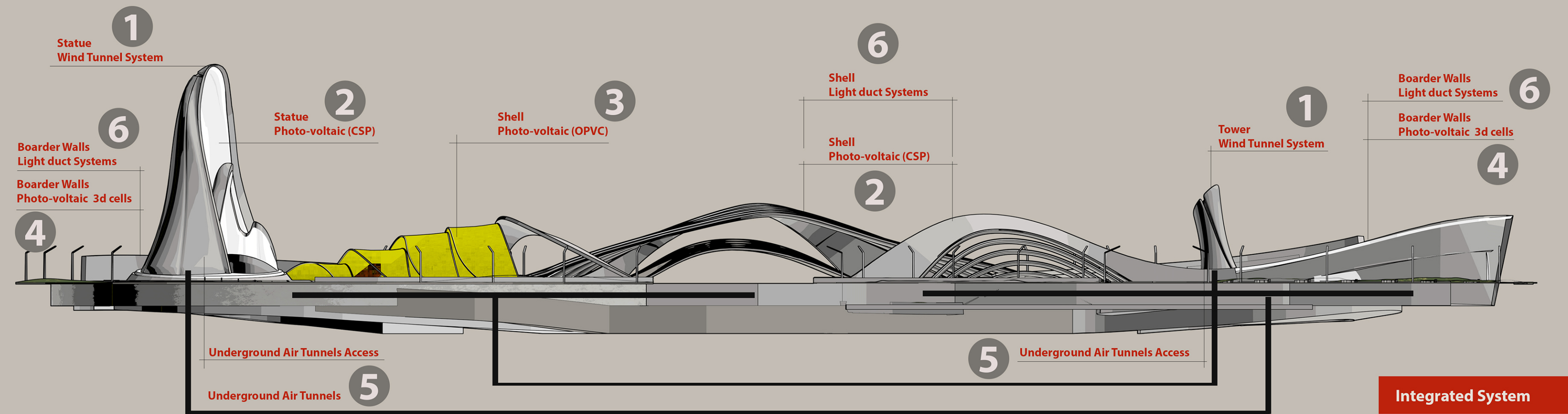
**2- Photo-voltaic cells (CSP) system** - Impeded inside the shells construction form located the photo-voltaic cells oriented towards the sun light movement also located covering the inside skin of the main statue giving an artistic theme to the artwork.

**3- Photo-voltaic cells system ( OPVC )** - located within the fabric textile shading formations the OPVC system consider a part of the formation textile appearance as an artwork design.

**4- Photo-voltaic 3D cells** - As a part of the boarder walls construction the 3D photo-voltaic cells integrate with the light ducts systems to reflect sunlight beams in purpose of illuminate the exhibited walls.

**5- Natural ventilation system (Underground air Tunnels)** - The two towers act also as a ventilation access of an Underground Air Tunnels for Cooling the surrounding atmosphere inside the main passage of the museum, the tunnels go beneath the project into the Soil temperature, at a depth of about 10 meter or more, which stays fairly constant throughout the year, and is approximately equal to the average annual ambient air temperature. The ground can, therefore, be used as a heat sink for cooling in the summer.

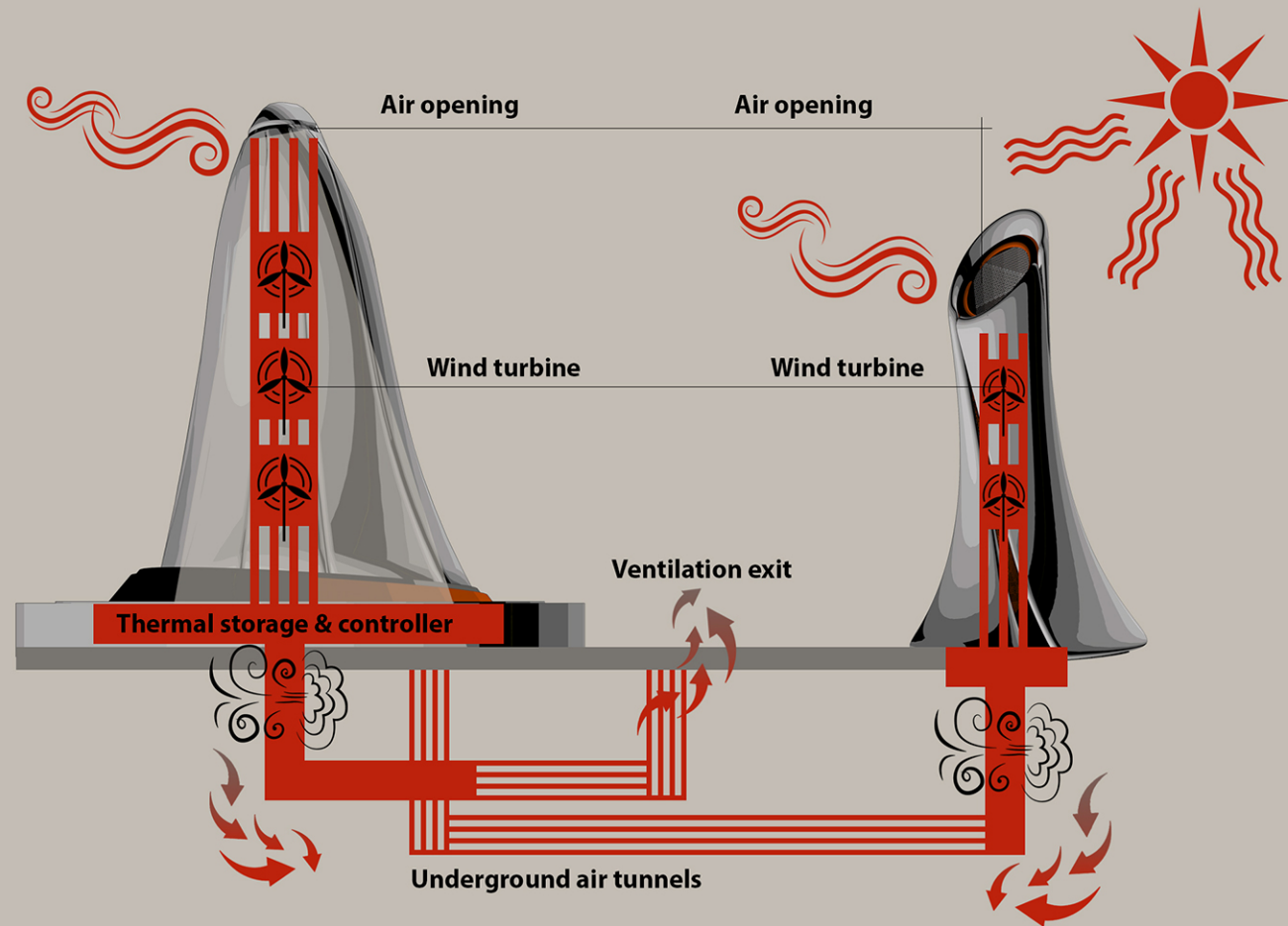
**6- Natural Daylight Light ducts system** - Using the edge of the museum boarder walls and the shell covering ceiling as a light duct to illuminate the museum different exhibited items also the mirror light duct uses the 3D photo-voltaic cells to obtain electricity from the reflected sunlight beams.



Integrated System

## 1 Wind Tunnel system

126MWH

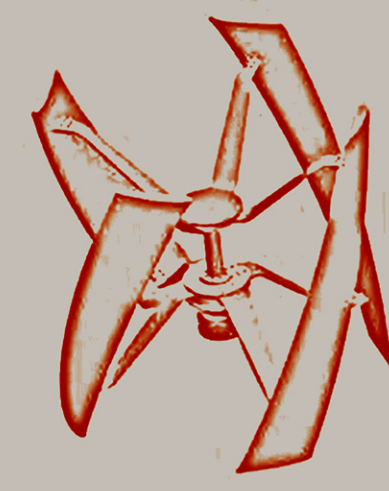


A wind turbine generator can have a vertical or horizontal rotation axis. A vertical-axis wind power generator is advantageous for installation in city centers, also, as the energy generated by a wind turbine is proportional to the swept area of the turbine and the third power of the wind speed, therefore, enlarging the swept area or increasing the wind speed can effectively increase the power output. The idea is to propose a system of several wind tunnels with vertical wind turbines integrated to produce about 126 MWH yearly with the cost of 96,000 dollar.

Multiple Vertical Wind Turbine installation



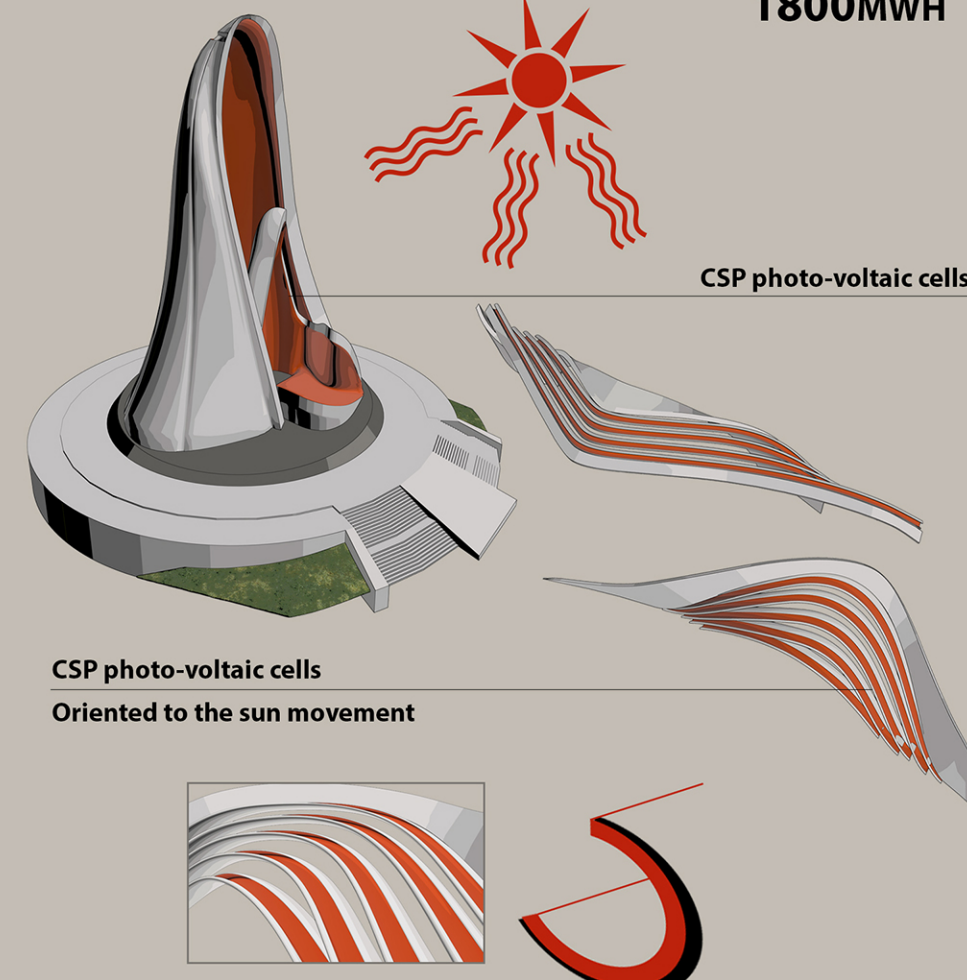
Suggested buffer tube to reduce noise and vibration



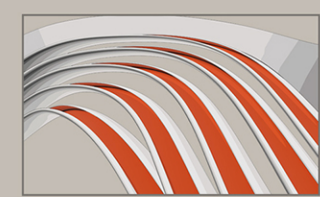
Vertical Wind Turbine

## 2 Photo-voltaic (CSP)

1800MWH



CSP photo-voltaic cells oriented to the sun movement

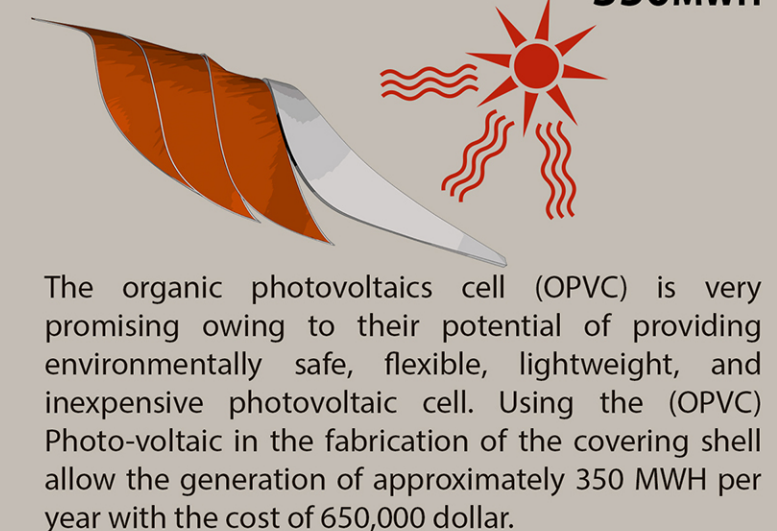


flexible reflectors in the form of a parabolic channel cross section

A system of flexible reflectors in the form of a parabolic channel cross section, impeded in the outer shell and the main landmark statue, where there are collector tubes in the focuses. The system approximately generates 2207 MWH per year with the cost of 3,428,000 dollar.

## 3 Photo-voltaic (OPVC)

350MWH



The organic photovoltaics cell (OPVC) is very promising owing to their potential of providing environmentally safe, flexible, lightweight, and inexpensive photovoltaic cell. Using the (OPVC) Photo-voltaic in the fabrication of the covering shell allow the generation of approximately 350 MWH per year with the cost of 650,000 dollar.

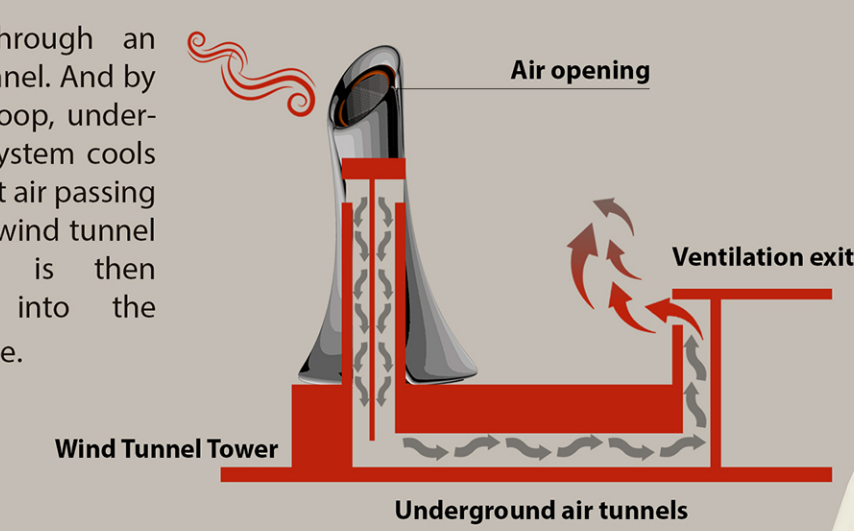
## 4 Photo-voltaic 3D Cell

473MWH

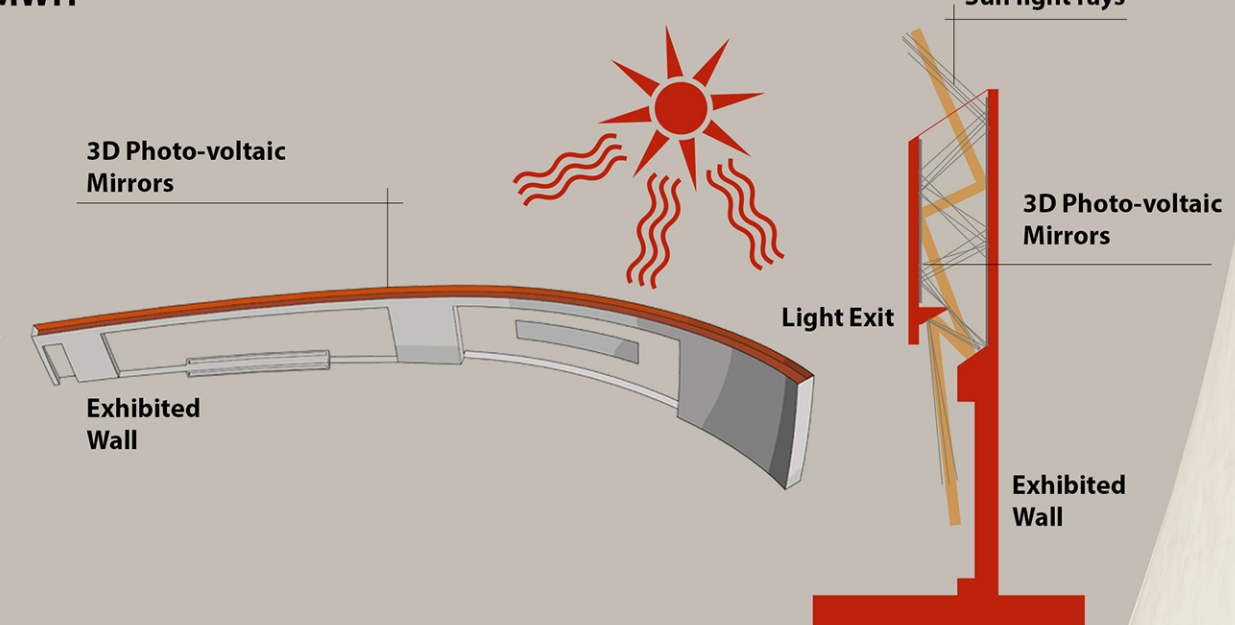
The 3D photo-voltaic structure can pick up light when the Sun is at lower angles and internal reflections within the structure help increase the amount of captured light. Integrated with the light duct concept the system could be very useful in generating power and illuminate the exhibited items by natural daylight artistic effects. Amount of generated power approximately 473 MWH by the boarder walls of the museum with the cost of 900,000 dollar. Marco Bernardi and pals at the Massachusetts Institute of Technology in Cambridge say there is a simple fix that could dramatically increase the performance of photovoltaics by as much as 20 times. Instead of two-dimensional flat panels, Bernardi and co suggest using three dimensional structures.

## 5 Underground Air Tunnels

By passing air through an underground air tunnel. And by integrate an open loop, underground air tunnel system cools or heats the ambient air passing through it with the wind tunnel system, This air is then introduced directly into the semi contained space.



## 6 Daylight Ducts



Project Interior Overview



Visual Shell Gate photo cell tunnels



Wind Tunnel Tower (Environmental air condition)