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PASSIVE AND BIOCLIMATIC BUILDINGS

Title: Passive to Bioclimatic architecture:

From vernacular architecture to architectural-energy concept

1 – Aims

The objective of studying passive to bioclimatic architecture is to understand and implement architectural design strategies that prioritize energy efficiency, human comfort, and sustainability by harnessing the natural climatic conditions of a specific location. Passive architecture refers to a design approach that relies on natural elements like sunlight, wind, and thermal mass to create comfortable indoor environments without relying heavily on mechanical systems. Bioclimatic architecture takes this concept further by integrating the principles of passive design with a deep understanding of the local climate and ecosystem, aiming to achieve a harmonious relationship between built environments and nature.

Learning about the PASSIVE AND BIOCLIMATIC BUILDINGS

Details can be found at https://passivehouse.com/ . The first research was started in 80s by a group of German architects and engineers: why buildings from that time were consuming so much energy, people were feeling cold in winter and too expensive?

According to [5] the difference between a passive house and a low-energy one is:

- ‘Passive Houses allow for space heating and cooling related energy savings of up to 90% compared with typical building stock and over 75% compared to average new builds. Passive Houses use less than 1.5 l of oil or 1.5 m3 of gas to heat one square meter of living space for a year – substantially less than common “low-energy” buildings. Vast energy savings have been demonstrated in warm climates where typical buildings also require active cooling.
- Passive Houses make efficient use of the sun, internal heat sources and heat recovery, rendering conventional heating systems unnecessary throughout even the coldest of winters. During warmer months, Passive Houses make use of passive cooling techniques such as strategic shading to keep comfortably cool.
- Passive Houses are praised for the high level of comfort they offer. Internal surface temperatures vary little from indoor air temperatures, even in the face

of extreme outdoor temperatures. Special windows and a building envelope consisting of a highly insulated roof and floor slab as well as highly insulated exterior walls keep the desired warmth in the house – or undesirable heat out.

- A ventilation system imperceptibly supplies constant fresh air, making for superior air quality without unpleasant draughts. A highly efficient heat recovery unit allows for the heat contained in the exhaust air to be re-used. '

The most known requirement is that the heating demand must be less than 15 kWh/m^2/year, in a moment when lighting consumption were above this value. Also airtightness is highly important, with a maximum of 0.6 air changes/ hour at 50 Pascals pressure (ACH50).

There is no specific requirement regarding artificial or natural lighting. There Is only a requiremt for windows that 'the window frames must be well insulated and fitted with low-e glazings filled with argon or krypton to prevent heat transfer. For most cool-termperate climates, this means a U-value of 0.80 W/(m²K) or less, with g-values around 50% (g-value= total solar transmittance, proportion of the solar energy available for the room)' [5]. For lighting in residential building, two calculation pages will indicate the daily and yearly use, orientation and geometry of the room and the dimensions and the height of the windows, for the use of the daylight for each space. The artificial lighting is a complement to the daylight .

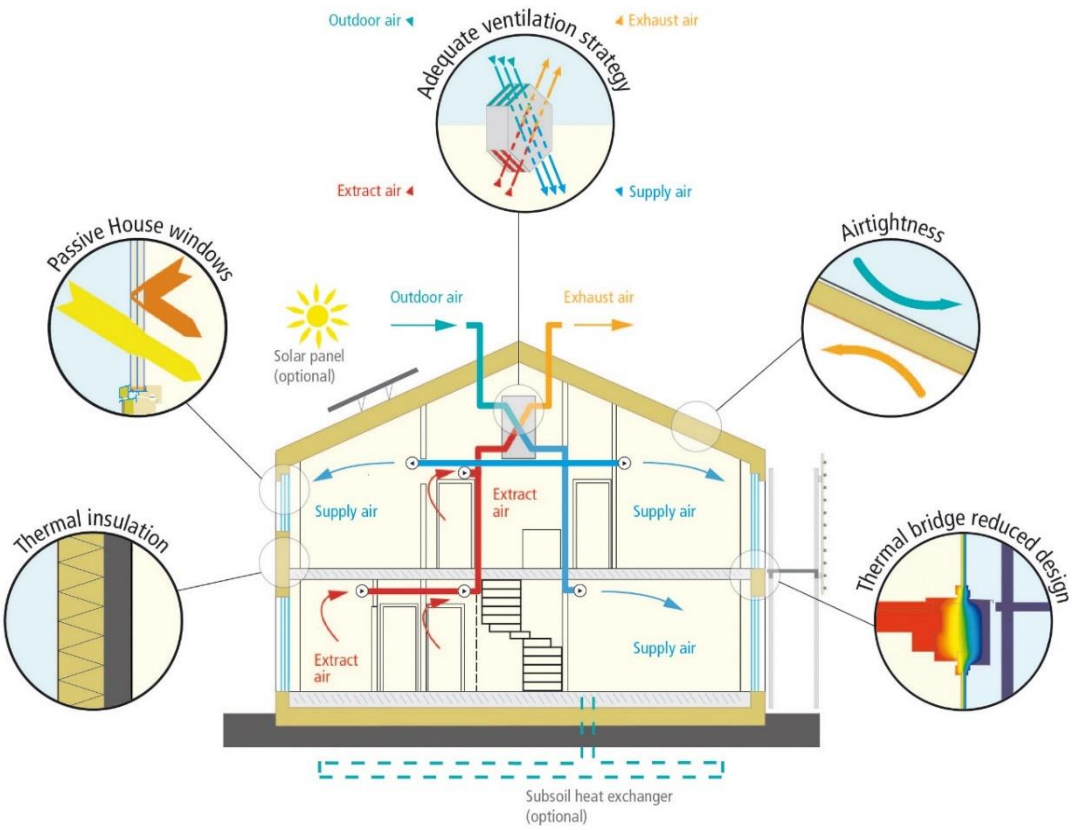


Figure 1 The five basic principles for a Passive House (source [5])

As we can see in Figure 1, in the case of Passive House the focus is on the insulation and airtightness, which are the passive elements, and less on lighting, either natural or artificial. There is no special interest in the material used, as long the targets of Passive House are reached, but the concept goes very well with the New Green Deal.

2 - Learning methodology

Students will read this tutorial and follow the steps shown in the tutorial, namely:

- Environmental adaptation, through passive measures
- Different approaches to conception of a new house, or in the refurbishment of an existing one
- Bioclimatic buildings
- Solar Gain and Thermal Mass
- Energy-Efficient Appliances and Lighting
- New technologies included in the new design (NbS – nature baed solutions + photovoltaic technology in a furrher stage of the project)

3 - Tutorial duration

The case sudeies were developed by our collegues Dorin Beu and Nina Dițoiu

4h lesson hours are suitable for this case studies tutorial.

4 – Necessary teaching recourses

Computer room with PCs with internet access.

Required software: Microsoft Office Package.

5 – Contents & tutorial

5.1 – Introduction

Bio-climatic architecture is an architecture that imply environmental adaptation, through passive measures and elements that allows retrieving and optimisation of technologies which require environmental conditions adaptation, the result being a new way to design a building, by tackling all constraints for climate change adaptation through a holistic view, without adverse impact on aesthetics, heritage and humanistic values.

One of the passive measures are related to building orientation and there is solar gain for heating in winter and an optimal daylighting for a certain room destination, natural ventilation or it cand improve the user wellbeing through biophilic design with Natural based Solutions – NbS.

Other passive measures are related to adaptation to extreme environmental conditions or just specific, which can imply also material and equipment durability or material lifecycle adaptation to earthquakes/storms etc. That means taking into consideration the roof slope or the possibility to sustain heavy rains, in-ground of the building or the use of the Canadian well for heating/cooling.

In the bio-climatic architecture, beside the passive measures, there are also included technologies which need optimization according to environmental conditions, for ventilation, lighting photovoltaic or thermo-solar panels, heat pumps or windmills.

As a common bio-climatic measure, glazed wall with south orientation are efficient architectural bio-climatic element, currently used, not always an inspired solution from aesthetic point of view, by passive houses, certificated PHI - The Passive House Institute [1] with technology based on artificial ventilation with heat recovery; this solution is used also for nZeB buildings (norms may differ from country to country – in Romania we are using Mc 0001/2022. The PHI certification system for the energy level from de concept phase, design, construction and checking for a building, an extremely valuable system as technical result, it is the best known and most people associate it automatically with the concept of ‚passive house' .

Passive houses are integrating passive solutions for heat gain from sun, efficient natural ventilation, good daylighting like traditional/vernacular/indigenous houses, which are adapted to climate, geographical and cultural zone: if to this it is added technology contribution, the result will be a bio-climatic architecture with an optimised holistic design.

In a paper by Gutierrez et al it is mentioned ‚South-facing walls achieve a higher solar gain in the winter than in the summer. East and west vertical orientations and horizontal orientations (skylights), all result in more heat in the summer than winter. The optimal orientation depends on the application. Some examples of applications depending of the orientation of the house are: South-facing glass: Is recommended when we trying to use solar energy during the winter for passive solar heating. This kind of orientation is relatively easy to shade with an overhang or awning during the summer to minimize solar heat gain. North-facing glass: This kind of buildings receives good daylight but relatively little direct insolation, so heat gain is less of a concern. East- and west-facing glazing: Is the most difficult to control (because of low sun angles) and the greatest contributors to unwanted heat gain. Daylighting can be achieved with almost any orientation, but control of natural light is critical and will depend on the glazing area, the types of glazing used, daylighting design strategies, and other key issues.'[2]

For the east/West orientation it is recommended to use, vertical louvres or deciduous local trees, which cast shadow in summer and allows solar gain in winter.

Patrulius [3] has analysed the evolution of dwelling through time, starting from pre-architecture, has established an historic-technic criteria as being relevant in studying the residential architecture programme ‚in a scroll of technique, therefore construction science' has realised the importance of environment adaptation ‚Dwelling was the most important ecological reaction of our ancestors'. Ecology as defined by the authors in 1975, is the the study of the relations of the environment with living creatures, and the etymology comes from two Greek words „oikos – house, logos – science". According to [3] the whole evolution of dwelling along history is related to the technical possibilities of the period, considering that environmental adaptation was always present and highly relevant.

So, besides the wording: green, passive, green etc. people want the dwellings to be safe , comfortable, and using as little energy as possible, by adapting to local climate and experience, the difference consists in existing technology, availability and affordability. So sometimes , it's only the rediscovery of forgotten principles.

According to [3] historical-technic principles, the update of traditional concepts to the available technology of the moment, lead to an evolution which started with the round shape of the straw hut to the rectangular one of the wooden houses, the plan being taken over by stone and other materials. So, the update of vernacular architecture of individual homes using current technology it's a classic approach of the architecture.

The use of bio-climatic principles from vernacular architecture may adapt each building from the concept phase to the environment local factors, also implying the overcoming of 'identity barrier' defined by Per Espen Stoknes [4], with traditional architecture being the base of community cultural heritage or of a valuable area. By analysing bio-climatic elements of the traditional architecture in Romania, Dabija [5] mentioned that contemporary architecture will return to the tradition, including by using local materials and solutions for an Anthropocene environment. In [5] it is mentioned that if we look carefully into the past, we can find solutions for the present. In other word, what we find innovative now, it may be invented and forgotten centuries ago.

5.2. Case studies:

Presented case studies there are applied and analysed the bio-climatic measures that can be used in the conception of a new house, or in the refurbishment of an existing one:

I – first case study is an iconic administrative building from Oradea with a set of bio-climatic measures applied;

II - the second case study it's an extension with research and restoration of a wall fragment from the second precinct from Cluj-Napoca

III – case studies with the analyse and retrieval of bio-climatic elements from traditional architecture in contemporary architecture;
IV – case studies for the refurbishment of a traditional building or for a new one.

5.3. Administrative building bio-climatic

5.3.1 Bio-climatic building . Headquarters of the Water Authority Criş, Oradea, Bihor County

Bio-climatic building – concept and details from the design step from the paper "Multi-disciplinarity in the local, sustainable design of the buildings" , which appeared in 2017, updated with new design/contracting stages of the ongoing project.

The project is developed in 4 stages, STAGE I (first concept draft for an extended site: fig.m4); STAGE II (concept draft final building fig. 1, 3-7, 12); STAGE III (building with changes that appeared during contracting fig. 8-11, 13); STAGE IV (photovoltaic technology insertion).

The building an administrative one and it is headquarters of the Water Authority Criș from Oradea, Bihor County, Romania .

The concept for an iconic building is based on the wave or water movement duet o the purpose of the building, Water Authority, is on a position closed to a small river, called Peta, in Oradea. The cultural identity of the area it's based on an interior court planimetry.

Figure 1 PHASE II - WEST aerial perspective image, rendering

The frame model for "transition design", where the elements of this frame model can be defined as follow:

1. concept+preliminary design;
2. flexibility;
3. detailed identity by retrieving cultural differences / culture of using spaces;
4. new technologies included in the new design (NbS – nature baed solutions + photovoltaic technology in a furrher stage of the project).

Table 5.1. Frame model "transition design" adapted after Cameron Tonkinwise

"Transition design" after *Cameron Tonkinwise* 1	1. Project adaptation by **arh. Dițoiu Nina-Cristina**[2]
1. „vision“	**1.1 Concept + preliminary design – STAGES I + II**: Green infrastructure through a green stretch along the small river + Wave equation from *Fig. 3* cwith the concept of the vertical shading device;
2. "change theories"	**1.2 Flexibility – STAGES II + III + IV**: *introduction from the design stage of suport measures for further interventions;*
3. "mentality / postura"	**1.3 Identity – STAGES I + II + III**: *Planimetry with inner court, iconic building for Water Authority with a focus on the river;*
4. "new ways to design	**1.4 Adaptation for new technologies - STAGES + III + IV**: *stage IVwith photovoltaic technology insertion.*

STAGE I – INITIAL	**STAGE II – INITIAL CONCEPT**
 Fig 2 Stage I – on of the first sketch for an extended site[3]	

[1] Online course "Designing the Future", „RMIT School of Media and Communication University", Melbourne, Australia, site web: https://www.futurelearn.com/courses/designing-futures, posted on 06.02.2017-11.03.2017, visualised on 21.06.2017.

[2] Dițoiu, Nina-Cristina, Agachi, Mihaela Ioana Maria, "Multi-disciplinarity in the local, sustainable design of the buildings," Acta Technica Napocensis: Civil Engineering & Architecture Vol. 60 No. 3, 15.03.2018 pp. 165-171, Part of ISSN: 1221- 5848, https://constructii.utcluj.ro/ActaCivilEng/download/atn/ATN2017(3)_15.pdf, workshop 07.07.2017 "Questions-between permanent and temporary," Cluj-Napoca, România;

[3] concept sketches arh. Nina-Cristina Diţoiu, project realized within Aquaprociv project, Cluj-Napoca, România, director ing. Dan Săcui

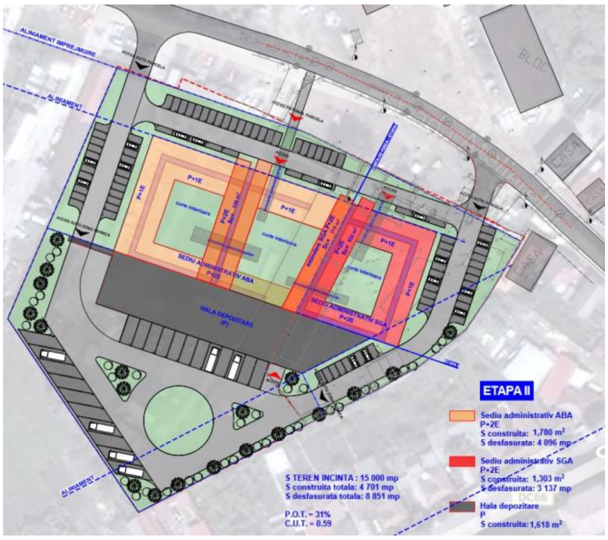
	Fig 3 Stage II – Sketch with the proposed building for contracting, concept NbS [4]
 Fig 4 STAGE I –Layout plan with the first draft concept[5]	 Fig 5 STAGE II – Layout, project in the contracting stage[6]

Figure 6 **STAGE II –** Aerial view perspectiv, night/day rendering, East perspective with vertical shading system[7]

4 ibidem

5 *Cad Drawings, concepts, arh. Diţoiu Nina-Cristina, design coordinator architecture specialization within Aquaprociv project*Cluj-Napoca, România, director ing. Dan Săcui

6 *ibidem*

7 *Ibidem.*

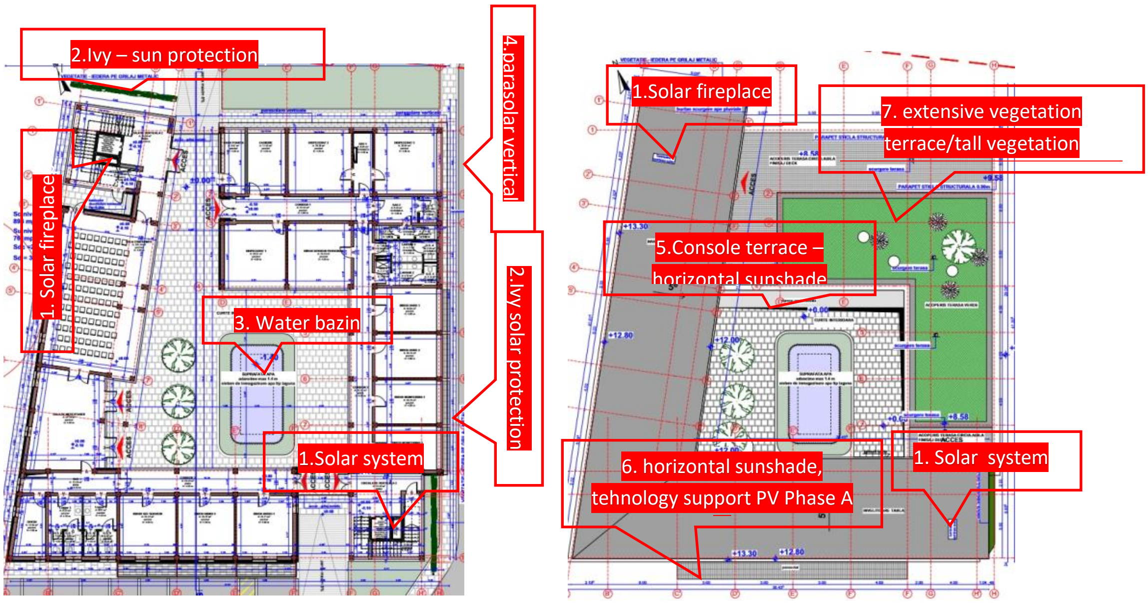


Figure 7 STAGE II CAD drawings, concept Dițoiu Nina-Cristina [8]- Planimetry: ground floor/roofing initial draft mentioning relevant bioclimatic architecture: 1.Solar chimney (natural ventilation, vertical circulation space); 2. Ivy on a metallic frame – solar protection; 3. Water pool on the interior court (well-being during summer); 4. Vertical shading system – West orientation; 5. Cantilevered terrace south orientation – Horizontal sun shading; 6. Metal horizontal sun shading (Metallic structure that support photovoltaic panels); 7. extensive vegetation terrace / high vegetation (well-being) - .

Figure 8 Phaze III CAD drawings, concept Dițoiu Nina-Cristina [9] - Plans for basement, groundfloor10/final version: no more 1. Solar fireplaces and 3. Water pool on the interior court; 6. Metal horizontal sun shading (Metallic structure that support photovoltaic panels); contracted: 2. Ivy on a metallic frame – solar protection; Vertical shading system – West orientation; 5. Cantilevered terrace south orientation –

[8] *Drawings Dițoiu Nina-Cristina, project realized as a practitioner within Aquaprociv project Cluj-Napoca, project coordination architecture specialization;*

[9] *Drawings Dițoiu Nina-Cristina, project realized as a practitioner within Aquaprociv project Cluj-Napoca, project coordination architecture specialization;*

[10] *Cad drawings, concepts, arh. Dițoiu Nina-Cristinaproject coordination architecture specialization* Aquaprociv Proiect, Cluj-Napoca, Romania, director ing. Dan Săcui

Horizontal sun shading; 7. 7. extensive vegetation terrace / high vegetation (well-being) explanatory comments - red/white color.

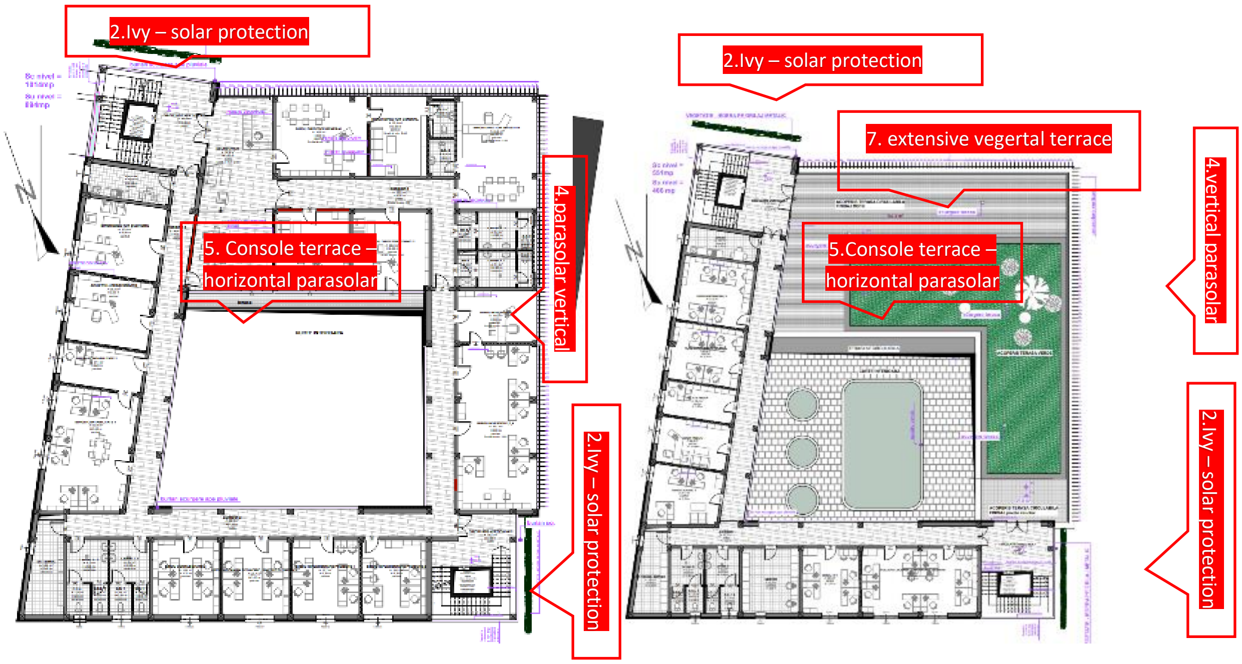


Figure 9 PHASE III Fall drawings, concept Dițoiu Nina-Cristina - Floor plans upper levels superstructure: floor 1, floor 2 executed variants: 1. solar fireplaces, 3. water basin in the inner courtyard and 6. horizontal metallic sunshade (structure metal supporting photovoltaic panels); It is executed 2. Ivy on a metal grid - solar protection; 4. Vertical western orientation sunshades; 5. Terrace in the southern orientation console – horizontal sunshade; 7. Terrace extensive vegetation / tall vegetation (well-being) - explanatory comments - red/white color

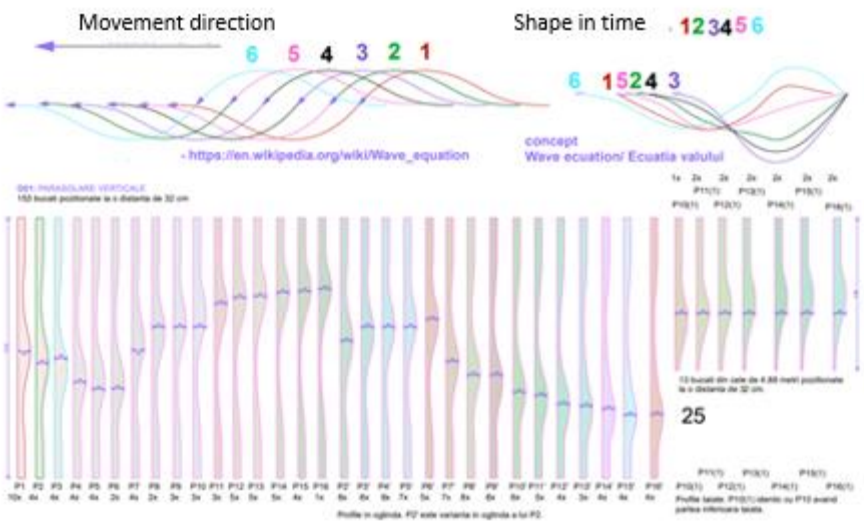


Figure 10 Cad drawings, concept Ditoiu Nina-Cristina-vertical sun visors details-concept wave equation drawing facsimiles source images vertical sun visors profiles, profile views-P1/P16, P2/P16', P10(1)/P16

It is presented ach of the four elements of the framework model /"framework" for the concept of "transition design" of Professor Cameron Tonkinwise adapted to this case study.

The concept of the building is the water that feeds the vegetation-green infrastructure + blue infrastructure wave equation (figure 9).

The" Green "vegetation is found on the three sides of the" water form " and develops from it: ivy on the north - east and southeast facades and the roof of the green terrace.

The volumetry of the building is noted by the wave shape found in the vertical sunshades. Adopting a bioclimatic building that protects the walls of the inner courtyard from overheating,the "water" materializes in a vertical sunshade system, the "green" ivy walls also protect against overheating, they function as sunshades in summer.

Flexibility– STAGES II + III + IV[11]

The design was conceived in two different stages that can only be found in sketches. The first designed building was built on an extended site, with several different functions: administrative, warehouse with materials and intervention vehicles.

The second stage is utopian at this point. The investment is made only for the administrative building on a small part of the original site. The culture of using spaces could explain the lack of flexibility of interior design with many individual offices. Some of the sustainability measures, such as the photovoltaic system, will be found at a later stage, but the solar fireplace adjacent to the elevator has been dismantled due to details during execution. The solar fireplace was a bioclimatic way of ventilating the glazed space of the vertical circulation.

Identity – STAGES I+ II + III[12]

The site of the investment is located in Oradea, a city that "is first mentioned in 1113, under the Latin name 'Varadinum' (...) Recent archaeological discoveries around the city provide evidence of a more or less continuous habitat since the Neolithic." The site is included in an area protected by the code "BH-I-s-B-00944" as an archaeological site.

The development of the historical city of Oradea is on the water course "Crişul Repede", "Peta" is the tributary in the north of the studied site.

Water is a part of the landscape in the area and a very special element of archetypal images for any inhabitant of this space. The local specificity of the traditional city are the buildings with courtyards. The location is located in the peripheral industrial area of the city, the reason why the materials chosen are not the traditional ones.

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[11] *Dițoiu, Nina-Cristina, extracted project realized as a practitioner within Aquaprociv project Cluj-Napoca, project coordination architecture specialization;*
[12, 13] *ibidem*

New technologies – STAGES II + III + IV13

Sustainability is a current topic, the sustainability of the building with the evening technology: NbS (Nature based Solution – in execution) and PV (photovoltaic system – phase II), are important factors for energy efficiency, are found as elements of a bioclimatic building in the first stage, and alternative energy sources PV for the second stage represent an unachieved target. The proposed photovoltaic systems were not provided for in the executed solution. New technologies demand a new design - solar architecture with protection against overheating of the inner courtyard, metal structures designed for solar panels (photovoltaic technology) are provided in the second stage.

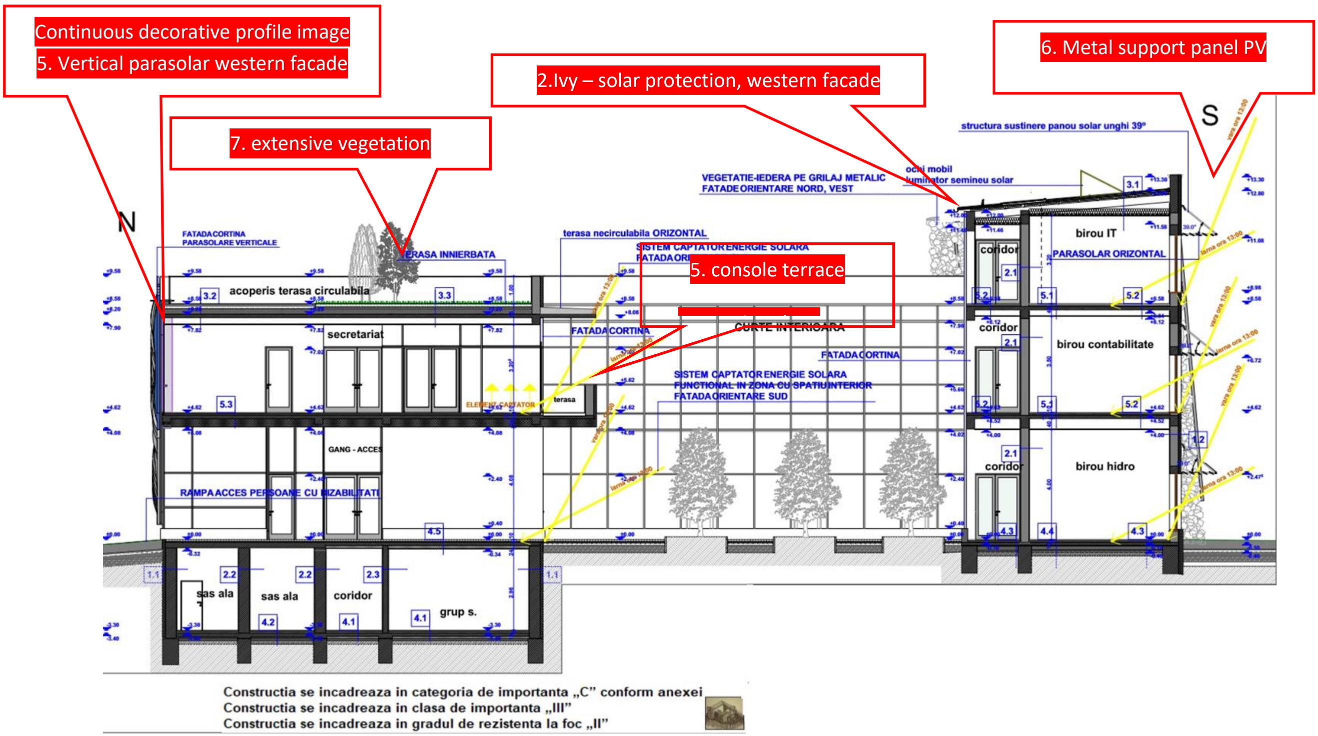


Figure 11 Phase II cad drawings, concept Ditioiu Nina-Cristina - section with metallic structures designed for a photovoltaic system; 1. View solar fireplace; 2. Ivy on metal grid-view; 4. Vertical sun visors view, the northern orientation does not require sun visors, they were made for aesthetic reasons on an iconic building; 5. Terrace in cantilever south orientation-horizontal sun visor; 6. Steel horizontal sun visor (metal structure supporting photovoltaic panels) - later stage; 7. Terrace extensive vegetation / high vegetation (well-being) - explanatory comments-color red / white.

Structure support 55 photovoltaic panels, designed in PVSyst version 6.64 preliminary design stage. 39° was the angle of inclination chosen after performing the simulation preliminary design phase: for azimuth angle (-19°), area covered with PV system panels: 107.6 sqm, number of 55 Bosch photovoltaic polycrystalline PV panels:

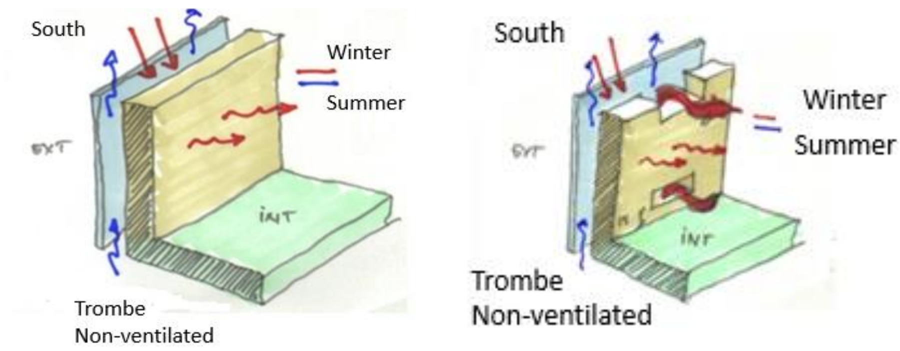
Module dimensions: 990mm x 1976mm x 50mm, power class 295W (best known value at the time of writing**14**).

The resulting rated power for 55 modules The power class 295W is 16.2 kWp. The estimated annual power according to the reports was: 20788 kWh - meteorological data Timisoara, angle of inclination: 40°; 20799 kWh - meteorological data Timişoara tilt angle: 39o, 20734 kWh - meteorological data Cluj-Napoca tilt angle: 39o. **15**

Figure 12 Project Concept Ditoiu Nina-Cristina-photos 27.05.2021, Ditoiu Nina-Cristina, The Curtain facade is to be shaded with vertical sun visors, Corian color White, initially with color inserts

5.3.2 Bioclimatic building + refurbishment

The proposal for a Tombe wall ventilated/ unventilated



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[13] *Ditoiu, Nina-Cristina, Agachi, Mihaela Ioana Maria, "Multi-disciplinarity in the local, sustainable design of the buildings," Acta Technica Napocensis: Civil Engineering & Architecture Vol. 60 No. 3, 15.03.2018 pp. 165-171, Part of ISSN: 1221-5848, https://constructii.utcluj.ro/ActaCivilEng/download/atn/ATN2017(3)_15.pdf, workshop 07.07.2017 "Questions-between permanent and temporary," Cluj-Napoca, Romania;*

[15] *Values from the reports preliminary design phase for choosing the optimal angle of inclination for Oradea (latitude 27.02o N, longitude 21.56o E) made in the software dedicated to PVSyst photovoltaic systems – educational version for the preliminary design phase by arch. Nina Diţoiu in order to establish the optimal angle of inclination for the photovoltaic system*

Figure 13 Sketches Ditoiu Nina-Cristina - ventilated / unventilated Tombe wall system, solar contribution by heating in winter and ventilation in summer, Trombe system The original wall with high thermal inertia is colored black to attract sunlight with a role in heating it[16]

The unventilated solution, with minimal changes introduced following a study regarding the hygrothermics of the building and the principles of restoration, can be a way to study for energy improvement proposals in the restoration of heritage buildings.

5.3.2.1 Study of bioclimatic building solution with restoration of precinct wall, Cluj-Napoca

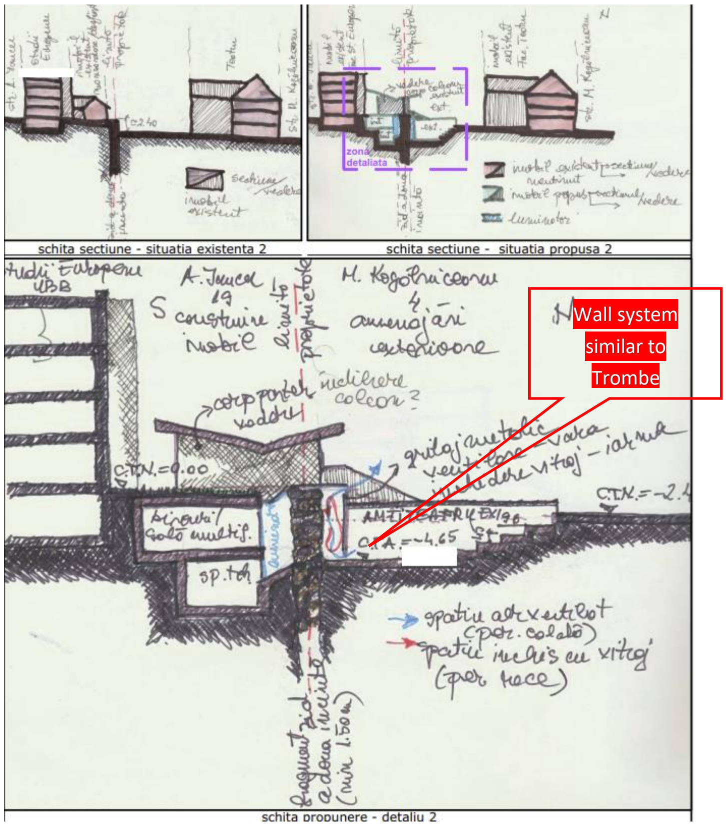

Figure 14 Ditioiu Nina Cristina, concept section sketch, 2017, study of building solution 2s + P partial building, fragment research Wall second medieval enclosure-explanatory comments-color red / white

The location is on Avram Iancu nr. 19 + plot Mihail Kogalniceanu nr. 4 .

Functional scheme - proposal:

1. ground floor level – elevation 0.00: vertical circulation for access to basement levels;

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[16] *Ditoiu Nina-Cristina sketch, Sketches from the personal portfolio - ventilated / unventilated Tombe wall system, sketches made for participation in the B.C.U. expansion contest within the Arhipro Arhitectura team, 2010*

2. basement level 1 – estimated elevation -3.60m: vertical circulation, doctoral school student offices, multifunctional room, toilets and hallway;

3. basement level 2 – estimated elevation -5.20m: vertical circulation, corridor, technical spaces.

The small surface of the ground floor allows the arrangement of the courtyard with green spaces, 15% of the plot area, according to the urbanistic regulation, with the grassy terrace and the distance from the medieval wall through a skylight that will allow natural lighting of the two basement levels. The information about the fragment of the wall of the second enclosure - underground part size of 1.80m, approximate thickness 1.90m - is taken from the geotechnical study.

On the plot with access from str. Mihail Kogălniceanu nr. 4 it is proposed to build an exterior amphitheater to highlight the fragment of medieval wall and as a space reserved for the current function of the headquarters building of the Faculty of Theatre within the University. Closing the medieval wall with glazing allows it to be protected on the northern orientation in the cold period of the year and its ventilation during the warm period of the year. Also, the glazing structure could allow the support of possible decorations in order to use the wall as the background of a scene.

The proposal includes research for the restoration with valorization and protection of the wall fragment of the second precinct of the medieval city, classified as a historical monument classified in category "A".

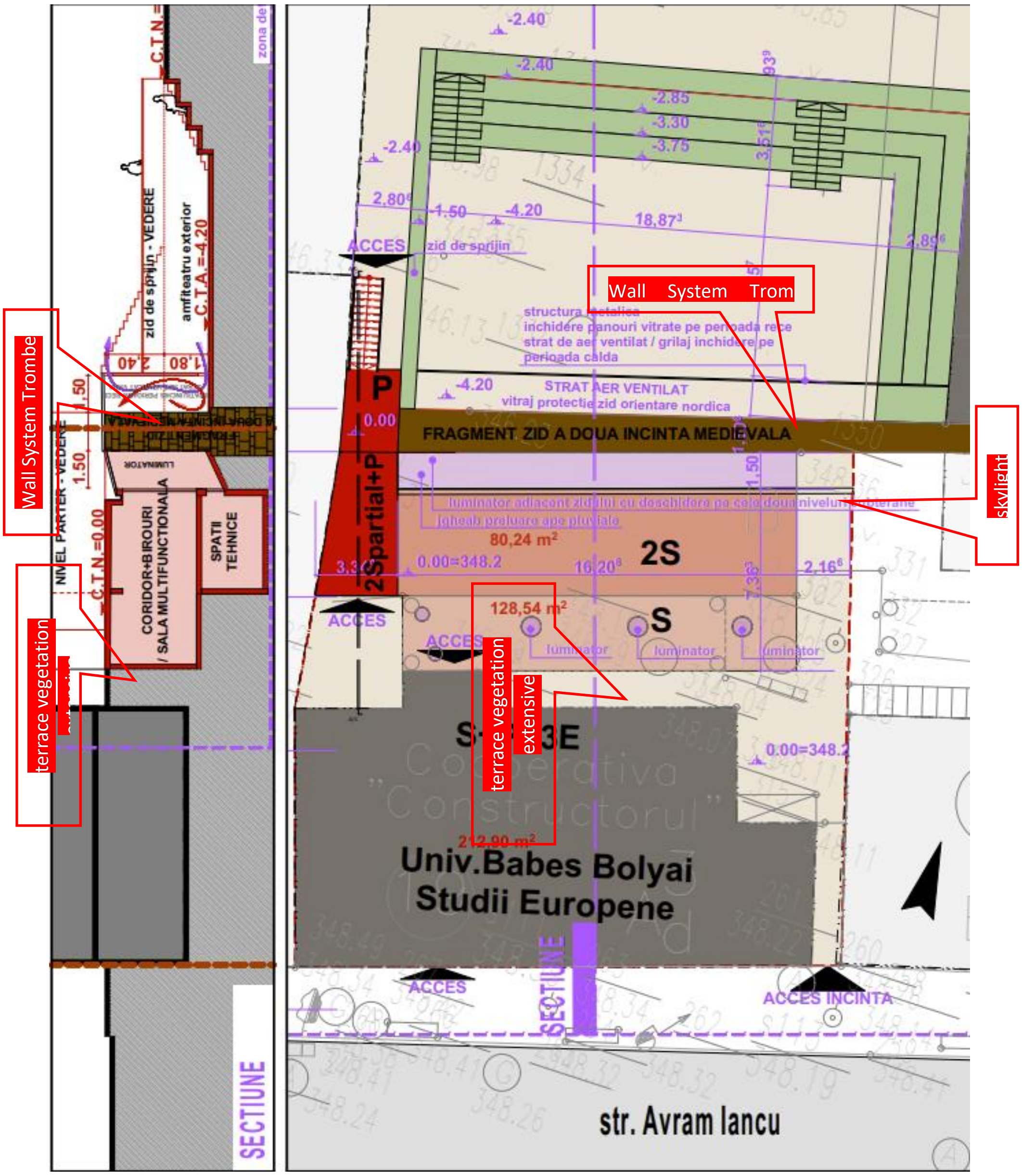

Figure 15 Ditioiu Nina Cristina DWG Drawing section, plan, 2017, study of building solution 2s + P partial, fragment research Wall second medieval enclosure-explanatory comments-color red / white

5.3.3 Bio-climatic architecture inspired by the traditional house

THE TRADITIONAL ARCHITECTURE OF THE HOUSE WITH SQUARE COURTYARD

The traditional household in Campu lui Neag, Hunedoara County, is a traditional wooden household in the Apuseni Mountains, with an inner courtyard that protects against the wind and ventilates the spaces of the building. It can be visited in the Ethnographic Museums in Bucharest .

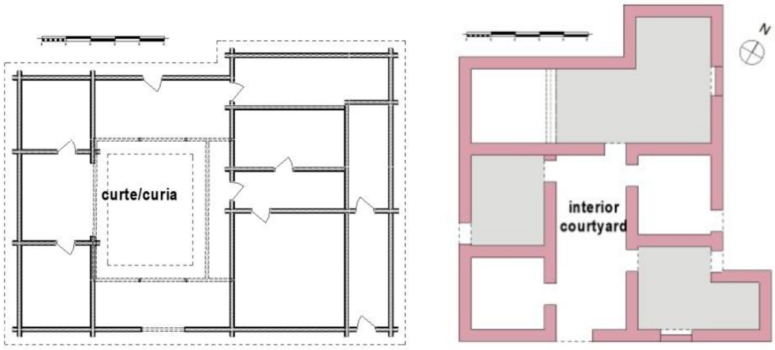

Figure 16 Sketches dwg facsimiles planimetry of peasant house with square yard 17 vs. other areas dwg facsimiles Plouneour-Menez, Brittany, France 18

The same aesthetics, but also similarity in materiality of traditional vernacular architecture from two different areas: Transylvania, Romania and Brittany, France *(planimetry figure 16)* could reveal a way specific to windy areas and a way of adapting the built environment to it. Thus, there is an apparent similarity of vernacular heritage architecture between two areas, without obvious cultural implications, with reservation, we will not detail a unity regarding the Neolithic roots of the culture that appears in archaeological research in the area, as well as possible migrations of Celtic culture**19**. But in terms of bioclimatic adaptation, the traditional architecture of Brittany (France) could have adopted the same solution for wind protection by using stone as a building material as the house in Ceru Băicăiniţii, although for the historical period it is not a common case in the area. But according to *Stefan Pascu*, the only reason for using wood over stone or brick is that they were expensive materials at that time, but also because the Romanian people in Transylvania were not allowed to build in stone or brick, wood being the current material for the buildings of houses and churches of this community, the Romanian one. Stefan Pascu also mentions about Dolha House, Maramureș County - "Domus lapidea" - which received a special approval from the king to use stone as the main material in building the household.

However, Pătrașcu argued: "Archaic cultures in very large areas of Europe, although very varied, have nevertheless experienced relative unity on general aspects, including the conception of the built space, as a result of too little known and possible common cultural origins or influences through migrations, equally relatively known. The brief analysis of some Neolithic and Bronze Age settlements outside the Carpathian-Danube area can give a broader picture of the role played by the occupant within the built space. The conclusions (...) can be extrapolated, but cautiously to other geographical areas of Europe."**20**

17 Pascu, Ștefan, Voivodeship of Transylvania, II, Dacia Publishing House, Cluj-Napoca, 1979, pg. 113, fig. 12D

18 Drawing of the floor plan after "Architecture rurale en Bretagne - 50 ans d'inventaire du patrimoine", Toscer, Catherine, Rioult, Jean-Jaques, Edition Lieux Dits, 2014, pg. 121

19 Rustoiu, Aurel, Napoca dela celți la daci. Povești și legende napocese - Povești despre Cluj, vol VI, pg 11- 29, Ed. School Ardeleană, Cluj-Napoca, 2020

20 Pătrașu, Gheorghe., "Arhitectura şi tehnica populară", Ed. Tehnica, Bucharest, 1974, pg. 24

a) Extension and rehabilitation inspired by the house with squarecourtyard, Belis, Cluj

Figure 17 Project Dițoiu Nina-Cristina, Inspiration for rehabilitation and extension of house with square coutyard, project [21]: The first image is the original guesthouse building, an architecture built in the 1990s as a rehabilitation of a traditional smaller house. The second image is a rendering with the proposed building for the extension and redevelopment of the farm stay with space for the indoor pool

Figure 18 Inspiration for rehabilitation and extension of house with square coutyard, project concept Dițoiu Nina-Cristina [22]: Section through the proposed building with the natural ventilation solution with extension 2022 in red, gray color - elements of the building initially maintained.

[21] Drawings, concept Dițoiu Nina-Cristina, excerpt project realized as a practitioner within Aquaprociv project Cluj-Napoca, project coordination architecture specialization;
[22] Drawings, concept Ditoiu Nina-Cristina, project extract realized as a practitioner within Aquaprociv Project Cluj-Napoca, project coordination specialization architecture;

b) Traditional architecture: house with porch


Figure 19 House with porch in Nicula, Cluj County

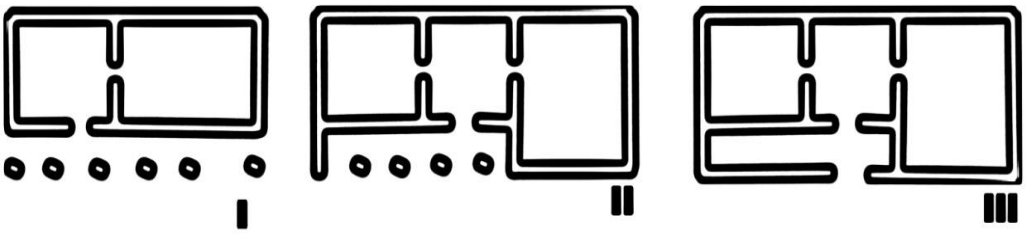

Figure 20 Planimetry evolution house with porch, Nicula, Cluj county[23]

The evaluation of the pickaxe / porch / veranda was made evolutionarily for the constructions in Nicula, Cluj County: Team project, 2003/2004 - Dițoiu Nina-Cristina, Fluieraș Delia, students from Arhitecture Faculty, Technical University of Cluj-Napoca. (figure 20)

Sketch of the evolution of a traditional house, Nicula, Cluj County, Transylvania, Romania: the first image is a typical traditional architecture, and the last two are just vernacular architecture of the twentieth century. (figure 21*)* .

Figure 21 The first image is a traditional wood architecture. The terrace of the house with a southern orientation is an open space. The terrace covering protects the entrance door and windows from overheating of the sun

- In the second image in Figure 21 the house plan appears extended with one room, the terrace is still open, and the building material is brick.

23 Dițoiu, Nina-Cristina, Mihaela, Ioana Maria Agachi, „Traditional architecture as an inspiration source for a sustainable contemporary design of the houses in Transylvania, Romania", website: www.eman-conference.org, pg. 1090-1096; EMAN 2017 "International scientific conference on economics and management", 30 martie 2017, Ljubljana, Slovenia; de drawing taken from the team project, 2003/2004-Ditoiu Nina-Cristina, Whistleras Delia, students of the Faculty of Architecture and Urbanism, Technical University of Cluj-Napoca

• The last image in figure 21 shows us the technological evolution of that period: the glass used to close the terrace space, the terrace became a space similar to a "Trombe wall". The old brick wall of the house, a material with high thermal inertia, works the same as the Trombe wall even if it is not black. It protects by ventilation against overheating in summer and heats up in winter.

Dabija is mentioning that „bioclimatic architectural elements existent in traditional houses are: walls in which argila is a low thermal conductivity material, low percentage of windows and their type, roof slope, stove in the midle of the house. Regarding solar protection, the open veranda play the role of buffer zone against wind and a protection role for walls against weather through horizontal elements."

Beside elements mentioned by Dabija it should be added the systems with wall similar to Trombe of the stone/brickwork (figure 22*)*, materials with high thermal inertia and porch/veranda/stoop closed by glazing, in our case with South orientation. Another observation ist the use of clay as thermal insulation material for a traditional house, in case of a thick masonry or the mixture of the clay with other thermalsinsulated materials, as wool, straw etc. with a lower conductivity, which works as thermal insulation system.

c) Contemporary arhitecture inspired by the porch house, Cluj-Napoca

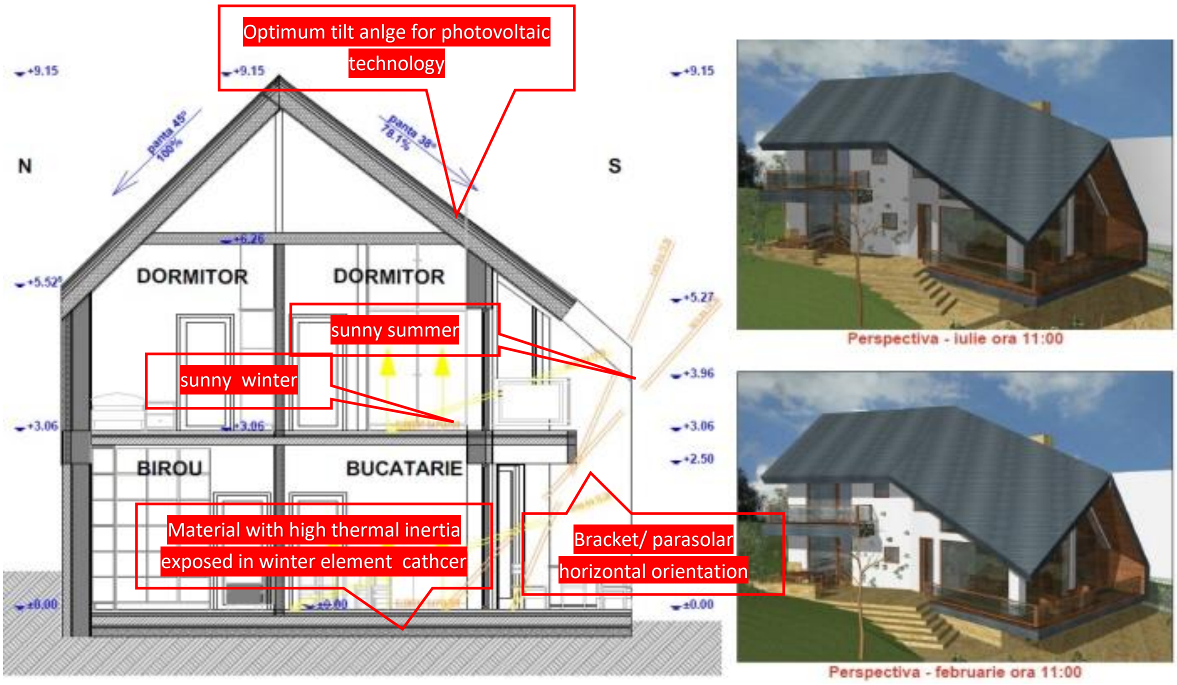

Figure 22 Secțion,rendering,, Project Concept Dițoiu Nina-Cristina [24]: Section on direction North-South, Renderings permanent brick dwelling, shading February 11: 00 p.m. vs. July 11: 00, Cluj-Napoca, Cluj County; explanatory comments Bio-climatic architecture-color red / white

[24] *Drawings, concept Ditoiu Nina-Cristina, project extract realized as a practitioner within Aquaprociv project Cluj-Napoca, project coordination architecture specialization;*

Bioclimatic systems used:

1. passive system: solar contribution to glazing heating southern orientation with horizontal shading system (floor console / covering) calculated as size + capture element made of material with high thermal inertia – stone interior finish, material recommended for underfloor heating;

2. Photovoltaic technology: providing support for photovoltaic technology at roof level optimized as orientation and inclination + aesthetic evaluation.

Bio-climatic architecture applications:from vernacular to architectural- energetic architecture

The Socratic Megaron it's an ancient model of solar architecture – *figure 23*.

Figure 23 Sketch Ditoiu Nina-Cristina facsimile of the solar potential of the Socratic Megaron, explanatory comments-color red / white

- "**Socrate Megaron"***25* (*Figure 23*) it has developed like PHI certified passive houses26, most of them, not mandatory, with southern-facing terraces with horizontal shading in the design (horizontal consoles / sunshades).
- **„House of Happiness - Olynth,"27** „according to J.B. Ache - an isolated villa, based on the plan scheme of grouped dwellings" may be relevant as a source of solar architecture whose ideas were later developed in contemporary architecture through atrium or solar fireplace "(...) What we have invented today may well have been invented and forgotten for centuries. It's true for many technologies, it's also true for solar architecture. Passive solar design involves careful observation and understanding of the rules of nature and nature that lead to a philosophy of building with nature and not against—or in spite of—it."28
- ***Architectural-energetic*** *concept -* When architecture changes its paradigm, the form becomes energetic**[29]** still respecting Vitruvius' principles, synthesis of functional, structural

[25] *File:Megaron.svg - Wikimedia Commons 30.05.2023*

[26] *Passivhaus Institut The Passive House Institute (PHI) 30.05.2023*

27 Patrulius, Radu R., „Locuința în timp și spațiu", Ed. Tehnică, București, 1975, pg.58

28 Dabija, Ana-Maria, „Building with the Sun. Passive Solar Daylighting Systems in Architecture", www.researchgate.com, february, 2017

[29] *Krippnner, Roland – ed., Gerd Becker, Ralf Haselhuhn, Claudia Hemmerle, Beat Kampfen, Roland Krippner, Tilmann E. Kuhn, Christoph Maurer, Georg W. Reinberg, Thomas Seltmann, Building-Integrated Solar technology-Architectural design with Photovoltaics and Solar Thermal Energy, Detail Green Books, Munch, Germany, 2017;*

and stylistic - photovoltaic technology in new buildings can generate an iconic architectural concept.

5.3.4 Traditional house architectural concept - energetic rehabilitation[30]

The existing building highlighted in Figure 24 analyzed by the reports in Figure 24: Reports show that the energy obtained by changing the roof with photovoltaic tiles ([PVsyst31] estimate) is sufficient for heat pump heating estimated in Polysun[32], with minimal changes such as changing electrical appliances with an efficient one with low energy consumption. These measures being sufficient can be achieved by maintaining the cultural heritage of the locality through a minimal aesthetic modification of the covering material, analyzes detaliate in the paper on the preservation of the cultural heritage of some localities in Transylvania [33].

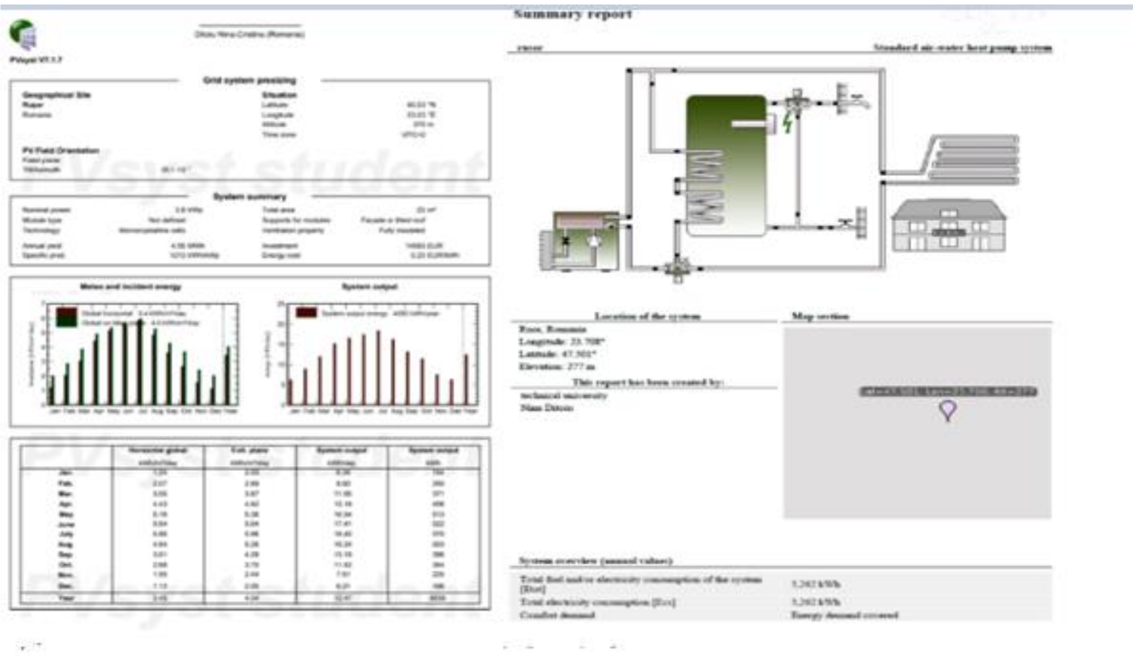

Figure 24 Preliminary design stage reports from dedicated software Pvsyst (www.pvsyst.com)

[30] *Diţoiu, Nina-Cristina, "A regenerative action as preservation measure of cultural landscape: the research of the photovoltaic technology upon Transilvania traditional architecture", WMCAUS 2022, Prague, Czech Republic, september 2022, ANTREDOC POCU/380/6/13/123927,;*

[31] *Report by Diţoiu Nina-Cristina in PVsyst 7.1.7, educational license, https://www.pvsyst.com/ (accessed: February 2021);*

[32] *Report by Diţoiu Nina-Cristina in Polysun, educational license, https://www.velasolaris.com/ (accessed: February 2021);*

[33] *Diţoiu, Nina-Cristina, "A regenerative action as preservation measure of cultural landscape: the research of the photovoltaic technology upon Transilvania traditional architecture", WMCAUS 2022, Prague, Czech Republic, september 2022, ANTREDOC project POCU/380/6/13/123927;*

Reports by Ditoiu Nina-Cristina in Figure 24, PVsyst / Polysun, Russor locality, Hunedoara County, poster "Tradition after the Fourth industrial revolution: the solar architecture of the photovoltaic technology on vernacular homes from Transylvania's villages, Romania"

Case study, Rehabilitation of existing dwelling Rușor, Hunedoara[34]

Existing building – vernacular architecture, Rusor locality, Hunedoara county

In two locations studied for Rusor, jud. Hunedoara and Roşia Montană, jud. Alba, case studies "individual dwellings with an approximate usable area of 100 sqm (...) Basic utilities covered by an air-to-water heat pump + photovoltaic surface afferent to buildings can be achieved by replacing the roof with photovoltaic tiles." [35]

Photos taken in January 2021, Rusor, Hunedoara county, Romania / cad

Figure 25 Photos, cad drawings , rounds-Ditoiu Nina-Cristina, traditional house with porch, Rusor village, Hunedoara County, poster excerpt "*Tradition after the fourth industrial revolution: The solar*

[34] *Diţoiu, Nina-Cristina, "A regenerative action as preservation measure of cultural landscape: the research of the photovoltaic technology upon Transilvania traditional architecture", WMCAUS 2022, Prague, Czech Republic, september 2022, ANTREDOC POCU/380/6/13/123927;*

architecture of the photovoltaic technology on vernacular homes from Transylvania's villages, Romania"[36] detailsi, design [37]

New building architectural – energy concept

The inclination for a solar photovoltaic / heating intake can be optimized depending on the period of use and depending on the heating system. If we talk about off-grid buildings, it is essential to adapt the solar intake to the period of use and the way of use.

For temporary use in winter or just summer, a cottage for example, adaptation to the climate zone is essential. Thus, I will exemplify for a case study from Rușor, Hunedoara county the image from the poster presented at PEARL-PV *CA 16235* - Figure 26[38]. Subsequently, through the report of the dedicated PVsyst software*39*, the optimization for the azimuth of 13o for the winter period October-March was analyzed, the optimal inclination is *60o, respectively 25o* during the summer in April-September. The reports made by Dițoiu Nina-Cristina in PVsyst 7.1.7, educational license, are included in *figures 26* and *27.*

[36] *Diţoiu, Nina-Cristina, "Tradition after the fourth industrial revolution: The solar architecture of the photovoltaic technology on vernacular homes from Transylvania's villages, Romania",06.08.2021, poster presentation PEARL PV COST Action CA 16235, al 3-leaTraining School "Simulation tools and models for the analysis of PV system performance", Braşov, România, july 2021;*

[37] *Diţoiu, Nina-Cristina, "A regenerative action as preservation measure of cultural landscape: the research of the photovoltaic technology upon Transilvania traditional architecture", WMCAUS 2022, Prague, Czech Republic, september 2022, project ANTREDOC POCU/380/6/13/123927;*

[38] *Diţoiu, Nina-Cristina, "Tradition after the fourth industrial revolution: The solar architecture of the photovoltaic technology on vernacular homes from Transylvania's villages, Romania", în 06.08.2021, poster presentation în cadrul PEARL PV COST Action CA 16235, al 3-leaTraining School "Simulation tools and models for the analysis of PV system performance", Braşov, România, july 2021*

[39] *Report by Ditoiu Nina-Cristina, PVSyst, 7.1.7, educational license, https://www.pvsyst.com/ (accessed: February 2021);*

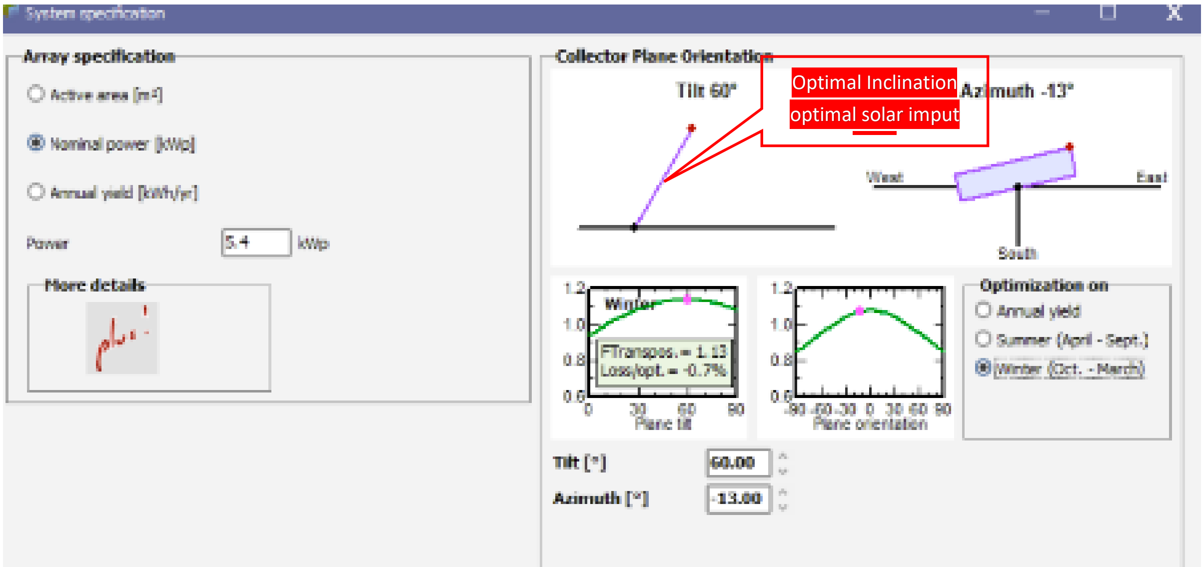

Figure 26 Reporting by Ditoiu Nina-Cristina, educational license PVSyst,

explanatory comments-color red / white

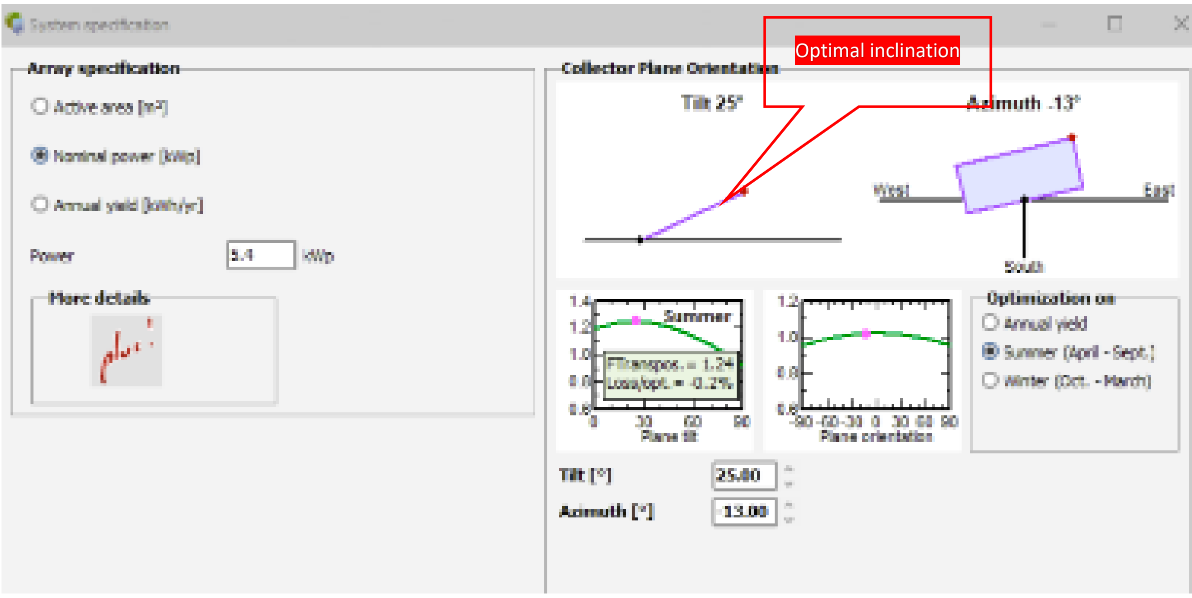

Figure 27 Report made by Dițoiu Nina-Cristina, PVSyst educational license, Tilt optimization for intake in **the summer months** (**April-September**)[40] inclination 25o/ the estimate was made, in order to be possible a comparison, for azimuth -13o, previously calculated, the optimum being at 0o,

Explanatory comments - red/white color

Case study, Architectural-energy concept house, Cluj-Napoca

New building – Cluj-Napoca, Cluj county

[40] *Ibid*

For a case study with grid connection, if the Technical Connection Approval does not regulate the use of the energy produced, it is possible and efficient to optimize the angle of inclination for one year, as follows 37o for Cluj-Napoca, Cluj County, azimuth 0o, in the context in which the connection to the electricity grid in the area allows it.

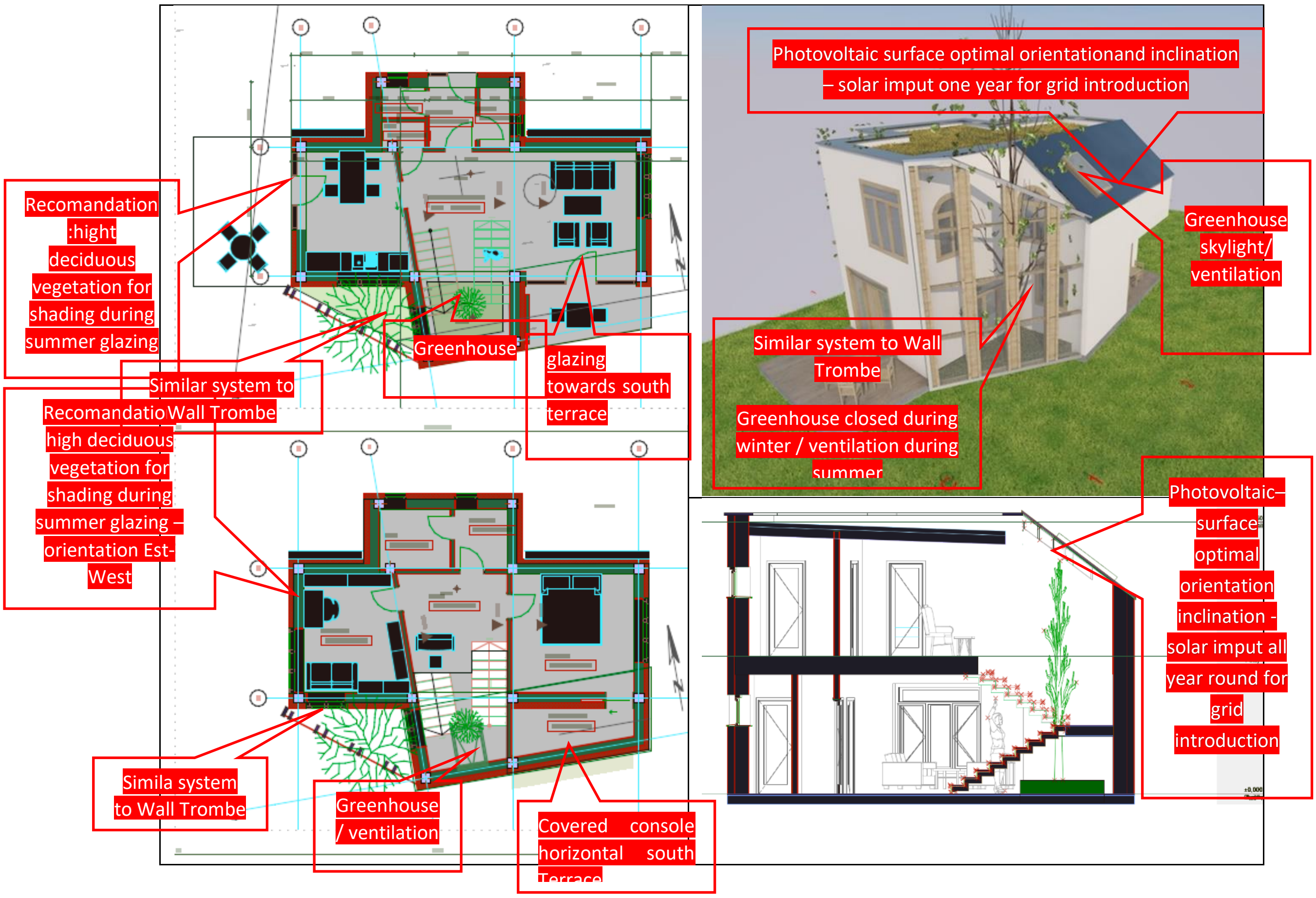

Figure 28 Project, concept and drawings Ditoiu Nina Cristina within Aquaprociv Project, New building solution study phase – Cluj-Napoca locality, Cluj county,[41] explanatory comments Bio-climatic architecture – red/white color

Bioclimatic building Cluj-Napoca, Cluj county, pre-project stage / solution study, architectural-energy concept: Inclined plane at roof level with optimal inclination for mounting photovoltaic panels (37o) with energy input produced into the network (optimization for one year: 37o, Southern orientation: azimuth 0.00o).

Other bioclimatic elements: because the project is in the early phase of preliminary design, the exterior arrangement with tall vegetation necessary for summer shading of the East/West orientation does not appear. Apart from the vertical sun visors used in the first case study in *figure 28,* tall deciduous vegetation that shades summer

[41] *DWG drawings, concept, renderings Nina-Cristina Diţoiu – architecture designer, early phase solution study project, Aquaprociv Project, Cluj-Napoca, Romania.sx*

but allows sunshine in winter is recommended as an optimal shading solution for East/West glazing.

The greenhouse, with the possibility of ventilation during summer, is also a biophilic element with significant contribution in improving the well-being of users (well-being), but also shading / control of sunshine with solar intake during winter. The glazing joinery with eclectic aesthetics is proposed to be from the circular economy of recycled materials, and the proposed terrace roof is with extensive vegetation and external access through the ivy support grille + access staircase on the northern side.

6. References

[1] https://passivehouse.com/

[2] Gutiérrez, E., Martínez, A., Fando, A., Cuervo, R., Gómez,J. Gutiérrez-Martinez, J. . PASSIVE HOUSE TO IMPROVE THE ENVIRONMENT. Conference: ECSEE 2013: The European Conference on Susteinability, Energy and the EnvironmentAt, 2013

[3] Patrulius, R., „Locuința în timp și spațiu”, Ed. Tehnică, București, 1975, pg.9

[4] Stoknes, P., https://www.weadapt.org/knowledge-base/using-climate-information/climate-psychology ,”Why Our Brains Ignore Climate Change - and What to Do About It”, Published: 16th. September 2016,

[5] Dabija, Ana Maria, “Tradition and innovation in contemporary Romanian architecture”, PLEA2006 - The 23rd Conference on Passive and Low Energy Architecture, Geneva, Switzerland, 6-8 September 2006

[6] http://prispa.org/sde2012/?lang=en

6 - Deliverables

To evaluate the success of the application, students will have to answer an online questionnaire.

7- What we have learned

Why passive and bioclimatic buildings.

Practical examples on: how to use different modalities to obtaion a passive bioclimatic buildings.

What new technologies are included in the new design nowdays.

How to approach different passive and bioclimatic building concepts like: a new house, or in the refurbishment of an existing one.