Gr22_HW02: Vernacular and Climate Sensitive Architecture; Case study of Havana and Saint Petersburg

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Point 1:

In this first point we want to analyse the different characteristics of the typical house present in the different place assigned by the course.

Havana

The first one is Havana, the capital city, largest city, province, major port, and leading commercial center of Cuba. The city has a population of 2.1 million inhabitants, and it spans a total of 728.26 km2 – making it the largest city by area, the most populous city, and the fourth largest metropolitan area in the Caribbean region. The city extends mostly westward and southward from the bay, which is entered through a narrow inlet and which divides into three main harbors. The sluggish Almendares River traverses the city from south to north, entering the Straits of Florida a few miles west of the bay. Havana, like much of Cuba, has a tropical climate that is tempered by the island's position in the belt of the trade winds and by the warm offshore currents. Under the climate classification, Havana has a tropical savanna climate that closely borders on a tropical monsoon climate. Average temperatures range from 22 °C in January and February to 28 °C in August. The temperature seldom drops below 10 °C. The lowest temperature was 1 °C in Santiago de Las Vegas, Boyeros. The lowest recorded temperature in Cuba was 0°C in Bainoa, Mayabeque Province. Rainfall is heaviest in June and October and lightest from December through April, averaging 1,200 mm annually. Hurricanes occasionally strike the island, but they ordinarily hit the south coast, and damage in Havana has been less than elsewhere in the country city with a typically hot temperature especially in the summer season, for this reason the typically housing is made by the aim to maintenance the temperature in the building mild and fresh in the hottest days. Due to the large number of the hours in comfort period, the climate inside the building is not very critical, only in the time of very high temperature the designer need to have a temperature control (in the summer season).

After the introduction of the city and a little information about the climate present in the area, we start to speak about the typically houses made in the past time in this plate; the name of the typically house of the past is "Casa Particular", a translation of particular home, very diffuse in the city of Havana. Now this type of house is very diffused in the city like bed and breakfast but in the past years represented the typical house of the Cuban people. This type of house is main composed by an internal balcony where some houses are connected together from the external part, and the external exposition are related for the windows, showing the street and the other part of the city.

Figure 1: Island of Cuba and the position of Havana (http://www.sciencedirect.com/science/article/pii/S0360132309000195)

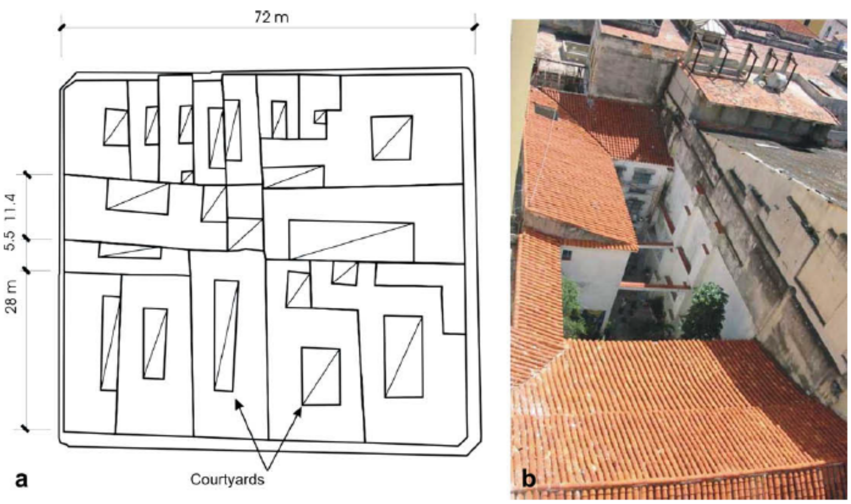

Figure 2: Distribution of the Casa Particolar in the city (http://www.sciencedirect.com/science/article/pii/S0360132309000195)

We can consider the site without many type of problem of comfort inside, because the most part of the year the climate are is in comfort condition, for this reason the houses have little consideration about the coolest condition outside, however the bad consideration of the house are the heating period of the year; we can consider the balcony outside for a concentration of fresh, because always in shadow condition and with a very good reason of comfort in the hottest season. Sometimes we have this kind of balcony with a internal plant to limit the pressure of the wind in the walls of the house.

Now we write about the internal distribution of the space, generally inside one house is present a toilette, in other cases, generally in the old one, the bathroom is in the external part of the house and is general used by few house together; Inside the house generally are present 1 or 2 different rooms and the maximum people reached by this building is 5/6, inside the house is present a kitchen.

Figure 3: The picture show the external balcony about the “Casa Particolar” (https://it.wikipedia.org/wiki/Casa_particular)

1° Period

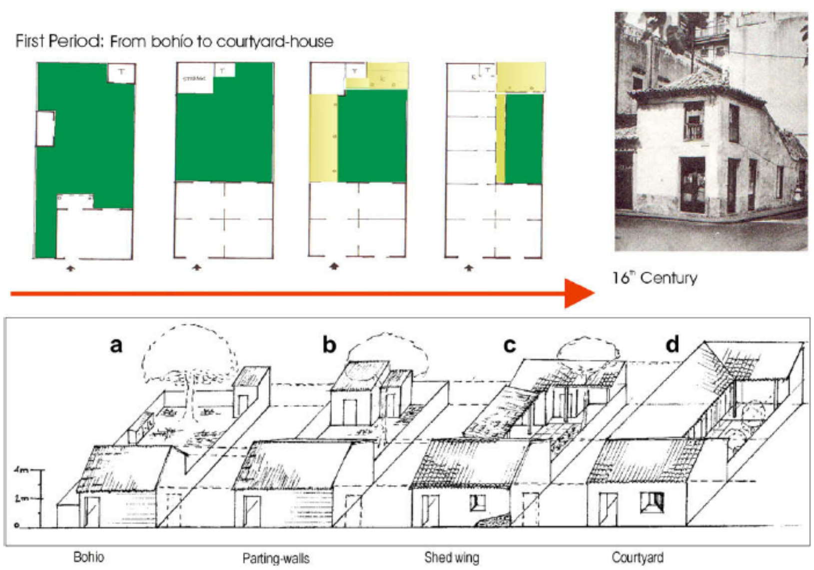

Figure 4: First period of architectural houses (http://www.sciencedirect.com/science/article/pii/S0360132309000195)

It is very interesting to understand how this typology of house changed in the time: starting in the pass time and until the 16° century, the houses were very little, considered the aborigine type of construction in

Havana, just with a little building in front of a little garden, generally only one floor; the shape is generally rectangular.

2° Period

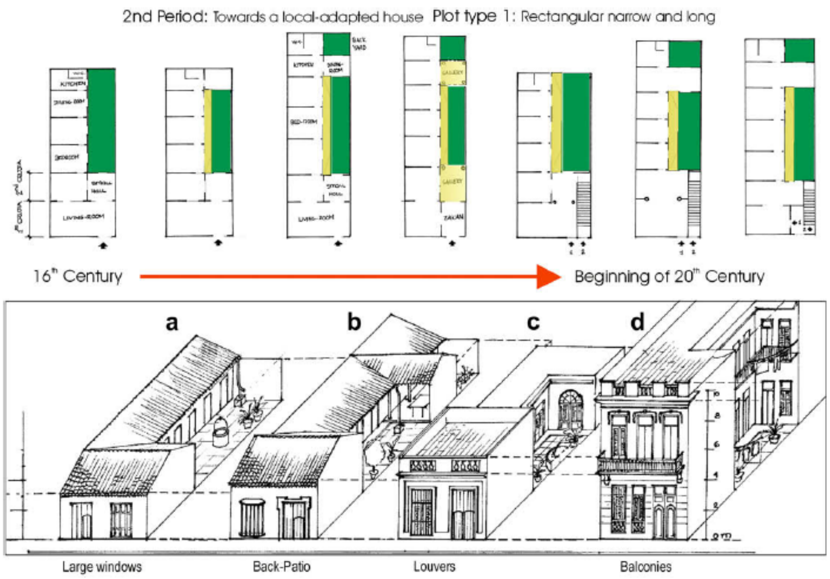

Figure 5: Second period of architectural houses (http://www.sciencedirect.com/science/article/pii/S0360132309000195)

The second period of the construction started in the 16° century and end in 20° century, the houses became higher than 1 floor in some cases and the people started to have a familiar houses; the shape is the same of the firth period but now the garden is still inside and among the wall of the building; the bulding start to have the particolar phenomena of the internal balcony and the people start to use this shadow for reduce the internal temperature.

The last picture show the houses of the rich people, we can show the internal balcony like the case before.

Some examples are present about this type of Vernacular House, with the characteristics showed before:

3° Period

Now we can see the most modern house, the stile is always the same but the quality of the house increased year by year, here we can see the internal balcony with some floor building with the access of the people in every apartment.

Some examples are present about this type of Vernacular House, with the characteristics showed before:

The materials used in this building are made by concrete and bricks, the railing is generally made by steel or bricks in the traditional construction of these, an other particolar kind of that is the large presents of balcony not in the internal area for have lunch or dinner outside respect the house.

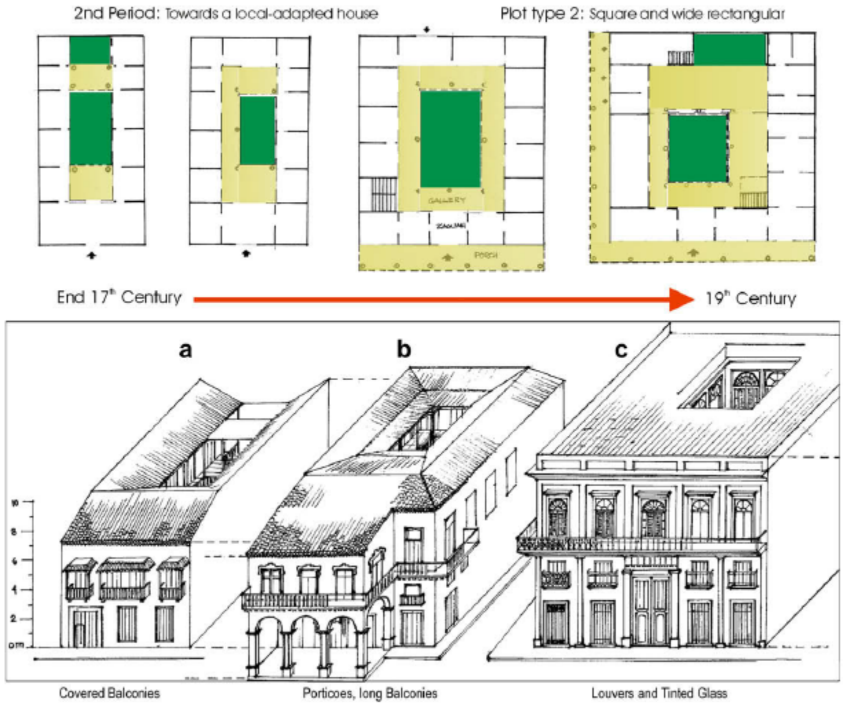

Figure 6: Second period of architectural houses for more rich people http://www.sciencedirect.com/science/article/pii/S0360132309000195)

Figure 7: Tipical Vernacolar House in Havana (http://havanatourcompany.com/casa-particular-in-cuba/)

Starting from 2011, the Cuban government has made it possible to rent these houses, making it one of Havana's symbols for tourists traveling on the island.

Figure 8: Tipical Vernacolar House in Havana (http://www.cuba-junky.com/havana/havana-casa-particulares-home.htm)

Figure 9: Tipical Vernacolar House in Havana (http://bestcubaguide.com/portfolio-items/casa-elvira-clean-low-cost/)

Saint Petersburg

The second one is Saint Petersburg, the second-largest city after Moscow, with five million inhabitants in 2012. An important Russian port on the Baltic Sea, it is politically administered as a federal subject. Under

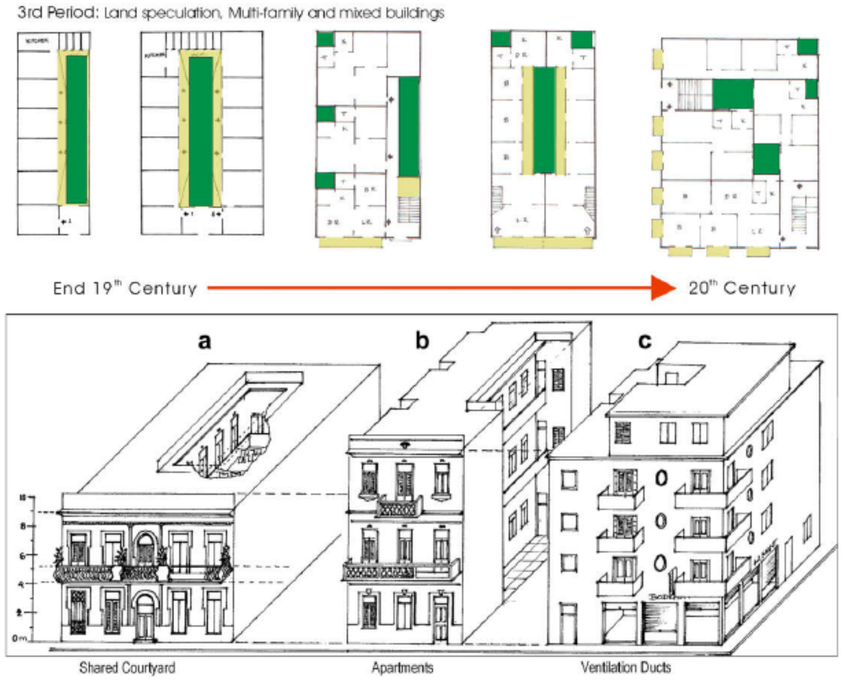

Figure 10: Third period of architectural houses (http://www.sciencedirect.com/science/article/pii/S0360132309000195)

Figure 11: Tipical Vernacolar House in Havana (http://www.washingtonpost.com/sf/world/2015/12/29/a-socialist-vision-fades-in-cubas-biggest-housing-project/)

the climate classification, Saint Petersburg is classified as Dfb, a humid continental climate. Distinct moderating influence of the Baltic Sea cyclones result in warm, humid and short summers and long, moderately cold wet winters. Climate of Saint Petersburg is close to the climate of Helsinki, although colder in winter and warmer in summer because of its more eastern location. The average maximum temperature in July is 23 °C, and the average minimum temperature in February is -8.5 degC; an extreme temperature of 37.1 degC occurred during the 2010 Northern Hemisphere summer heat wave. A winter minimum of -35.9 degC was recorded in 1883. The average annual temperature is 5.8 degC. The Neva River within the city limits usually freezes up in November–December and break-up occurs in April. From December to March there are 118 days average with snow cover, which reaches an average snow depth of 19 cm by February. The frost-free period in the city lasts on average for about 135 days. Despite St. Petersburg's northern location, its winters are warmer than Moscow's due to the Gulf of Finland and some Gulf Stream influence from Scandinavian winds that can bring temperature slightly above freezing. The city also has a slightly warmer climate than its suburbs. Weather conditions are quite variable all year round. Average annual precipitation varies across the city, averaging 660 millimeters per year and reaching maximum in late summer. Soil moisture is almost always high because of lower evapotranspiration due to the cool climate. Air humidity is 78% on average, and there is on average, 165 overcast days per year.

Figure 12: Position of Saint Petersburg near the Europe (https://www.britannica.com/place/St-Petersburg-Russia)

The Vernacular houses of this place are called Izba, very typical house in all the Russia's place, made in most of the part in wood, very frequently diffused, respect rocks, not very diffused in Russia and respect other material like metal, glass and stones very expensive for this type of house, used in the most part from farmers. The Izba is a particular type of house, made without any type of foundation and with a roof made in straw; this particular house, shoved in the pictures, it's made with a very big garden outside the house, an opening kitchen and a building for the animals; this type of building is general build near a street. It's interesting to understand how this house was traditionally constructed without any kind of crane or similar (the system very large used today) but the construction is especially made with ropes, axes, knives, and spades, very diffused in the fifteen centuries..

If we consider the control climate in the internal part of the Izba, we consider the large amount of the hours present during all the year in the heating season, and it's not present a hours in the cooling season, for

Figure 13: South view of an Izba (https://flore.unifi.it/retrieve/handle/2158/990007/31208/PhD%20Porzilli%20parte%202.pdf)

this reason this type of house don't need a climate control against the hot temperature; if we consider the system of heating the house, all the Izba are made with a particular type of own inside the building, very large (in some case arrive to occupy $\frac{1}{4}$ of the floor) where the people, in the coldest hours of the day and in winter, sleep near or above this. The windows are in the large part present in the South pole, to guarantee a good insolation of the rooms and a better solar gains respect the other pole, in the North pole generally are present the stalls for the animal, because don't need some lighting and hot. Starting from the seventeen century this type of building became very typical in Russia and are not only a building to guarantee survival of the people, but became a house where the people want to have a good life, for this reason the people stared to make it well, with some type of embellishments.

Figure 14: 4 views of an Izba (https://flore.unifi.it/retrieve/handle/2158/990007/31208/PhD%20Porzilli%20parte%202.pdf)

Now we consider the distribution of the internal space of the Izba, in the ground floor is present the day part of the house, where the people spent the large part of the days and in the upper floors there is the night part of the house, because we know the principle of the thermodynamics of the flux of heating, go from the own in the upper part of the house in the time. So much rooms are present in the floors, and the most important room have a position in the middle area of the floor of in the South Pole, for the reason explicated before (Solar Gains and temperature control). The picture below show the map of the typical Izba house.

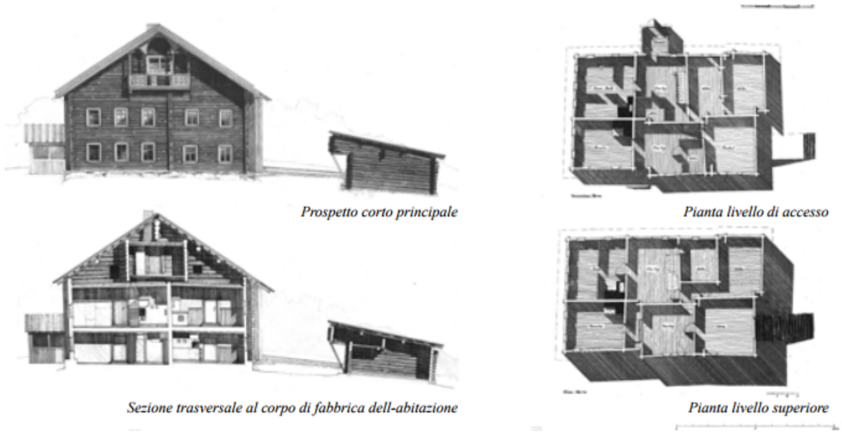

Figure 15: Sections of a tipical Izba (https://flore.unifi.it/retrieve/handle/2158/990007/31208/PhD%20Porzilli%20parte%202.pdf)

Some other picture show the tipical Russian Izba: in these pictures are very clear the solution adopted against the snow, for example the roof with an very high degree of slope; an other characteristic of the Izba is the material used, generally the wood, very frequently present in the Russian environment.

Figure 16: Tipical Izba present in Russia (https://en.wikipedia.org/wiki/Izba)

Figure 17: Tipical Izba present in Russia (http://www.doit.house/russian-log-house.shtml)

Figure 18: Tipical Izba present in Russia (http://www.skyscrapercity.com/showthread.php?t=1102285)

Point 2:

In the second chapter we use Watson&Labs matrix for both Havana and Saint Petersburg to see the different strategies, in cold and hot season, that can improve drastically the use of plants to cool down or heat the building.

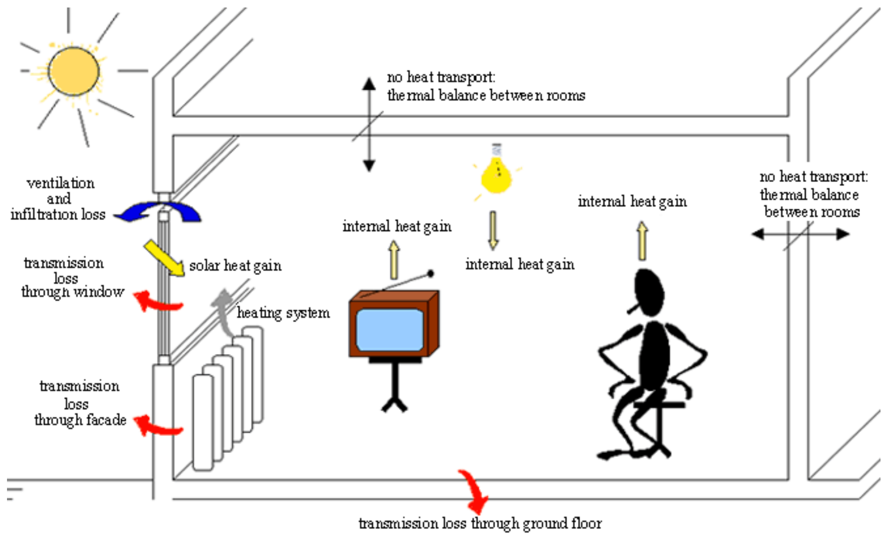

Figure 19: Energy balance for a typical room building (http://www.seedengr.com/Blog/?tag=ies-modelling)

Havana

Havana is characterized by a tropical climate, that is closely borders on a tropical monsoon climate, it results tempered by the island's position in the belt of the trade winds and by the warm offshore currents. Rainfall is heaviest in June and October and lightest from December through April, averaging 1,200 mm annually.

In this type of climate there is no meaning to consider a winter season because the average temperature is, more or less, the same during the whole year, so we don't consider making some strategies to reduce the energy related to heating system.

For what concern the summer period we can study some different type of strategies to reduce energy for cooling system.

CONDUCTION

Consider conduction strategies we can use the envelope, like walls and roofs, to improve the thermal resistance and limit the conduction phenomena of heat through envelope; we can do this increasing the thickness of insulation, or using a better type of insulating material, also the type of glass and the frame is important to limit conduction through window, using also thermal break. But increase the insulation thickness is not convenient, because temperature never fall down to a low value so it can be a waste of money; a better strategy in this type of climate can the micro ventilation, we can create a little thickness in walls and roofs to permit the air to circulate, this can be very useful because the heat reaching the external surface is firstly stopped by an external skin, next a good part of the heat transfer through the wall is remove by micro ventilation, so without any type on insulator and without thermal mass we can reduce a lot heat gains for conduction.

VENTILATION

It's very important to consider the ventilation in this climate; we must avoid as much as possible air exchanges and infiltration with hot air, this meaning that is better to avoid natural ventilation in the hottest hours of the day especially during sunny and hot days; in the contrary during coldest hours like during the night we

		Heat sources			
Season	Main strategies	Conduction	Ventilation	Radiation	Evaporation
WINTER (cold season)	Increase Heat Gain	Improve heat storage	Improve indirect gains from warm soil or sun	Improve solar gains	-
	Reduce Heat Loss	Reduce heat transfer from inside to outside throught building envelope	Reduce air exchange and infiltration	-	-
SUMMER (hot season)	Reduce Heat Gain	Reduce heat transfer from outside to inside throught building envelope	Reduce hot air exchange and infiltration come from external environment	Limit as possile solar gains (heating effect)	-
	Increase Heat Loss	Increase heat transfer from inside to outside throught building envelope	Improve fresh air exchange and infiltration come from external environment	Increase radiant losses (cooling effect)	Use evaporative cooling

Sources	-	Atmosphere	Sun	
Sinks	Earth	Atmosphere	Sky	Atmosphere

can use natural ventilation to cool down without any type of plants. Natural ventilation is very important to the health and comfort of the people inside buildings, and reduce stagnation, a phenomenon that can create discomfort. To allow natural ventilation we can simply open window in opposite façade, and open internal door to allow natural movement of air but only if there are no problem for acoustic insulation. During hottest hours we consider avoiding natural ventilation closing the window and limit as much as possible infiltration, especially through the windows.

SOLAR GAINS

Talking about solar gains is better to limit this parameter to avoid an increase of internal air temperature; to make it possible we can use some type of shading device or overhang to limit the solar gains through the windows especially during summer season, overhang is good here because stop solar radiation during hottest season and hottest hours in the year, due to the sun inclination in these periods. To stop also solar radiation, we can use external threes that are able to stop direct solar radiation. For improve the heat losses due to radiation we can use the temperature of the sky especially during night without clouds where the building can directly "see" the sky.

ROOF

The roof is the part of the building most subjected to the solar radiation, so we can work on it. We can use light painting changing albedo to improve the reflection coefficient instead transmission and adsorption coefficient, limiting the heat through the external envelope; or we can use green roof, this type of solution is

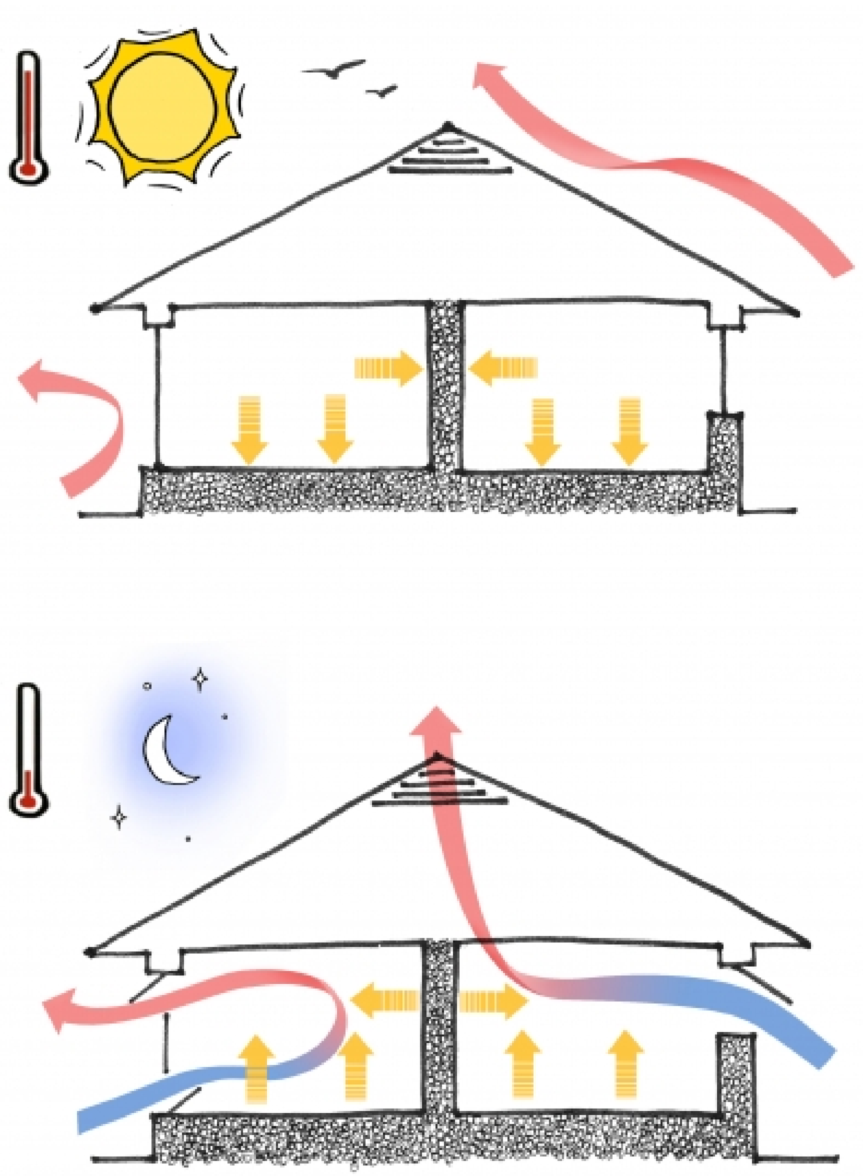

Figure 20: Example of night ventilation for heat removing (https://sustainabilityworkshop.autodesk.com/buildings/night-purge-ventilation)

interesting because the thickness of soil can improve the thermal mass and the thermal insulation of the roof without any type of insulting material, and with the help of the plants can reduce a lot the incident solar radiation, this is due thanks to the leaves that reflect a big part of solar radiation, making a sensation of fresh in the room under the roof; it can create also advantages for rain because ground can adsorb store and gradually release the water instead traditional roofs, that flow all the water rain in the street. Green roof to be efficient require a good maintenance to assure the plants life, and to avoid damage on the substructure.

OTHER STRATEGIES

Another strategies to consider is the thermal mass that can adsorb a good quantity of solar energy during days and release it during night, but in this type of climate is better to consider light envelope with consideration

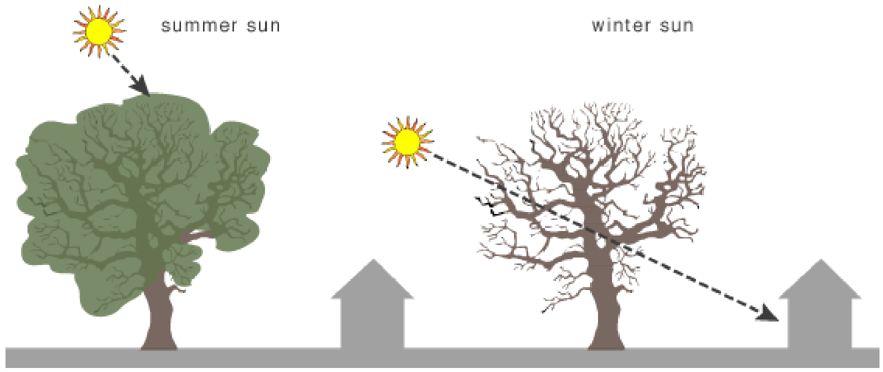

Figure 21: Trees effect on solar radiation (http://www.greenspec.co.uk/building-design/solar-siting-orientation/)

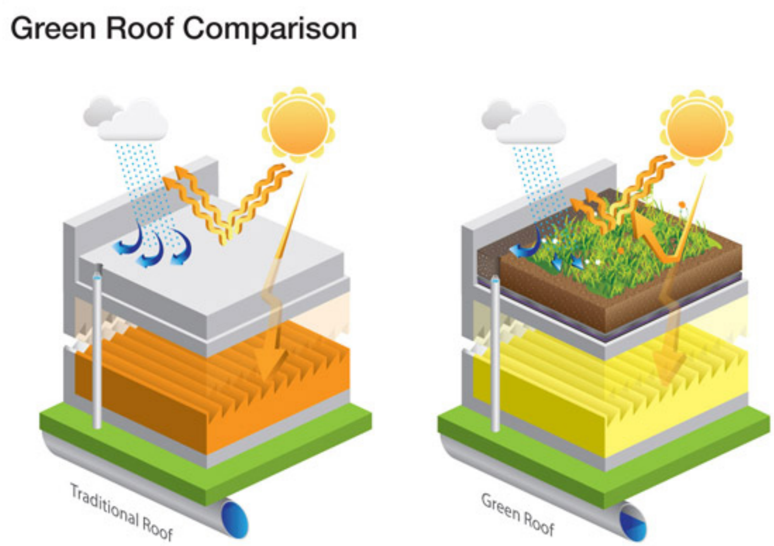

Figure 22: Advantages of green roof (http://lagoscleanbeach.wix.com/site1/apps/blog/green-white-green-roofs)

to ventilation respect to the thermal mass. Also using evaporative cooling, it can be not useful in this type of climate due to the very high relative humidity of the air in the external environment.

Saint Petersburg

Saint Petersburg is characterized by a humid continental climate that has warm, humid and short summers and long, moderately cold wet winters. Average annual precipitation varies across the city, averaging 660 millimeters per year and reaching maximum in late summer. Soil moisture is almost always high because of lower evapotranspiration due to the cool climate and Air humidity is 78% on average.

In this type of climate there the major topic is to limit the consumption for the heating system because the

		Heat sources			
Season	Main strategies	Conduction	Ventilation	Radiation	Evaporation
WINTER (cold season)	Increase Heat Gain	Improve heat storage	Improve indirect gains from warm soil or sun	Improve solar gains	-
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	Increase Heat Loss	Increase heat transfer from inside to outside throught building envelope	Improve fresh air exchange and infiltration come from external environment	Increase radiant losses (cooling effect)	Use evaporative cooling

Sources	-	Atmosphere	Sun	
Sinks	Earth	Atmosphere	Sky	Atmosphere

climate is very cold and rigid especially during winter, also in summer the temperature not reach very high values remaining at least in the comfort range (20 – 26 °C) for the whole year.

For these consideration is more important to study strategies for cold period limiting the energy using for heating system.

CONDUCTION

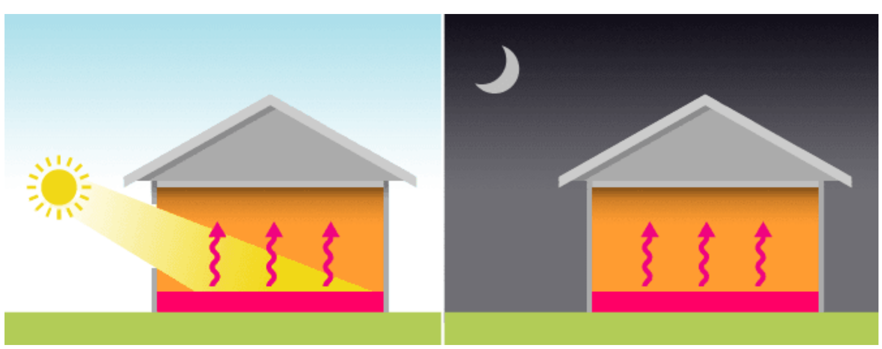

Figure 23: Use of thermal mass in a building (http://ourjourneytosustainability.blogspot.it/2013/05/why-tire-house-renovating-two-story.html)

Consider conduction strategies we can use the envelope, like walls and roofs, to improve the thermal resistance and limit the conduction phenomena of heat through envelope; we can do this increasing the thickness of insulation, or using a better type of insulating material, also the type of glass and the frame are important to limit conduction through window, using also thermal break; it is better to use a double or triple glasses with an interspace fill with gas for example argon, to improve a lot the thermal resistance. Using thermal mass in this climate can be useful because during the day walls and floor can adsorb a lot of heat energy that can be release to the internal environment during the night, getting higher the internal air temperature in the coldest hours of the day. It is also very important to limit the thermal bridge in the building especially near corners and windows, in a cold climate is easy without a good design to create thermal bridge with a low internal surface temperature, this can create discomfort and can affect also the heath of the people inside it.

VENTILATION

The ventilation in this climate can affect negatively the internal condition of the building, living in a rigid climate and using ventilation without any type of treatment like AHU we can drastically reduce the internal temperature creating discomfort. So the designer must avoid as much as possible infiltration and heat losses through envelope and windows.

SOLAR GAINS

Solar gains can play a big role for reducing the use of heating system. We can use sun radiation as possible to improve internal air temperature without any kind of plants. To improve the solar gains through the windows we must choose a good orientation of the building that can allow the building to receive the bigger amount of solar radiation, study also the position respect to the other buildings. It is better to improve the glazing area in the building especially in south façade respect to the other orientation, in this way we can improve the solar radiation come into the building and reach internal floor and limit dispersion from the Windows to the other facade; if we combine this solution with a floor that has a good thermal mass we can improve also the temperature during night; the floor impressed by solar radiation can storage the energy comes to the sun during the day and gradually release it during night. A good choice for the orientation of the building can improve also the natural illumination comes from the sun especially during winter when the hours of sun are very few.

Point 3:

Havana

At first, we analysed the Great Houses of Havana, which is the modern climate responsive architectures in Cuba.

BUILDING INTRODUCTION

The United States' diplomatic presence in Cuba is housed in a severe, early-1950s office building perched on the shoreline over Havana Bay. Walled off from the city and pulled back from the street, the building has the uneasy presence of a haunted castle – shunned and maligned by its neighbors, but subjected to the unending scrutiny of suspicious eyes and intrigued gossip of the locals. With its regimented orthogonalities and the unmistakably foreign imprint of modernist efficiencies, both the embassy's architecture and the optimistic political spirit it embodies seem to belong to another era, a cooperative past no longer conceivable in the wake of a half century of underhanded diplomacy, calumnious propaganda, and failed attempts to restore relations between the embattled countries.

BUILDING DESIGN

Designed in 1950 by the renowned team of Wallace Harrison and Max Abramovitz, architects of the CIA

Figure 24: Building in early-1950s (https://www.archdaily.com/584114/ad-classics-united-states-embassy-in-havana-harrison-and-abramovitz/54a99ed8e58ecee47e000065-unnamed-png)

Headquarters at Langley and a host of other civic projects, the embassy was completed to great critical acclaim in 1953. It earned a prominent place that same year in an exhibition on "Architecture for the State Department" at the Museum of Modern Art, alongside another consulate by the duo in Rio de Jainero and seven other embassies from around the world. The scheme in Havana was simple and elegant: a sprawling ground floor level with two courtyard patios that contained information, visa, and consular desks, and a setback office tower that housed diplomatic offices and bases of operations for more sensitive government missions. Clad in imported travertine panels, the embassy's clean lines and simple rectangular geometries epitomized both the industrial aesthetic of International Style modernism and the seemingly inescapable influence of encroaching American culture.

BUILDING FUNCTION

True to its name, the appeal of International Style modernism had little to do with a concern for regional sensitivity or local conditions. Its theoretical origins as a universal architecture of standardized mass production generally precluded the necessity (and sometimes the capacity) of contextual adaptation at the project level. Accordingly, while Harrison and Abramovitz displayed a token amount of interest in the building's immediate environs, it was only as an afterthought to the larger design concept, and early attempts at environmental tuning were met with mixed results. For example, the architects aligned the thin office block on a north-south axis, hoping to intercept the strong east-west winds of the shoreline through large operable windows. Well intended though they were, the actual ability of these windows to ventilate the building and offset the searing greenhouse effect of the glass facades was minimal and unreliable, ultimately leading to an extensive mechanical and material renovation in 1997.

BUILDING RELATIONSHIP

It is no coincidence that the building bears a remarkable resemblance to another, more famous house of diplomacy. While the architecture of the United Nations Secretariat Building in New York (1952) has often

Figure 25: United States Embassy in Havana(https://www.archdaily.com/584114/ad-classics-united-states-embassy-in-havana-harrison-and-abramovitz/54a99df9e58ecee47e000063-flickr_user_terry_feuerborn-jpg

Figure 26: Building facades(https://www.archdaily.com/584114/ad-classics-united-states-embassy-in-havana-harrison-and-abramovitz/54a99b9ee58eceffe500004d-u-s-_department_of_state_2-jpg)

been attributed to Niemeyer and Le Corbusier, two of the giants behind its design, it was actually Harrison that was placed in charge of the international collaboration. Like the embassy in Havana, the Secretariat has an oblong, rectangular footprint aligned along a north-south axis. Windows cover the east and west facades; while solid, light-colored panels cover the north, south, and uppermost profiles. The result is the form of a capital pi (Π), heavily outlined and infilled with glass, a scheme that has since been redeployed in projects around the world. Although the UN prototype was primarily the brainchild of Niemeyer—who used the scheme to great success five years later in Brasilia—its success as a model was undoubtedly appreciated and borrowed by Harrison in Havana.

Figure 27: Surrounding building environment(https://www.archdaily.com/584114/ad-classics-united-states-embassy-in-havana-harrison-and-abramovitz/54a99e87e58ecee47e000064-bin_im_garten-jpg)

The calculated decision to build the embassy in this particular style had important cultural meaning in the context of the broader, global political climate. Modernism deliberately represented the political values that the United States hoped would inspire the world to follow in its lead: a promise of prosperity and opportunity through the mechanisms of technology and industrialization. In the context of the Cold War, it was equally important that the classicism of prewar Soviet embassy architecture reflected a dialectic opposition to this philosophy: one of imperialist monumentality, intimidation, and grandeur. Although Soviet architecture abroad eventually made an about-face to align more congruently with its proletarian values, for the time being, these contrasting approaches defined one of the Cold War's more intriguing and prolific cultural battlefields.

Saint Petersburg

BUILDING INTRODUCTION

The sports pavilion with an area of 113 m^2 was built in the suburbs of Saint Petersburg in 2015. The project is notable not only for its elegant architectural forms but also for unique building technologies used during its construction process.

The architects were faced with a task to design a complete sports facility within an existing suburban landscape and limited space. As a result, the pavilion became part of the landscape and the landscape became part of the pavilion: only 30 m^2 of the forest grounds were allowed for construction with all the trees preserved and integrated into the interior of the building.

CLIMATE-FRIENDLY DESIGN

The desire to preserve the trees on the building site meant that no construction equipment could be installed during the construction stage, all excavation works were done by hand and the assembly works were done by special manipulators. The basement was constructed using a top-down technique: the ground was removed level by level and the building was erected downwards.

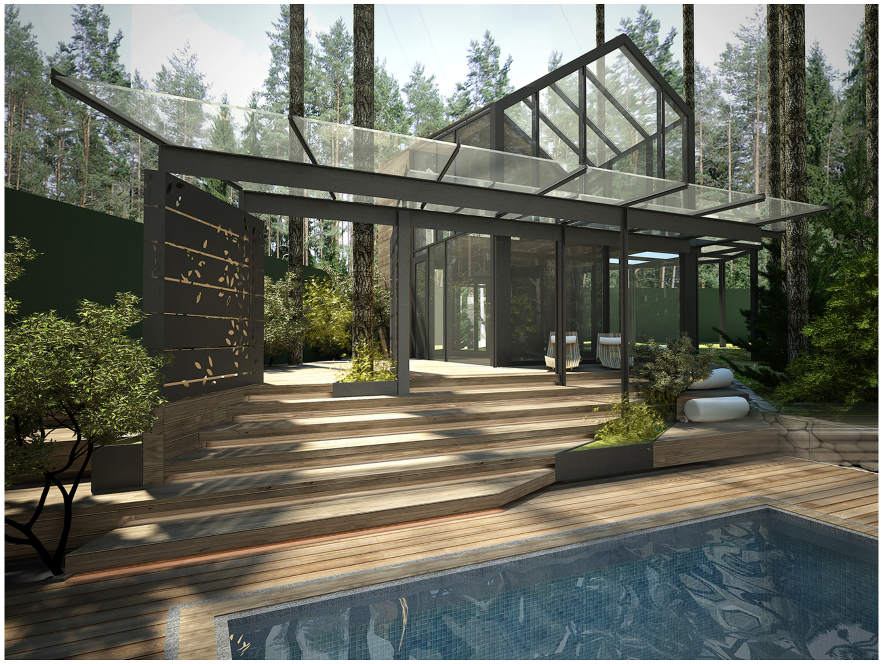

Figure 28: Overall Building(https://www.archdaily.com/806618/the-sports-pavilion-horomystudio/58bc34d8e58ece04510002e4-the-sports-pavilion-horomystudio-photo)

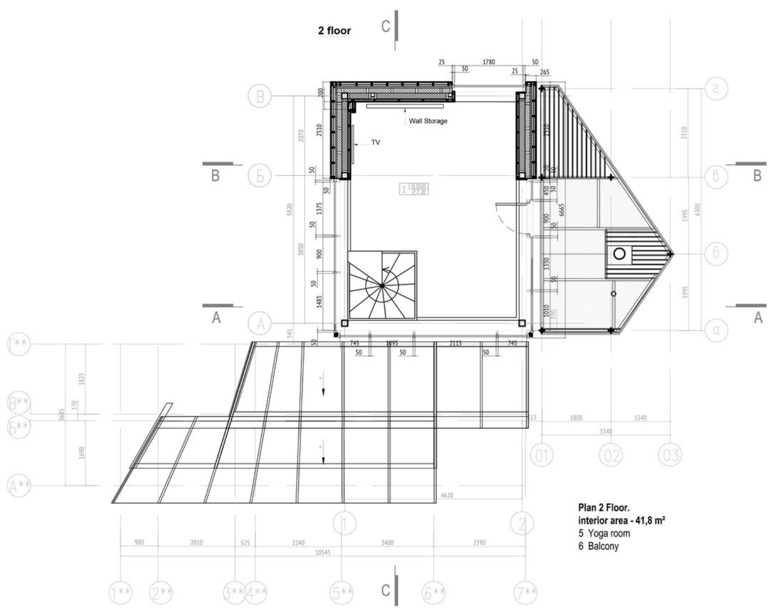

Figure 29: Plans of Building(https://www.archdaily.com/806618/the-sports-pavilion-horomystudio/58bc355ee58ececdd000014d-the-sports-pavilion-horomystudio-roof-plan)

The basement containing locker rooms and weight benches, the ground floor with cardio-vascular machines and the first floor accommodating a yoga gym - constitute the necessary building area requirements.

The angle of the roof's ridge brings a certain dynamic to the building's architectural form, while the pavilion itself consists of two parts - the northern glazed part and the southern wooden part. Multi-level terraces frame the pavilion with canopies for comfortable outdoor activities in any weather. In the northern part, the terrace connects the sports pavilion with the existing bathing facility.

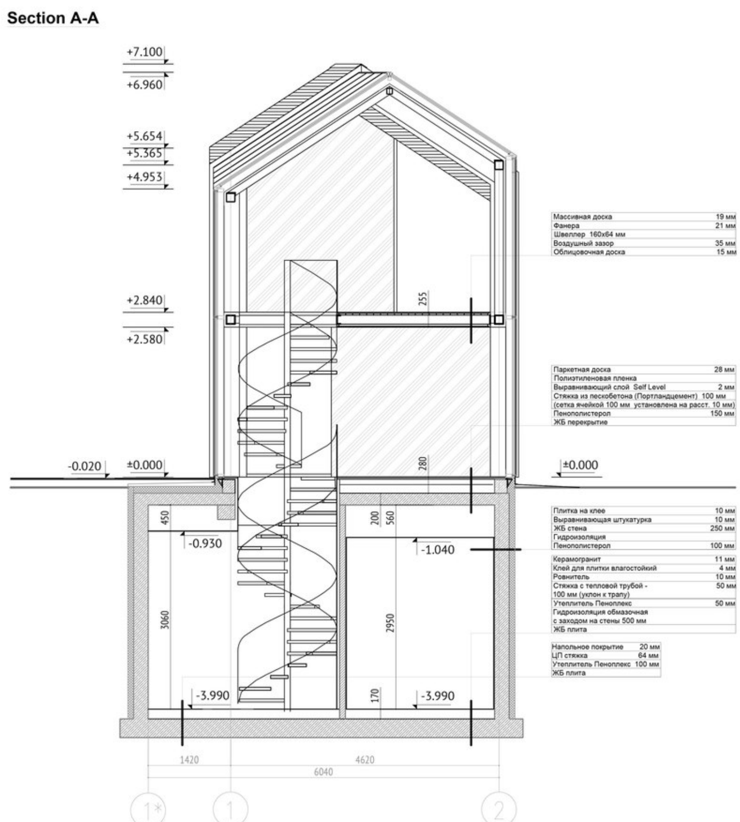

Figure 30: Section of Builiding(https://www.archdaily.com/806618/the-sports-pavilion-horomystudio/58bc35afe58ece04510002e9-the-sports-pavilion-horomystudio-section-a-a)

The pavilion is carefully integrated into the existing landscape. The first-floor balcony is made from glass to create less shade for the site, while the gym on the ground floor is equipped with glass sliding doors that erase the borders between the interior and exterior. The building's supporting structures situated between trees are clad with lightboxes. The steps of the terrace have built-in decorative boxes for plants.

The three floors are connected by a spiral staircase with an intricate hand railing from copper plates. The rubber-coated polymer steps enable one to safely move between the floors.

The interior design of the pavilion meets the highest design standards for sports facilities: the project includes professional flooring (SPORTEC style and MIRAGE hardwood sports flooring), and pays special attention to the natural ventilation system - special air gaps are left between the ground floor and the second floor for better air circulation.

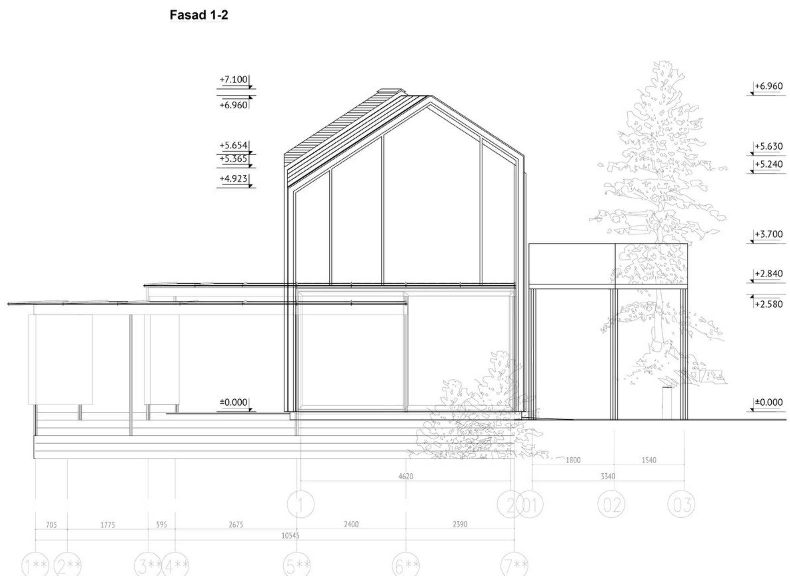

Figure 31: Outline of Building(https://www.archdaily.com/806618/the-sports-pavilion-horomystudio/58bc356de58ece04510002e7-the-sports-pavilion-horomystudio-facade-1-2)

PRODUCT DISCRIPTION

In this project we used German sliding doors system "Schueco" with high thermal insulation made of aluminum, series: ASS 70.HI.. This system made it possible to combine a sport hall with forest outside and increase the living space of the building. Due to extremely high strength of aluminum, we used the construction with narrow sash and large glazed surfaces that provide the maximum degree of transparency premises and penetration of daylight.

Reference:

http://www.sciencedirect.com/science/article/pii/S0360132309000195

https://flore.unifi.it/retrieve/handle/2158/990007/31208/PhD%20Porzilli%20parte%202.pdf

http://www.archdaily.com/584114/ad-classics-united-states-embassy-in-havana-harrison-and-abramovitz

https://www.archdaily.com/806618/the-sports-pavilion-horomystudio

http://www.seedengr.com/Blog/?tag=ies-modelling

https://sustainabilityworkshop.autodesk.com/buildings/night-purge-ventilation

http://www.greenspec.co.uk/building-design/solar-siting-orientation/

http://lagoscleanbeach.wix.com/site1/apps/blog/green-white-green-roofs

http://ourjourneytosustainability.blogspot.it/2013/05/why-tire-house-renovating-two-story.html