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TIMISOARA MOVING GREEN

Sustainable city via sustainable neighbourhood

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Abstract

Climatic changes made humans to become more aware of the surroundings and their conservation in the purest and undamaged state as possible. Sustainability is now to become a lifestyle, not only a set of measures to be used in industrial production.

The current paper has as goal the study of how the different scales of urban developments are influenced by sustainable measures and how they impact one on the other.

Starting the urban requalification considering the natural context and resources in terms of orientation, location, climatic parameters, landscape and reaching the district and building design by modifying the anthropomorphic factors like car use, constructed solids, energy production.

Treating the city as a complex system which adapts to any changes despite their scale and location in the hierarchy of the urban layers; the study defined the main catalyst for nowadays most profiting urban changes – transportation; emphasizing the transposition from “driving – in” or car dependent society to “green moving – in” concept or bicycle and public transport dependence. Furthermore applying this in a domino effect style the paper elaborates a thorough program for smaller scales like district and building sustainable development. Architecture, structure and technology of the construction development were regarded in such way to reduce climatic impact via energy required for each stage of project evolution.

The research set the rehabilitation directions to be applied for a city coming from strong industrial background and streaming towards a new urban allure defined by social cohesion and cultural upgrading prevalence.

Estratto

I cambiamenti climatici hanno fatto in modo che gli esseri umani diventano più consapevoli di cio che li circonda e della necessita di salvguardarlo nello stato più puro e intatto possibile. La sostenibilità è ormai diventata uno stile di vita, non solo una serie di indicazioni da utilizzare nella produzione industriale.

La ricerca corrente ha come obiettivo lo studio di come le diverse scale dello sviluppo urbano sono influenzate dalle misure sostenibili e di come uno incide sull'altro.

Iniziare la riqualificazione urbana, considerando come guida il contesto naturale e le risorse, l'ubicazione,i parametri climatici,il paesaggio e raggiungendo il distretto e la progettazione dei singoli edifice modificando i fattori antropomorfi come l'uso delle auto, construzioni massicce,la produzione di energia.

Considerare la città come un sistema complesso capace di adattarsi a qualsiasi cambiamento, nonostante la sua dimensione e la sua posizione nella gerarchia del tessuto urbano; lo studio ha definito il catalizzatore principale che al giorno d'oggi risulta essere il piu proficuo per cambiamenti urbani – trasporto; sottolineando la trasposizione da "driving - in" o società dipendente dai mezzi di transport privati al concetto "Verde in movimento " o dipendenza dalla bicicletta e dai mezzi di trasporto pubblici. Inoltre, applicando un effetto domino, la ricerca elabora un programma completo per scale più piccole come I quartieri e sviluppo edilizio sostenibile.   L'architettura, la struttura e la tecnologia dello sviluppo della costruzione sono stati considerati in modo tale da ridurre l'impatto climatico tramite l'energia necessaria per ogni fase dell'evoluzione del progetto.

La ricerca fissa le direzioni della riabilitazione da applicare per una città nata da un forte background industriale e apre la strada verso una nuova imagine urbana definita dalla coesione sociale e dalla diffusione di un rinnovamento culturale.

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II.1 The Historiography of Urban Metamorphosis

In order to understand better the inertia of a city one should go back and remove the layers of historical topsoil and acknowledge the dynamics of their construction and development; as the cities were realised by the convergence between practical exigence and the idea of a functional and beautiful place.

Timisoara, one of the most prosperous cities in the Western part of Romania presents at its turn a very rich and captivating timeline. Starting from a small settlement on the river shore and becoming the capital of Banat area, its evolution would be presented as a sequence of different thematical cities.

II.1.1 Castrum Romanum

Proof of human existance in the area long before the first settlements were invented are backed up by archeological discoveries although the traces of the ancient settlement are uncertain. It is thought that the first locality in that region was since Roman invasion in 101-103 and 105 BC. PTOLEMAEUS, Claudius (IInd century) in his work Geographike Hyphegesis is mentioning the city of Zurobara (Zambara) having the characteristics of a *Castrum Romanum* and being one of the most important 44 settlements in Dacia. The coordinates locate the city somewhere in Banat area. The main function according to the geopolitical international situation - a military camp built for the Roman troops that were controling the conquered area having a defensive position and structure. The camp allowed for the Romans to keep a rested and supplied army in position. There are no historical remains of the first settlement supposed to be at the foundation of Timisoara.

Only around 1212 the Fortress of Timis - *Castrum Temesiense* is mentioned officialy in the documents belonging to the King Andrew II of Hungary. An official map or sketch of the city silhouette is not available but an assumption of the organization can be made considering the typical structure of a Roman castrum. Streets and buildings location strictly in direct dependence of the military character of the place: parade street, commander house, headquarters streets and devisions, barracks, major buildings, main access gate, supply gate etc. The plan was simple and well organized.

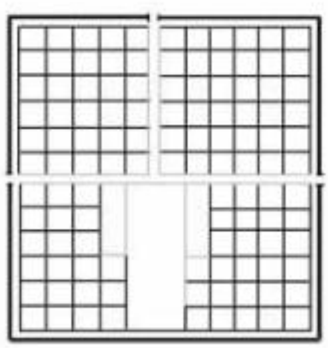


Figure 1 Castrum Romanium scheme

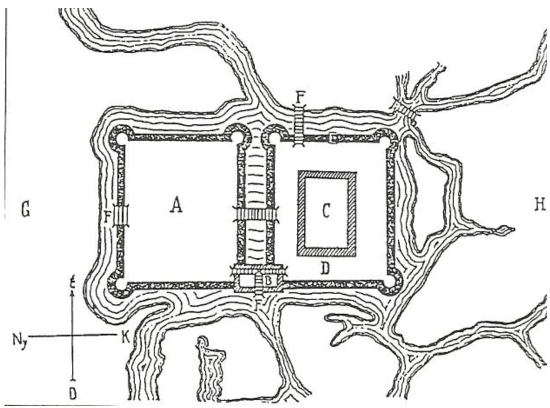


Figure 2 Timisoara during XIVth Century

II.1.2 Capital City

The next important step in the city development was done due to the orders of Charles Robert of Anjou that during a visit of the area decided to build a new castel. In eight years the Italian and Austrian craftsmen transformed the poor settlement into a very important city developed (civitas) around the king's castel – forming two rectangles with the corners directed towards the four cardinal points; surrounded by moats and walls. In 1315 – the first king of Hungary, feeling threaten in Buda by the hostile attitude of its inhabitants, the capital of Hungary, decided to move the entire court to Timisoara until 1323 when the capital was moved to Visegrad. Timisoara lost its political and administrative role but was still the most strategic military point in resisting the turks.

The palace, part of the fortress and a series of buildings are seriously damaged during the big earthquake from 1443.

II.1.3 Medieval Fortress Ciyt: defensive city

In 1552 Timisoara felt under Ottoman domination and for the next 164 years was to become the strategic military point at the confluence of two empires: Ottoman and Austrian.

The city was restructurated such that to fulfill all the requirements of a military fortification. Repairs were done to the castle and new fortification system was developed combined with the natural ones (swamps). The city was still composed of two parts: fortress and the city with organically developed streets. The period is fixed in the history as the wooden city period.

Figure 3 Fortress bastion

Figure 4 The components city & castel

The details on the fortress arrangement are given by the turk traveler EVLIYA ÇELEBI around 1660: five wooden gates with bolted arches and strong and massive iron doors. The doors being closed during night time by lifting the bridge that connects the gate with the surrondings. The walls were massive measuring 50-60 feet. A deep moat was surronding the walls. On foot the distance around fortress was done in one hour, the perimeter being almost 6km. He mentioned "The big fortress was erected in 1052". There were almost 1200 houses with one floor or without, four monasteries, seven schools, three inns, two baths, 400 shops and a bazaar. The houses were made out of wood and adobe and covered with shingles, the streets were narrow and paved with wood boards. Outside the walls there were 10 suburbs comprising 1500 houses with courtyards and gardens and special entrances for humans and carriages.

Figure 5 Ottoman Timisoara 1667

Figure 6 Ottoman Timisoara 1700

II.1.4 Industrial Cit: bastion city

Space representation reached the highest expression and form at the beginning of XVIII[th] century. From a military fortress in the center of a swamp area the city became an economical and industrial centre, being the label of evolution from feudalism to capitalism; escaping from balkan-asian influence and embrassing the new west european structural and cultural values.

Figure 7 Timisoara 1717

Figure 8 Timisoara 1728 - 1729

The modern city started with the conquest of the area by Eugene of Savoy in 1716 and liberation from Ottoman domination. The prince named the governor Florimund Claudius Count of Mercy in charge for city organization – considered the founder of the most beautiful and modern city in the Empire. Bega Canal was executed such that to drain the swamps, the agriculture was encouraged and a new industrial neighbourhood was developed (Fabric). The second fortification (in stone) was executed by 1765: the concept of the fortress according to Vauban was a triple row of walls and moats which were following the shape of a poligonal star, the height of the walls being between 10-12m. First aqueduct was bringing drinkable water into the city in 1774.

The buildings were no longer executed only in stone, but also in bricks – hence the brick city nickname.

Figure 9 Fortress in 1734

Figure 10 Fortress in 1740

Around the fortress new neighbourhoods were emerging developing also the functional and ethnic zoning of the city: 1718 Elisabetin (agricultural and residential – Romanian and German), 1720 Fabric (industrial - Serbian and German) and in 1744 Iosefin (industrial) and Mehala (agricultural). A series of public buildings were constructed to give to the city the new modern look that the ambition of the Count was streaming towards. Each important building was in assembly with a large square in front of it (Old City Hall and Liberation Square; Orthodox Church and Unification Square). In 1781 Timisoara was proclaimed a municipality (free royal city) by Joseph the IInd.

Figure 11 Timisoara 1744

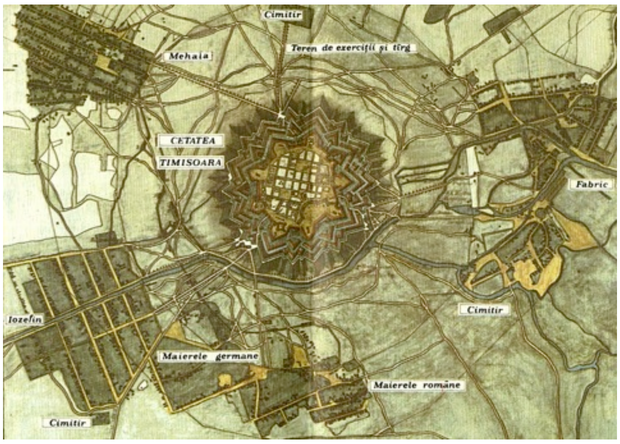


Figure 12 Timisoara 1780

It was also the period of great colonization: families from German speaking countries and even from Spain were brought to revitalize the area. In this way Timisoara became a very cosmopolit area where almost each family was able to speak around 5 languages.

Figure 13 Migration map from Europe to Banat

In 1809 Timisoara became the temporary deposit of the royal heritage brought from Vienne to avoid its capture by Napoleon – an event coinciding with the instauration of the city militia in charge with its safety.

The public gardens were fashionable and the governors of the area encouraged their arrangement (1850).

II.1.5 Modern City: open city

Due to its flowering evolution the city walls became like a "corsette" that was not allowing the city to breath. Thus the decision to demolish them starting w ith 1892. The new city planning followed the urban model adopted by Vienna – called "Ringstrasse". Vienna and later Milan, transformed as new cities using the old defence walls for defining the most important infrastructure lines. Ringstrasse was a street with an impressive cross-section along which the buildings with most important functions (univeristies, administrative, cultural) were alinged.

Demolition of the fortress walls and connection with the surrounding neighbourhoods via radial concentric boulevards were realized. The centre being cut by a large esplanade called "Corso" lined with many stately public buildings in lieu of the fortifications. At the same time along Bega Canal a "neckless" of public gardens was developed. By 1910 all the districts were connected with Cetate. New districts were the villages around Cetate which after being annexed had a lot of improvements: infrastructure, paved roads, electric lights and trams. (eg Mehala). It was the period when Timisoara was nicknamed "Little Vienna".

Figure 14 Vienna Ringstrasse (about 1860)

Figure 15 Timisoara at the beginning to XXth century

Big destruction of the city during the revolution from 1848 - 1849 (Revolution against the traditional authority up to date - Hungarian revolutionists against the Austrian domination) took place – 372 buildings were destroyed during the cannon fights. After 1867 the city encountered a new evolution stage. The dynamic progression in urban planning and construction made out of it one of the avangard cities in urban modernization of Europe.

Figure 16 Timisoara 1890

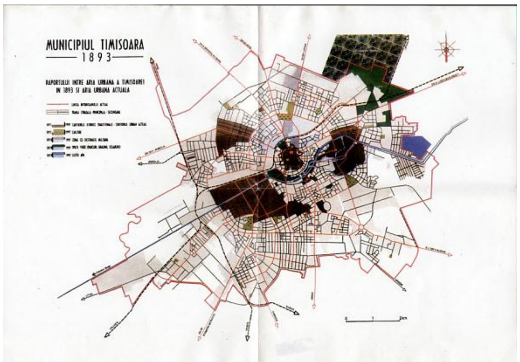


Figure 17 Timisoara 1893

It was the era of park belts along Bega and of the increased infrastructure and transportation networks (first railway linked Timisoara with Budapest in 1875). By 1900 the city was comprising nine railway lines, seven roads (sosea) and a navigable canal.

The WWI changed the character of the social aspect of the city: loss of human lifes (specialy men sent to war) and the increase of working hours due to reorientation of the industrial sector only on weapons production, while numerous industrial units went bankrupt. However, there were no big changes in the city allure.

Figure 18 Timiosara 1910

Figure 19 Timisoara 1936

The interwar period was a very prosperous one for the city. The material and moral reconstruction was based on models from the past. In the economical field there was an increase in the number of factories, banks and commercial entities; together with the large increment in number of schools in different languages and cultural asociations. The city became a university center (King Ferdinand's edict – 1920)

The World War II meant a new period of cultural heritage loss - a large number of buildings were destroyed during the German bombings in 1944. The crises put an end to the urban planning experiments for a long term, redirecting it to the concept connected to emergency.

II.1.6 Artificial city

At the beginning of XXth century the city entered the "greyest" period of its development. The new political and economical regime – socialism - imposed new urban development rules. The goal was to reach the complete urbanisation driven by the ecstasy of controlling the means of production and massive cooperativization. The population from rural area was forced to move to the cities where the development was not taking into consideration the context and the background. Residential and industrial grey buildings were growing in the city landscape without any rationality.

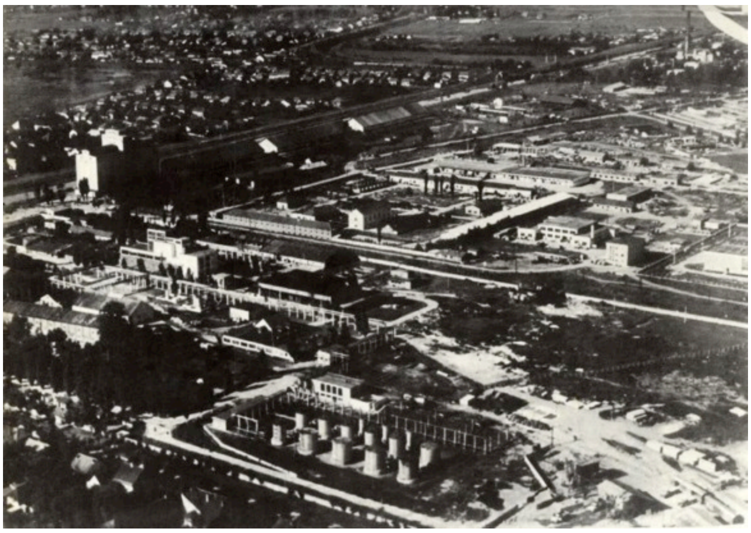


Figure 20 Industrial area Solventu inside residential neighbourhood

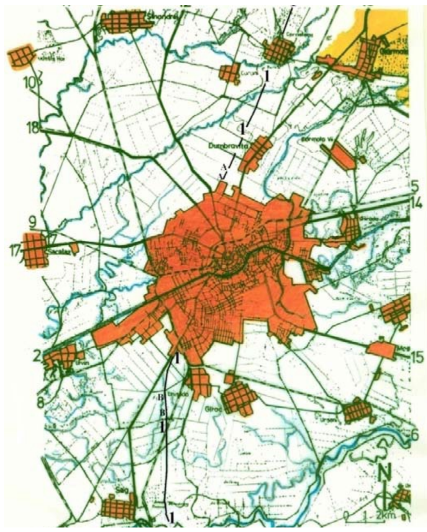


Figure 21 Timisoara 1965

In 1913 the city was counting 69,000.00 inhabitants and by adding Mehala an extension of 1,800.00 ha was done, following the same radial concentric pattern.

In just 30 years – 1943 – the area and the population of the city almost doubled. Timisoara was measuring 3,200.00 ha with 115,839.00 inhabitants and 312 km of streets out of which 52% were paved, 46% provided with water supply network and 31% having a sewerage system.

The 1955 plan's prediction on the population growth considered as the growth factor the dynamicity of economical force: the estimation was looking at a growth from 140,000.00 inhabitant in 1955 to 180,000.00 inh in 1975 with a possibility to reach even 200,000.00inh.

The scheme of 1959, which was not considering a clear provision on the functional evolution of city parcels,was characterized by the following parameters 148,600.00inh and 4,100.00ha, and was envisaging 250,000.00inh in 1980. The peak was registered in 1990's when Timisoara had 351,293 inhabitants.

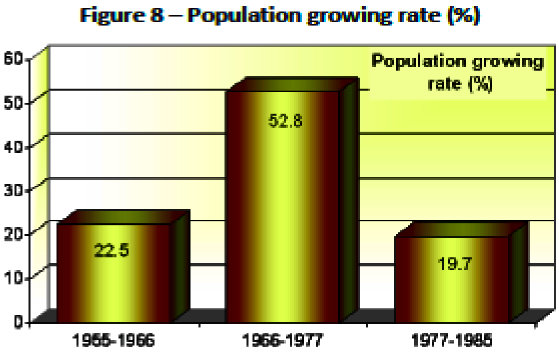


Figure 22 Population growing rate in Timisoara

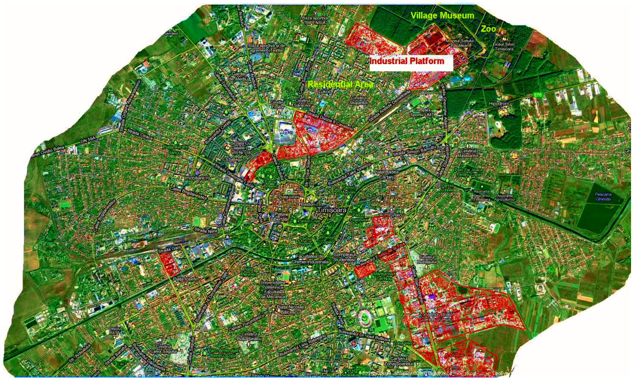


Figure 23Insertion of industrial platforms within residential and leisure areas

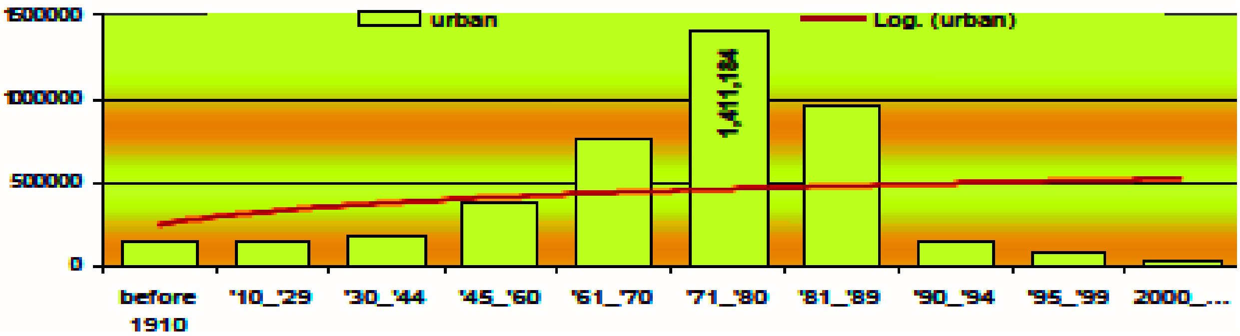


Figure 24 Evolution of the building of houses (national level)

The city was forced to consolidate and to get the totalitarian expression of equality, which lead to discrepancy with the beautiful shape that city was nurturing since the beginning of XVIIIth century.

II.1.7 Shrunk city

The new era, after the communist domination, brought to light the fact that the city growth was not based on real indeces: natural growth and the urbanisation percentage being too much controlled and imposed.

Migration of people to the rural area or even abroad, diminution of the industrial production, negative natural growth statistics shown the flaws of the urbanisation prior to 1990s. Despite the positive general priviews and trends – Timisoara a “Growing Pole”for Western area,the city needed a natural process of reconfiguration, as in two decades it lost 14% of its population.

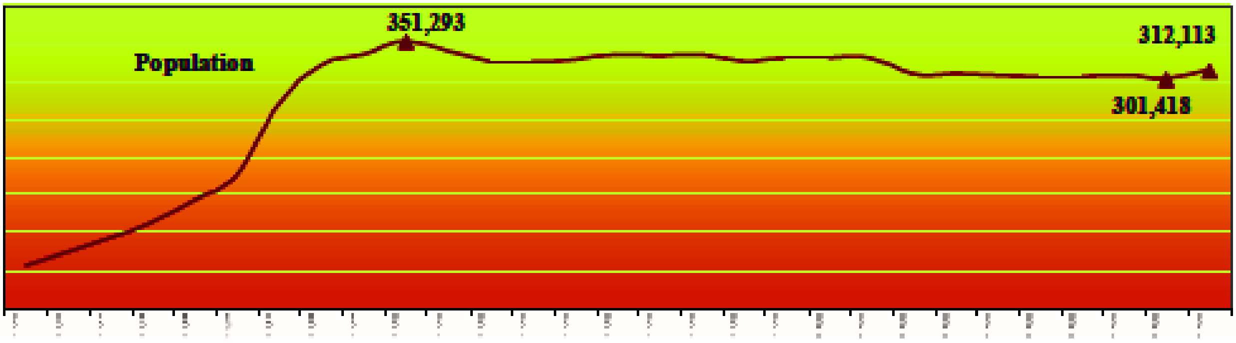


Figure 25 Population evolution in Timisoara

The city was still an attractive center for a large percentage of the population from VVest region and even from around the country. Houses’price was high and the construction process consistent. The villages around the city registered an impressive development – especially as a residential area as per western model – which lead to rate of Timisoara as 1st rang city with metropolitan area in Romania.

Figure 26 Timisoara and its metropolitan area

The context od suburbanization of Timisoara’s rural area was one of the causes of the shrinking phenomenon in the city. The dream to own a house after years of flats convivence decreased the pressure on the locative space requirements in the city and as well decreased the population density.

The density distribution in the city was influenced by all the factors discussed above: migration, jobs losses, new locative requirements, reconfiguration of former industrial or residential areas. Thedistribution pattern is eclectic, the quarters with high density (blocks of flats) being quite mixed with other low density areas (as historical hoauses). But it still developed more or less in a concentric profile as per city evolution – higher density around the historical cores.

The shrinking of the city issue laid the way to a new chapter in city development and planning: sustainable city.

Cities with a strong economic background and stagnating or gradually shrinking populations. Most of the small and medium-sized European cities will be in this category. In these cities, the gradual shrinkage of a city does not necessarily cause serious difficulties, and it may even be an advantage as the density of the urban environment decreases. The challenge for these cities is to create flexible urban strategies that can accommodate both upward and downward population changes, as well as changes in socio-economic composition

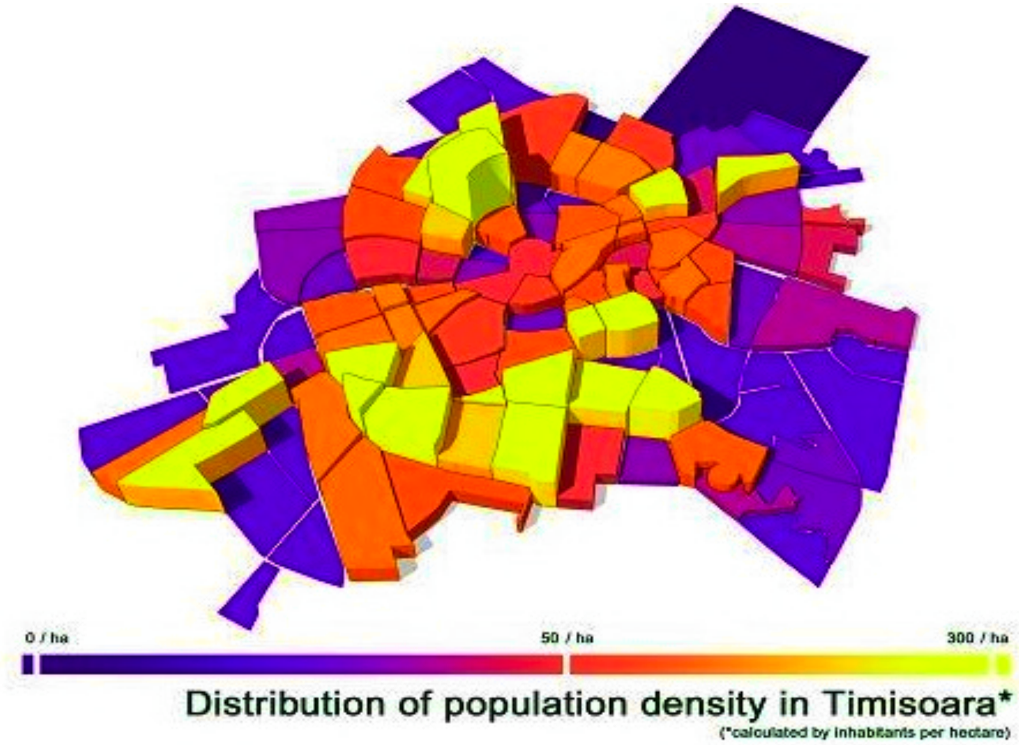


Figure 27 Distribution of population density in Timisoara

II.1.8 Sustainable city

A city with a strong cultural, educational and economical infrastructure decided at the beginning of 2000 to approach a new strategy in city urban marketing. Filled at shrunk city cathegory and with incresing problem in traffic management, the City Hall decided that it was time for a new set of guidelines to improve the image and liveability of their city.

Starting with informal documentation under workshops form in 2005 – Timisoara 2020 – and later adopting official European guides and norms – Leipzig Charter (2007) on Sustainable European Cities – Timisoara managed to redirect the efforts of urban planning towards new dimensions.

The Masterplan of 2012 urban policies focus on dealing with deprived neighbourhoods, improving public space, modernising infrastructure with focus on energy saving, better education for young people and better and more efficient public transport in and between cities.

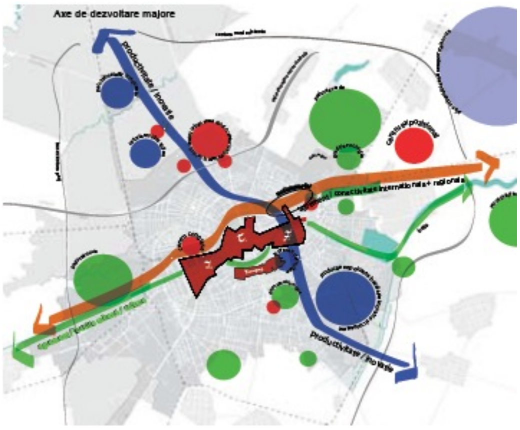


Figure 29 Timisoara vision 2012 Masterplan

Figure 28 GUP for transportation network

Fig…Timisoara vision 2012 Masterplan Fig…GUP for transportation network

The vision emphazises the two axes of action: East - West – urban life/culture/education and research; and North – South: production and technological innovation/ eduaction and research. At the intersection point it will be defined the regional and metropolitan transportation interchange point.

It is not any longer the expansion the target or the economical boom valorification; the quality of the city will be worked on. The conservation of cultural heritage by implementation of refurbishment and thermal rehabilitation programs, reconversion of dead areas in sustainable multifunctional places, redefinition of mobility and accessibility and many other aspects that will allow Timisoara to keep its status of leading city in the innovation field and visionaire city in redifining itself.

II.1.9 Urban evolution on paper – official GUPs

Due to the city character and its urban development major part of the technical information was not available for studies.

As the city was a military fortress until 1892, a lot of monographs written between XVIIth and XIXth century have not exact information about the part of the city containing the fortress as the access to the plans was restricted. Later on, the research of documentation was still difficult as different parts of it were kept in different locations: Bucharest, Timisoara, Vienne and Budapest; as well the dimensions reaching up to 2meters, it was challenging to reproduce or copy the plans.

Around 1950 another “brick in the wall” was added by the communist secrete services, who classified a large part of the planimetric drawings as “top secret”. Only after 1970 detailed investigation was allowed, proving that part of the assumptions and speculations made before were completely wrong.

Thus, in terms of urban plans providing details on city evolution one can start with the plan from 1730, the one that redefined the ancient city center texture that can be seen even nowadays.
In 1895, the decision of renouncing at the title of military fortress for Timisoara and the removal of the walls, leads to a new plan, elaborated by the architect Ybl. The fortress became the city center connected with the external neighborhoods via large boulevards and having around it two ring roads –

prefiguring the actual radial concentric structure of the city. The plan is revised in 1903 - 1905 and in 1911 - 1913 when a new suburb –Mehala - is annexed to Timisoara.

After the WWII the so called “systematization schemes” are bonded together by the Technical Department of the city hall in 1947 and revised and enriched in 1950 – 1951, 1955 and 1959 by the Department but this time at Bucharest.

The 1959 plan is retaken by the Institute of Design in Timisoara and accomplished in 1965 with several revisions: no functional zoning is considered, just population and city area growth.
In 1978 the scheme is revised after the functional zoning of the city deliniated in a pregnant way: the massive industrial areas all over the city, the residential blocks development with the sacrifice of numerous singe family dwellings.

After the anti-communist revolution, from 1989, first General Urban Plan (PUG – PlanUrban General) is elaborated in 1990 – 1992. According to the economic and political evolution the plan undergoes a revision in 1999 – 2001.

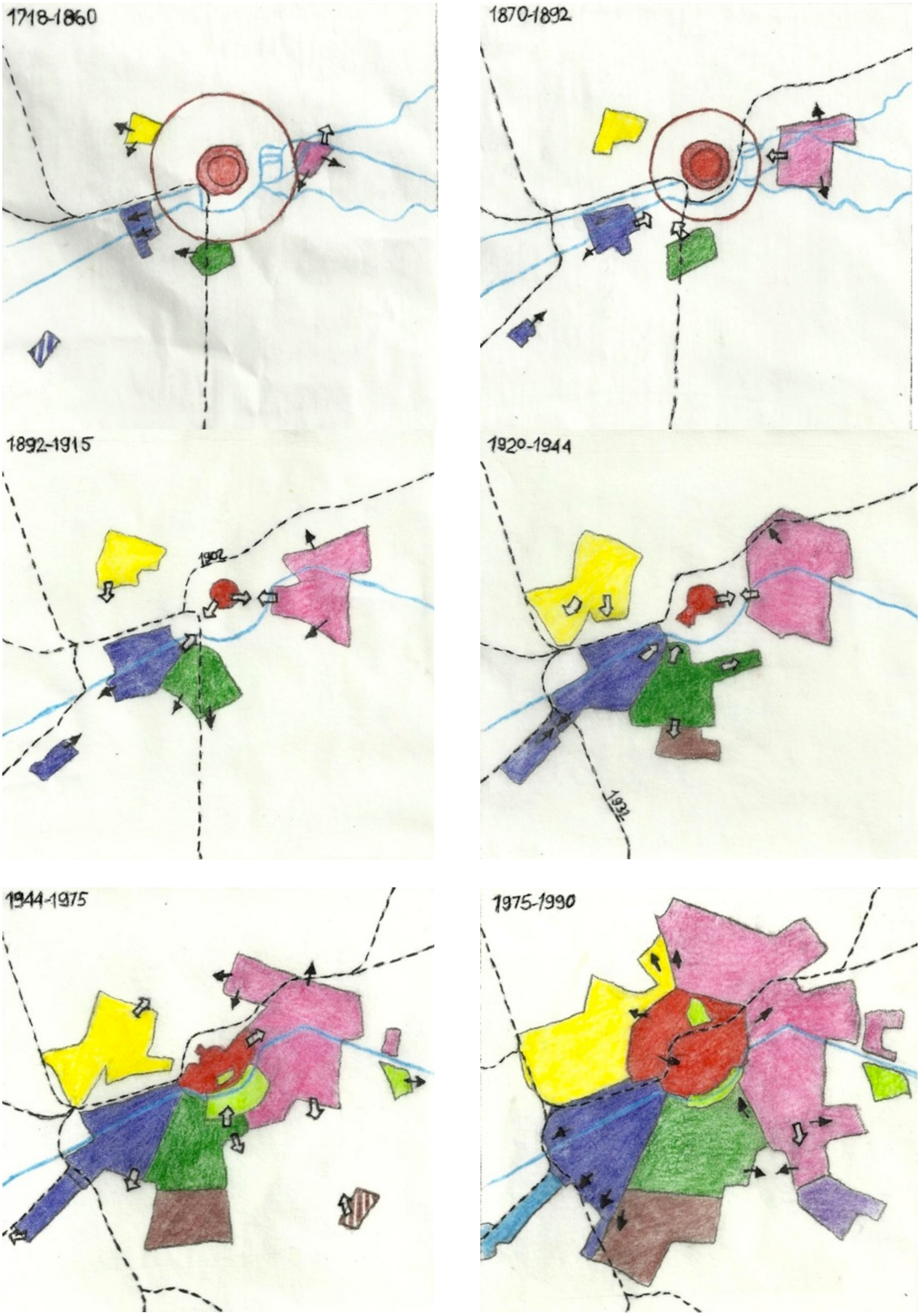
In 2012 was elaborated a new masterplan for Timisoara based on the new trends of Sutainable cities and of the European Union targets in figthing the climate changes via a smart urban and architectural developments.

II.1.10 Cycle of transformation - conclusion

From city urban evolution one can see that an important catalyst in its evolution was the transportation, and especially the ecological one. The tram made it possible the connections with the surrounding settlements and neighbourhoods and consolidated Timisoara in a powerful industrial and urban centre.

As well the location of different neighborhoods and their characteristic (industrial or agricultural) were considering the natural conditions: more fertile lands for agriculture, the industrial area such that to take advantage of the predominant winds direction, to avoid particle dispertion in the city.
Later the city growth was not that considerent to this aspects. The major concept, politicaly imposed, was in icreasing the built up densities, economy in use of land with a confinement of buildable perimeter; in contrast with the industrial developments and massive increase in population in urban area.

At the end the urban structure of Timisoara shows a relatively clear configuration: Cetate, the center of urban aglomeration, around which other urban subsystems revolve. The streets have the important role to coagulate and organize the aglomeration. The polinuclear urban character of Timisoara, its decentralization allows the functional release of central nucleus but at the same time presents the risk of identity loss, generating a relatively unitary urban texture in specific areas.



1718-1860
1870-1892
1892-1915
1902
1920-1944
1932
1944-1975
1975-1990

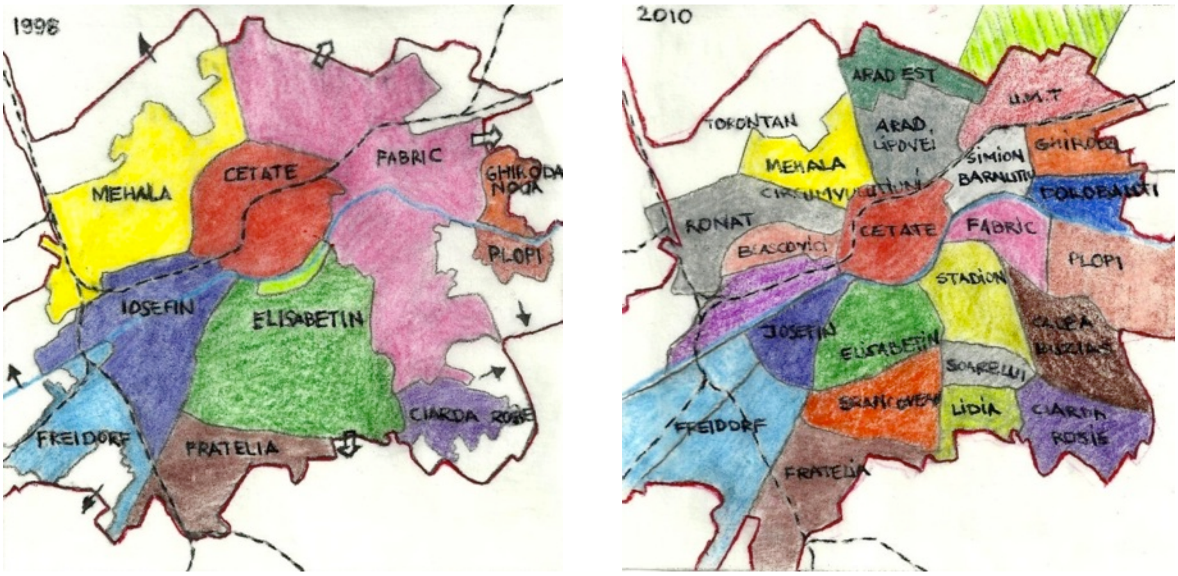


Figure 30 City evolution function of morph structural unit : neigbourhood

Nowadays visison returns to the past. The natural environment and the co-existence of man and nature became the main objectives in designing cities and buildings. New urban developments shape the spatial pattern of the urban agglomerations for many decades. Vulnerabilities of lives and livelihood to climate-related environmental processes are primarily the result of inadequate and unsustainable urban planning practices associated with complex natural settings and societal structures. Buildings and infrastructure in these highly vulnerable regions can be adapted to cope with the climate change risks.

II.2 Genesis of architectural expression. Definition of urban shpe via distribution of architectural pieces

Architecture can not be separated from the society's history, from its evolution, from first settlements with commercial character up to big residential assemblies, having as a final result their urban development.

For Timisoara the architecture is divided in two: the Byzantine – Ottoman influence and the Austrian – modern one. With the fall of Ottoman administration in Timisoara also the medieval architectural style ended: the reconstruction of the city implied the demolition of parts of the old city and its reorganization according to european aesthetical and ethical principals.

The medieval fortress information is available and in 2009 archeological remains were brought to sunlight. But the strong medieval urban morphostructural and architectural expression were completely erased and reconstructed in accordance with the architects belonging to the Imperial Court of Vienna.

Figure 31 Medieval fortress

Figure 32 Medieval castel ruins

It is well known that the medieval architecture was emphasizing the importance of public or royal buildings. In Timisoara of that time, the King's castel was the landmark, as the rest as it was described by EVLIYA ÇELEBI had a very modest and discreet form; the residential buildings were comprised of only ground floor and sometimes first floor and the materials used were wood and stone.

The new modern styles adopted were the results of a strong intellectual, social and economical movement. The visionary Count Mercy managed to combine all the aspects by transforming Timisoara into a leading city in the modern development of Europe.

The Baroque Architecture (XVIIIth century) is the oldest style that can be mentioned after the abandonement of Ottoman influence. Typical for the sumptuous Baroque, the buildings emanated spectacular characteristics and even today are considered as the most beautiful specimens of architectural history in the city. The style denotes movement, energy and tension by using curved lines and decorated surfaces; sketching perfectly the rhythm and spiritul state of the city at that time. It is the period of counter reformation so the accent on religious architecture is emphasised. Examples of baroque grandeur: Episcopal serbian church, Catholic church of Notre Dame, House of prince Eugene of Savoy, Roman Catholic Dome, Baroque Palace, Old city hall.

Figure 33 Roman Catholic Dome

Figure 34 Orthodox Serbian Church

Figure 35 Baroque Palace

Figure 36 Prince Savoy Residential House

The nineteenth century was the age of industrial progress leading to the evolution of material and technologies to build which cause a demoralization of architects in the design process. The rapid changes in use of new materials like steel and glass and new technologies with prefabricated elements made the result of the design process to look sometimes unattractive, standardized and not adapted to the urban scale: unreasoning eclectism. The architectural expression was also in forms of archeological servitude developing the new medieval revival of *Classical*: a sober and academic expression of art - Deschan Palace; *Romanesque* styles: massive churches having the opening ending in an arch - Millenium Church and *Gothic*: passion and sensibility of humans embraces new poetic forms by rediscovering medieval values: broken arch, rich decorations – Huniade Castel, Roman Catholic Church Elisabetin.

Figure 37 Deschan Palace

Figure 38 Millenium Church

Figure 39 Castelul Hunjade

Figure 40 Romano Catholic church, Elisabetin

In Timisoara the eclectic style developed in the second half of XIXth century was prefered by wealthy bankers. The decorations were rich and the chiaro-scuro was used to emphasize the plasticity of façade. Built on a rectangular plan the edifices were comprised of ground floor and two or three floors, enclosing an inner courtyard of same rectangular shape. Some examples of this monumental style are: National Agrarian Bank, Credit Bank, State Bank, Dicasterial Palace, Sinagogue from Fabric, National Theatre, Timisana Building.

Figure 41 National Agrarian Bank

Figure 42 Credit Bank

Figure 43 Dicasterial Palace

Figure 44 National Theatre

City expansion, the powerful industrialization at the beginning of XXth century and the strong influence from Austrian cultural movements and model, brought the Seccession Style. The two phases of the current were: The Organic Phase which was using curved lines and decorations and the Linear Phase characterised by geometric simplified forms and the almost abstract look. Some examples of this style are: Slaughterhouse, Public bath, Orthodox Church from Fabric,Hydro-electric plant, Szechenyi Palace, Water towers.


Figure 45 Timisoara abattoir


Figure 46 Neptun public baths


Figure 47 Water tower


Figure 48 Szechenyi Palace

The Soviet occupation and the Communism brought in the new simplicity into the scene. The dorm neighbourds and the industrial platforms were promoting the prefabricated technology over night. By 1980, 2/3 of population was living in prefabricated 4 to 10 storey buildings. Quantity and not quality was the main interest of the time and this led to the nationalisation of a large number of industrial units in order to be able to control better the industrial process and to impose a rhythm that will allow to reach the quatity desired.

Figure 49 City scape after 50 years of political regime

Figure 50 Residential prefabricated neighbourhood

The contemporary period tries to reclaim what is best from all the architectural stylies. The cultural heritage buildings are protected and the rehabilitation is done according to the UNESCO agreements; while the residential block of flats entered in a thermal rehabilitation program. The image of the “grey” buildings is to be changed into a more joyfull spectrum.

Figure 51 Thermal rehabilitated residential block

Figure 52 New residential complex

As well new buildings and group of building are popping up around the city in the form of new residential assembles or office and commercial buildings. The residential buildings are trying to follow the horizontal skyline of the city reaching 6 – 7 floors and embrassing the new model of more semiprivate – public courtyard. The commenrcial and office buildings do not blend in that much. The materials used and the shapes prove in a way the lack of architectural perspective and the ambition to spend money.

Figure 53 Romanian development bank headquarter

Figure 54 Office building in Fabric

History gives answers to questions about what is the truth, what influences the architecture, what it is the architecture ideology at a certain moment in time and what dictated that ideology.

Mies van der Rohe said that “Architecture belongs to the epoch and under the influence of science and technology it expresses the essence of the epoch”. For Timisoara the influence of technological evolution had a big impact on the architectural form. The innovations were the binder and at the same time the mean to develop a city according to the western principles of estethics and functionality.

The new epoch – starting with 2012 – should apply more than ever the principle of innovation and architecture colaboration, as well as architecture and natural environment co - influence.

The Urban Design engages the role of architecture in the formation of a discourse on urbanism at this moment of post-industrial development and indeed, of post-urban sensibility relative to traditional Euro-American settlement norms. As cities continue to evolve, innovative policies and practices are needed so that development is equitable and sustainable

II.3 Timisoara, a city of technical premiers

Innovations: Since early times the city had a predilection to new things. Always open to implement technologies and technics that will make the city more livable and attractive, more accessible and international; a wheel in this mechanism that is called evolution!

From the medieval times the important achievements in terms of construction can be only deduced. Building a castel (residence of Charles Robert) on a swamp area required very good knowledge in executed waterproof foundations, not common at that time for the geographical area. As well as having a chief architect– in the person of Radonia Meimar - was not common around 1699.

Modern era gave start to new visions. In terms of urban development, the city industrialization gave new directions to the organisation of the neighbourhoods and their links, in the construction of the buildings – made of bricks to prevent fires in case of sieges – being the most advanced example of European urbanism' principles of of that time.

In terms of technologies it was the beginning of a set of innovations that will propulsate the city as the leaders of modernisation, not only localy but also on a European scale.

Before going into details of technologies, one interesting aspect of industrialization was the establishment in Timisoara of the first brewery in the territory of present Romania – in 1718.

Figure 55 Bega around 1910

Figure 56 Old Brewary around 1915

Infrastructure was the keyword. In 1728 Count Mercy decided to make the area more accessible by draining all the swamps in an artificial canal – improving in this way the roads and creating a new means of transport: a waterway; which connected the city via Tisa and Danube to the river system of Central Europe. Furthermore, the drinkable water provision was available by 1774 via an aqueduct connecting to the main city center, Cetate, with the industrial area Fabric already in the possesion of a "hydraulic machine" that was pumping filtered water from Bega - 1732. Between 1758 – 1763 the hydro technical system of Banat was improved and updated, being functional even nowadays and considered the oldest in the country territoy.

An important center needs different means of communication, which also include the form of published information. In this regard, the first printing factory (tipografie) opened in 1771.

By the mid of XIXth century, the technics and technologies reached their peak development. In 1853 the telegraph, in 1857 public lighting based on gas (1st city in the country) and connection to the european railway system were realized. Ten years later the transportation embraced a new form: horse tram, which improved the connections between neighborhoods. In 1881 the modern telephone line was installed and by 1884 Timisoara was illuminated using electric street lighting system (1st city in Europe). The infrastructure encountered a new improvement in 1895 when the decision of asphalting streets was implemented.


Figure 57 Maintenance electric public light


Figure 58 Electric tram around 1899

In 1899, only a short time after the innovation was implemented by Vienne in 1897, Timisoara adopted also the electic tram, being ahead of many European cities. A big step in improving the means of locomotion and a small step towards cure of the housing difficulties and accessibility.

Between 1907 – 1910 hydroelectric power plant was erected on Bega at the entrance of Fabric and was called “turbines”, being the first installation of the kind in the territoty of Romania.


Figure 59 'Turbines' building around 1915


Figure 60 Bus for public transportation

During 1912 – 1914 the modernisation of water and sewerage system was accomplished.

Another breakthrough related to transportation took place in 1942 when the first trolley line was inaugurated in Timisoara. The first vehicles belonged to Fiat Torino and were called “filobuse”.

In December 1989 Timisoara was the first free city out of the communist domination which was a result of being the trigger location of the Anticommunist Revolution.

Seeing all these “firsts” in the history of the city, one can assume that in terms of sustainable design and implementation of new standards for the design and construction in building industry, Timisoara is more than the right place to start a new trend in Eastern Europe. “Thinking outside the box” mentality facilitates the approach through proposal submission and public involvement in taking final decisions for the best of the community and of the city.

It can be seen as the transition period from Palaeo technic era – the Industrial Age when the liberating agents were electrical power, telephone and the car – to Neo technic era - New age of the industrial decentralization in which case the liberating factors become solar energy, GPS and fast and sustainable public transport.

II.4 Sustainability – new vision for smart cities

II.4.1 Sustainability – friend or foe ?!

In 1990's a new mantra entered the vocabulary of urban planners and architects: sustainable urban development. The city was visioned as a competitive, compact and efficient aglomeration of urban forms; focused on urban renaissance in terms of new technologies.

Depression of trade and industry, creation of new dead spaces, decrease of natural growth, and shrinkage of the city launched a new competition for the space valutation and regeneration. Urban environment should became an element that supported life and encouraged higher rate of social activity.

Global awareness of climate changes (greenhouse effect due to human activity) and on the finiteness of many resources (fossil fuels especially) made this sustainable approach more attractive than ever.

It was interesting how the possibility to shape the environment via the potential offered by architecture and building was possible using invisible quantities: sustainability and energy efficiency of buildings.

Figure 61 Europe by night

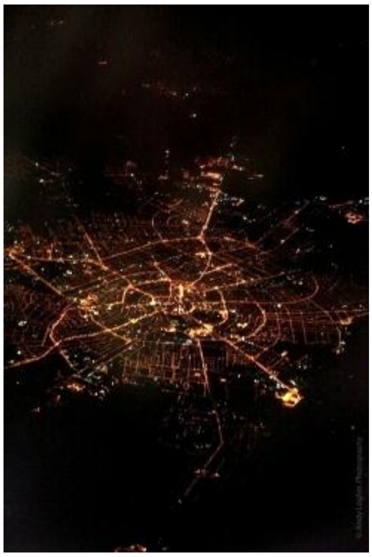
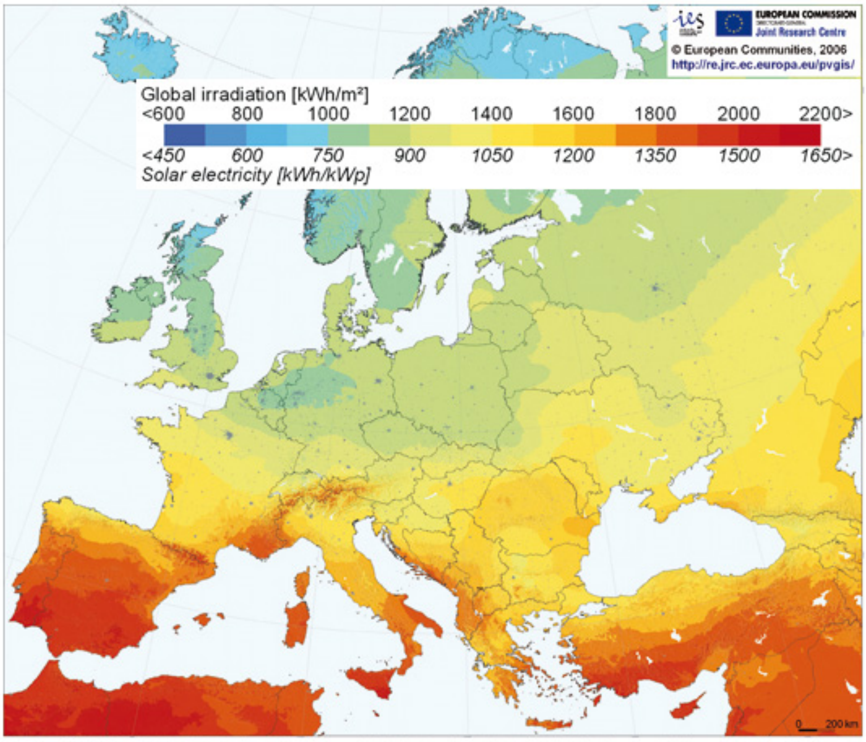


Figure 62 Timisoara by night

From sustainability point of view, the change should be perceived not only in terms of quality of the object being built, but also its position and development process should be considered. In terms of energy, the question raised was: which element of energy supply should be changed and in which direction? Is it the new resources that should be encouraged or the sparing and efficient use of the old ones? To start better grasping the aspect of energy efficiency one analysed the comparison between renewable, fossil and nuclear energy.

RENEWABLE	FOSSIL	NUCLEAR
Inexhaustable: lasting, guaranteed supply	Finite: rising of the cost; bottleneck and emergencies	
Almost zero impact	Massive environmental interference with consequences	
Available everywhere; obtained with fewer infrastructure requirements	Only local distribution; long supply chain; high infrastructure expenditure	
Economic efficiency; political independence; preserving peace	At the base of many international conflicts	
Cost decrease with impoving of technology	Cost increase due to limit resources and infrastructure cost	

The conclusion of the table above emphasised the direction of use of renewable energy which includes solar, wind and water energy.



Quelle: Šúri M., Huld T.A., Dunlop E.D. Ossenbrink H.A., 2007. Potential of solar electricity generation in the European Union member states and candidate countries <http://dx.doi.org/10.1016/j.solener.2006.12.007> . Solar Energy <http://dx.doi.org/10.1016/j.solener.2006.12.007> , 81, 1295-1305, http://re.jrc.ec.europa.eu/pvgis/.

Figure 63 Potential of solar electrcity in the EU

At the international scale there is a big sustainability movement that is also affecting the building and construction industry. Studies are being done and new goals are set (e.g. Kyoto protocol for reduction in pollutants emission).

For Europe the target is 20 – 20 – 20, meaning 20% reduction of greenhouse gas emission, 20% energy consumption reduction and 20% increase of energy production from renewable sources.

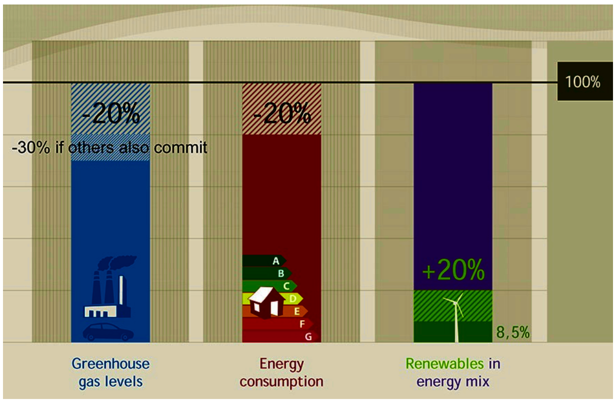


Figure 64 EU goal by 2020

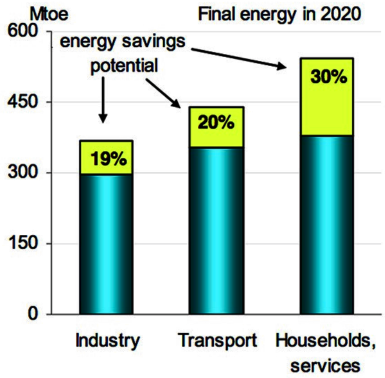


Figure 65 Sectors providing highest potential

II.4.2 Adaptation to climate change at European scale

To cope better with the new movement and trend, a small investigation on its efficiency was done.

The importance of climatic conditions for human comfort is well known. The latest analyses have proven that the climatic conditions are connected with urban development. Air pollution results from the increased urban growth and excessive car based ideologies. These findings lead to a significant impact on city planning. The proposed developments embracing the new dimensions: mitigation and adaptation.
At the urban scale, urban green and blue spaces have been identified to simultaneously contribute to mitigation and adaptation to climate change.
Defining better mitigation and adaptation, in the first case, one looks at the globaly responsible thing to do; actions that reduce the emissions that contribute to climate change. In case of adaptation, reference is made to the locally responsible thing to do; actions that minimize or prevent the negative impacts of climate change.
At the intersection area between the two directions are the same technical solutions

MITIGATION				ADAPTATION
• Sustainable transport • Energy conservation • Building code changes to improve energy efficiency • Renewable energy • Improve vehicle fuel efficiency	→	Geothermal Solar thermal Building design for natural ventilation Tree planting Local food production Water conservation Green roofs	←	• Increase use of green and blue spaces • Infrastructure upgrade: green aeration corridors • Residential programs: thermal rehabilitation, high albedo roofs, green roofs • Emergency & business continuity planning

Green space as a means to both mitigation & adaptation to climate changes scheme

A number of existing initiatives related to green and blue spaces reinforce their importance in the strategy described above.

- Green Roof Program: provides incentives for their installation on new or renovated buildings

- Green Development Standards: sets performance targets for construction and design of new developments
- Draft design guidelines for greening surfaces

In order to understand better the strategies implemented in various countries and their results, we can have a look at specific cases:

Case 1. Slovakia: Development of open space standards, 2009:

Initiatives were taken by the Ministry for Construction and Regional Development in order to update the national standards for land use planning such that to consider the climate change adaptation.
The result was a set of quantitative and qualitative standards for open space planning and development control, emphasising the role of green spaces in enhancement of ecology, adaptation to climate change and improving the quality of the urban realm.


Figure 66 Green spaces & encroaching development in Bratislava


Figure 67 New development in Bratislava

In the tabels below details on the initiative are sketched

Open spaces		STANDARD FOR SIZE CATEGORY OF MUNICIPALITIES IN THOUSANDS OF INHABITANTS						
category	Indicator	▾5	5 ▸ 10	10 ▸ 20	20 ▸ 30	30 ▸ 50	50 ▸ 100	▴100
Parks, public gardens and green spaces	Minimum park area	5 000 m^2, and minimal width 25m	5 000 m^2, and minimal width 25m	5 000 m^2, and minimal width 25m	5 000 m^2, and minimal width 25m	5 000 m^2, and minimal width 25m	5 000 m^2, and minimal width 25m	5 000 m^2, and minimal width 25m
	[m^2/inhabitant]	8-14	8-14	8-14	8-14	8-14	8-14	8-14
Local level	[m^2/inhabitant]	8-14	8-14	2-5	2-5	2-5	2-5	2-5
	accessibility	300 m	300 m	300 m	300 m	300 m	300 m	300 m
District level	[m^2/inhabitant]			2-5	2-5	2-5	2-5	2-5
	accessibility	-	-	1.2 km	1.2 km	1.2 km	1.2 km	1.2 km
City level	minimum area [ha]			5	5	5	5	5
	accessibility	-	-	3.2 km	3.2 km	3.2 km	3.2 km	up to 5 km
Other green spaces								
Playgrounds, sport facilities	min. area [ha]/ 1000 inhabitants	0.8 ha per 1,000 inhabitants	0.8 ha per 1,000 inhabitants	0.8 – 1.6 ha per 1,000 inhabitants	0.8 – 1.6 ha per 1,000 inhabitants	0.8 – 1.6 ha per 1,000 inhabitants	0.8 – 1.6 ha per 1,000 inhabitants	0.8 – 1.6 ha per 1,000 inhabitants
• Playgrounds for small children	Accessibility within	up to 150 m	up to 150 m	up to 150 m	up to 150 m	up to 150 m	up to 150 m	up to 150 m
• Playgrounds for children of 10-13	Accessibility within	up to 300 m	up to 300 m	up to 300 m	up to 300 m	up to 300 m	accessibility within 300 m	accessibility within 300 m

Fig…Quantitative standards for the provision of open space (excerpt) from Chapter 5 of “Standards for municipal infrastructure – A methodological guidance for land-use planning documentation”, Slovakia

Open spaces		**STANDARD FOR SIZE CATEGORY OF MUNICIPALITIES IN THOUSANDS OF INHABITANTS**						
facility	**indicator**	**▾5**	**5 ▸ 10**	**10 ▸ 20**	**20 ▸ 30**	**30 ▸ 50**	**50 ▸ 100**	**▴100**
Parks, public gardens and green spaces	[% of vegetation surfaces]	80%	80%	80%	80%	80%	80%	80%
	[% of coverage by woody plants]	60%	60%	60%	60%	60%	60%	60%
Local level	[% of vegetation surfaces]	80%	80%	80%	80%	80%	80%	80%
	[% of coverage by woody plants]	60%	60%	60%	60%	60%	60%	60%
District level	[% of vegetation surfaces]	80%	80%	80%	80%	80%	80%	80%
	[% of coverage by woody plants]	60%	60%	60%	60%	60%	60%	60%
City level	[% of vegetation surfaces]	80%	80%	80%	80%	80%	80%	80%
	[% of coverage by woody plants]	60%	60%	60%	60%	60%	60%	60%
Civic space (sealed surfaces), roads and other transport routes								
• Urban squares and plazas								
Local level	[% of vegetation surfaces]	Min. 30%	Min. 30%	Min. 30%	Min. 30%	Min. 30%	Min. 30%	Min. 30%
	Index of impermeableness	max. 40%	max. 40%	max. 40%	max. 40%	max. 40%	max. 40%	max. 40%
District level	[% of vegetation surfaces]	30%	30%	30%	30%	30%	30%	30%
	Index of impermeableness	max. 40%	max. 40%	max. 40%	max. 40%	max. 40%	max. 40%	max. 40%
City level	[% of vegetation surfaces]	20%	20%	20%	20%	20%	20%	20%
	Index of impermeableness	max. 45%	max. 45%	max. 45%	max. 45%	max. 45%	max. 45%	max. 45%
• Pedestrian streets	Index of impermeableness	max. 45%	max. 45%	max. 45%	max. 45%	max. 45%	max. 45%	max. 45%
• Residential streets	Number of trees per 1 km	80 pc as minimum	80 pc as minimum	80 pc as minimum	80 pc as minimum	80 pc as minimum	80 pc as minimum	80 pc as minimum
• Other roads	unlimited	unlimited	unlimited	unlimited	unlimited	unlimited	unlimited	unlimited

Fig…Qualitative standards related to the % of vegetated surfaces and tree cover for the characteristics of green spaces, open spaces and external spaces in different types of development (excerpt) from Chapter 5 of “Standards for municipal infrastructure – A methodological guidance for land-use planning documentation”, Slovakia

The results of the standard will lead to significant increase of vegetation cover and surface permeability assisting with adaptation to climate change impacts.

Case 2. Italy, Faenza: Extra cubature for developers in return for green spaces, 2009 :

The Municipality of Faenza via the Town Planning Regulations put the base of a new type of development: bio – neighbourhood. The scope was to start the adaptation to future climate changes by energy savings, better microclimate conditions allowing the developers to built more only if the building was fulfilling certain environmental sustainability criteria (including green roofs, green walls, water retention systems, public green spaces continuity).

Figure 68 Examples of green / permeable spaces landscaping and buildings in bio-neighbourhoods

The list below present the main criteria to be followed:

Box 1.The green building criteria

- Spatial orientation: the buildings should have large windows facing south-east and west
- Promote use of natural and environmentally friendly materials
- Avoid sources of pollution (including electromagnetic and acoustic pollution)
- Promote natural ventilation
- Use electrical systems which limit alteration of natural electromagnetic field
- Use low-energy, low-emission and efficient heating systems
- Use rainwater-recovery systems and use rainwater for watering plants
- Green spaces should be arranged in a way that provides shading and cooling, as well as screening of wind and noise. Appropriate tree species should be selected.
- Take into account local context, e.g. the environment, architecture and building types

Figure 69 Rules for implementation of incentives to green buidling meaures, Faenza

Additionally, in order to receive the permission to build, the developer should present the analysis of the immediate building development context and the surrounding environment; building plans and description of the infrastructure and building materials and at least three different proposals of development for the site.

Starting with 2010 the new developments were done according to the new regulations encouraging implementation of innovative solutions and leading also to new improvements in the "green system" which links the town with the country side. Due to this improvement in town quality, the population of Faenza increased with 6%.

Case 3. Germany, Berlin: The Biotope area factor, 1994 :

Germany has one of the strongest ecological traditions in Europe. The Passive House prototype is one good example in how Germans approach the sustainable design.

For new developments in Berlin new regulations are advanced that require certain proportion of the area of the project to be left as green space in order to be able to create the city's green infrastructure. The proportion of the green space to the entire development area is referred to as Biotope Area Factor (BAF). The regulations are part of the documentation for landscape planning and design.
The main drive is to reduce the impact of the city on the environment by compensating the deficits in open space.
All potential green areas (courtyards, roofs, walls) are included in the BAF, but the difference in their evapotranspiring qualities, permeability, possibility to store water, relationship to soil functioning and provision of habitat for plants and animals are weighed differently.

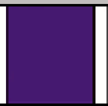
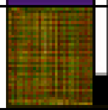
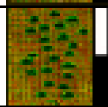
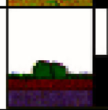
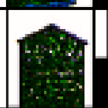
Surface type		Weighting factor
Sealed surface Impermeable to air and water and has no plant growth (concrete, asphalt, slabs with a solid subbase)		0.0
Partially sealed surfaces Permeable to water and air, but no plant growth (mosaic paving, slabs with a sand/ gravel subbase)		0.3
Semi-open surfaces Permeable to water and air, some plant growth (gravel with grass coverage, wood-block paving, honeycomb brick with grass)		0.5
Surfaces with vegetation unconnected to soil below On cellar covers or underground garages with less than 80 cm of soil covering		0.5
Surfaces with vegetation unconnected to soil below No connection to soil below but with more than 80 cm of soil covering		0.7
Surfaces with vegetation connected to soil below Vegetation connected to soil below, available for development of flora and fauna		1.0
Rainwater infiltration per m² of roof area Rainwater infiltration for replenishment of groundwater; infiltration over surfaces with existing vegetation		0.2
Vertical greenery up to 10m in height Greenery covering walls and outer walls with no windows; the actual height, up to 10 m, is taken into account		0.5
Green roofs Extensive and intensive coverage of rooftop with greenery		0.7

Figure 70 Weight of different type of surfaces

Figure 71 Examples of greening courtyards

Alterations or extensions of existing development		New development
Degree of coverage	BAF	
Residential units		
up to 0.37 0.38 to 0.49 over 0.50	0.60 0.45 0.30	0.60
Commercial use		
N/A	0.30	0.30
Commercial enterprises and central business facilities; administrative and general use		
N/A	0.30	0.30
Public facilities		
up to 0.37 0.38 to 0.49 over 0.50	0.60 0.45 0.30	0.60
Schools and education complexes		
N/A	0.30	0.30
Nursery Schools and Day Care Centres		
up to 0.37 0.38 to 0.49 over 0.50	0.60 0.45 0.30	0.60
Technical Infrastructure		
N/A	0.30	0.30

Figure 72 BAF targets for different types of development

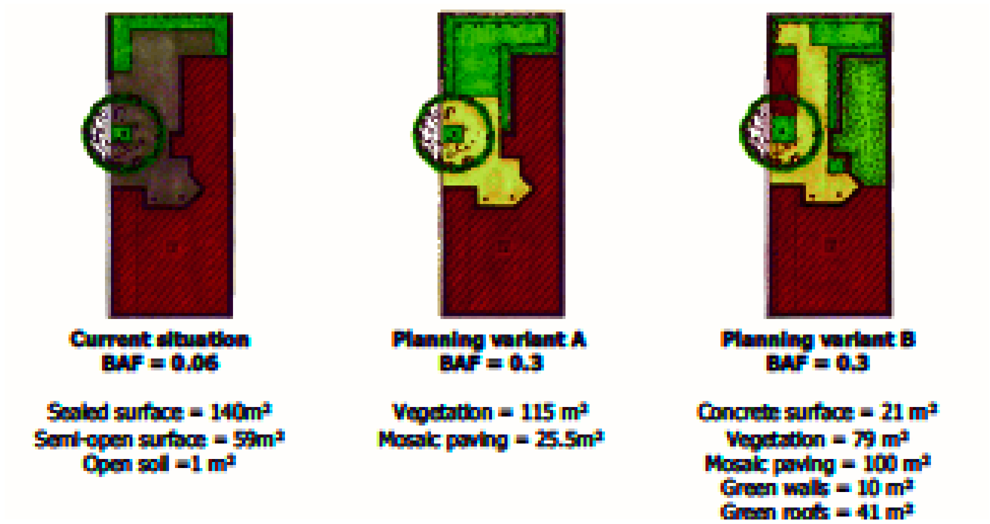


Figure 73 Exampl of different methods of achieving BAF of 0.3

The program is considered one of the decision factors in town planning, the natural conservation and presence of habitats has increased since the rules' implementation. The densely developed areas no longer have the highly negative influence on the climate changes due to the provision of vegetation.

II.4.3 Timisoara's Vision

Timisoara started to be more interested in the movement around 2005. There were several important events that open this "revolutionary road".
The International Workshop on architecture and urban design held by Politecnico di Milano, 2005 under the name: Timisoara 2020. Where terms like urban green, ecological corridors, sustainable use of land, liveable city, encouragement of public transportation were often mentioned and suggested for the future General Urban Plan to be developed.

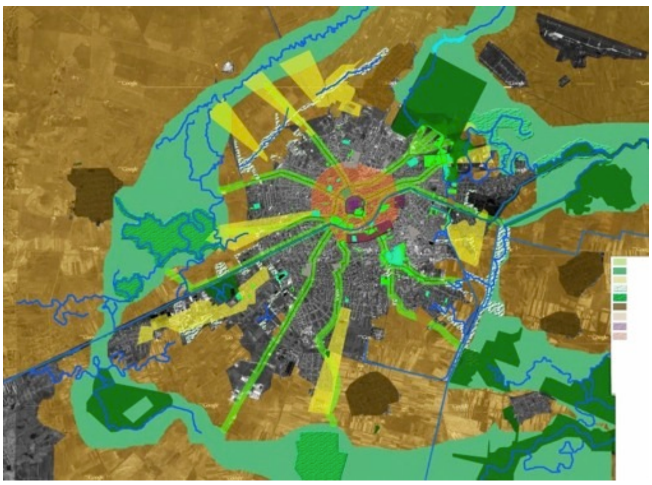


Figure 74 Proposal for the city green

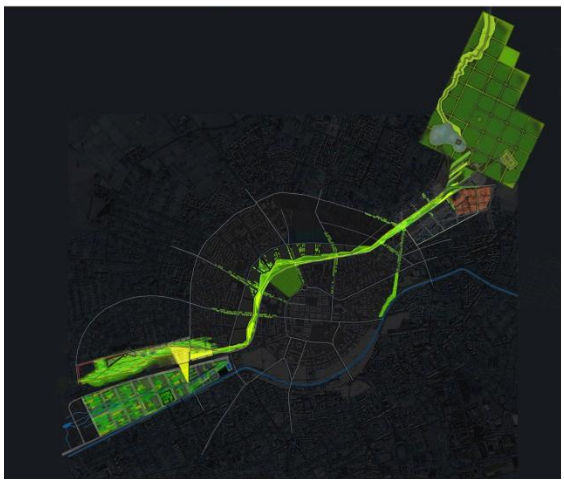


Figure 75 Proposal New Corridor of Development

Vision 2030 - Timisoara document: initiative started in 2006 by a professor from “Politehnica”din Timisoara, Fraunhofer IPA and the City Hall and focused mainly on the development of the urban infrastructure and improvement of the mobility in the city.
The solutions were directed towards five main categories:

1. Railway Project (Obiectiv “C.F.R”.): Main objective is European integration; through removal of the freight train from the city, creating a railway ring road; and connection with airport.

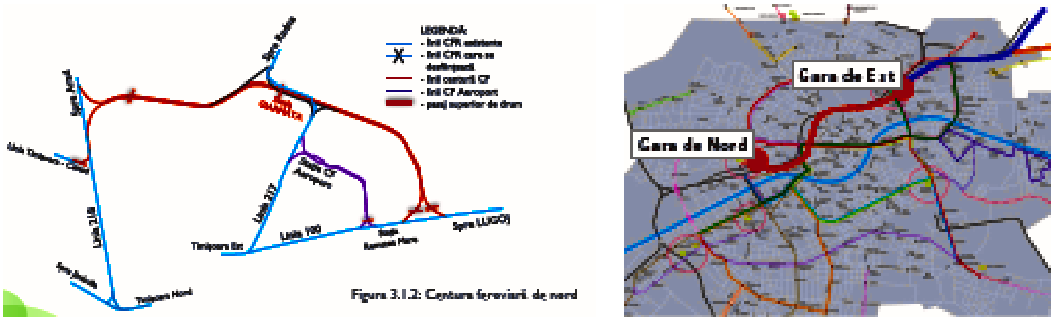


Figure 76 Proposal for the railway network

2. Publica transport Project (Obiectiv “Transport Public”): Extension of all networks in periurban area; prioritization of in-city mobility; park & ride points; implementation of traffic management system; utilizing Bega Canal for transportation.


Figure 77 Park and Ride suggestions

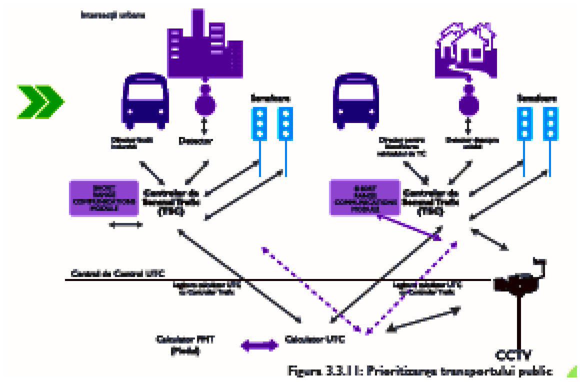


Figure 78 Prioritizing Public Transport

3. Roads Project (Obiectiv “Drumuri”): Development of new ring roads; network for non motorized transport and new parking places; rearranging important crossroads; improving the physical state of roads.

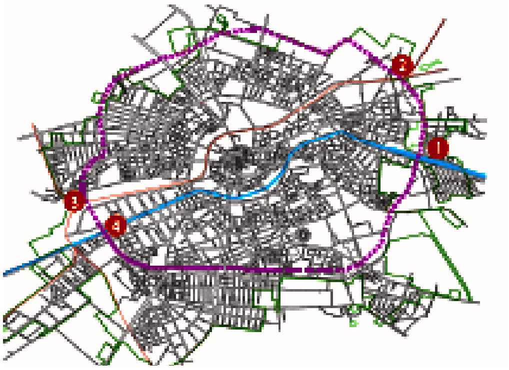


Figure 79 Proposal for Ring Road

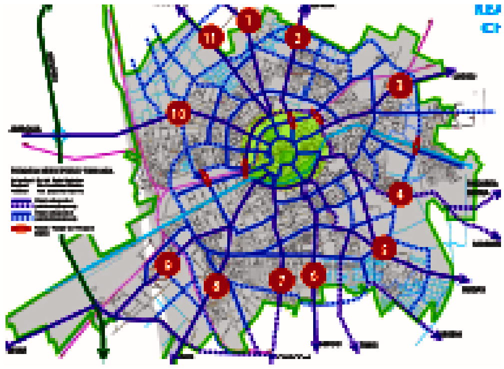


Figure 80 Crossroads rearrangement solution

4. Airport Project (Obiectiv “Aeroport”): Integration in the public transport network; connection to the outside important highways and national roads.

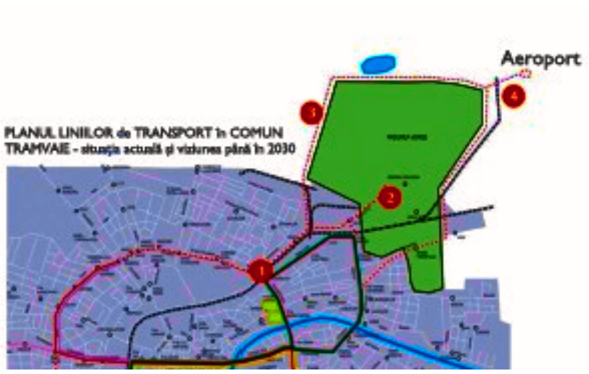


Figure 81 Airport connection to PT

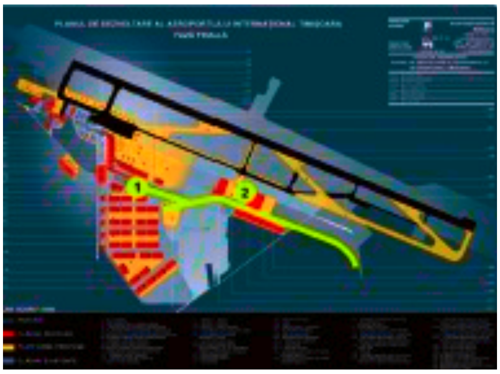


Figure 82 Airport HUB station proposal

5. Urbanism Project (Obiectiv “Urbanism’): Modern space development; coherance of open spaces; hi-tech platforms; CLUSTER concept for industrial platforms; increased interest for green areas.

Another important step in increasing Timisoara’s interest in the sustainable design was the participation in 2007 to the “Smart Cities” ranking of European medium-sized cities in their perspective for development. On www.smartcities.com can be find a list of 70 cities and their performance based on six factors which give actually the definition of a smart city.

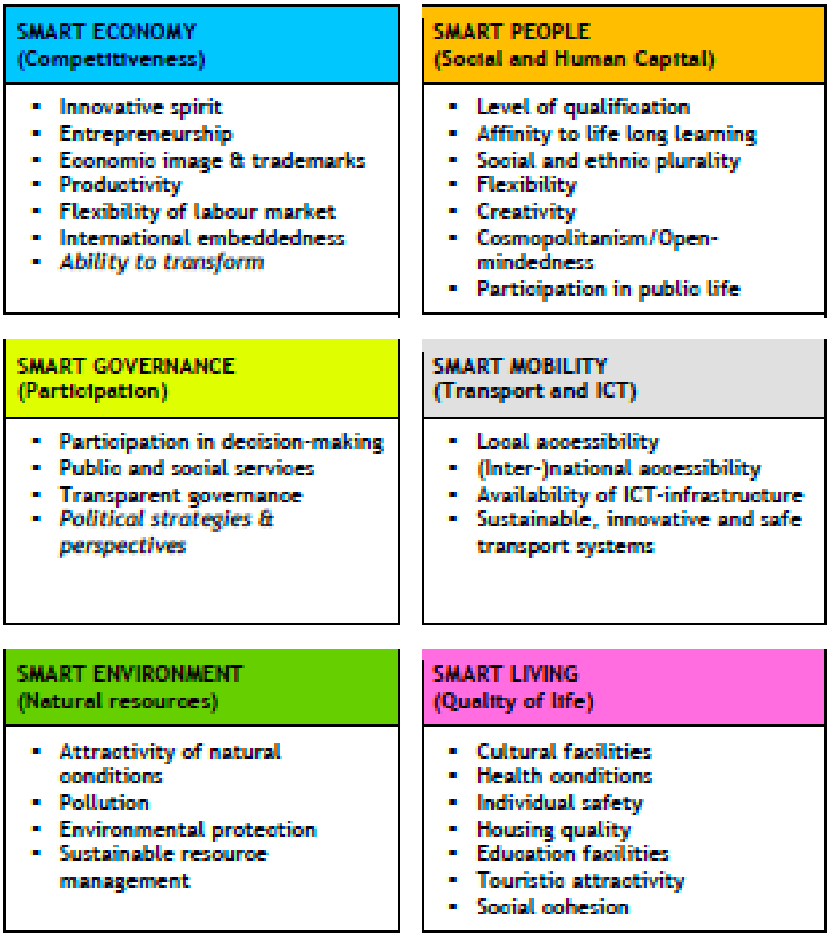


Figure 83 Characteristics and factors of a smart city

Timisoara occupies the 55th position having as the most positive aspect the smart environment (4th place out of 70) – high potential for the design emphasizing the use of green space.

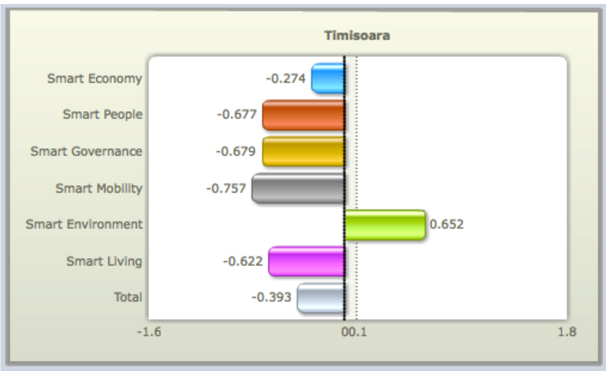


Figure 84 Final results for Timisoara as Smart City

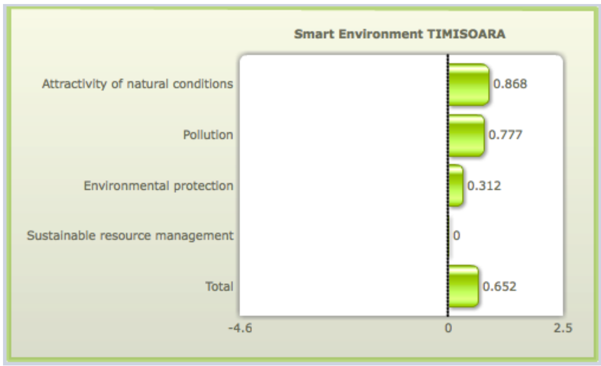


Figure 85 Results for Smart Environment

The most negative aspect should be also considered for the future development and as it is visible in the graphs below are quite related with the trigger point for Vision 2030 - Smart Mobility.

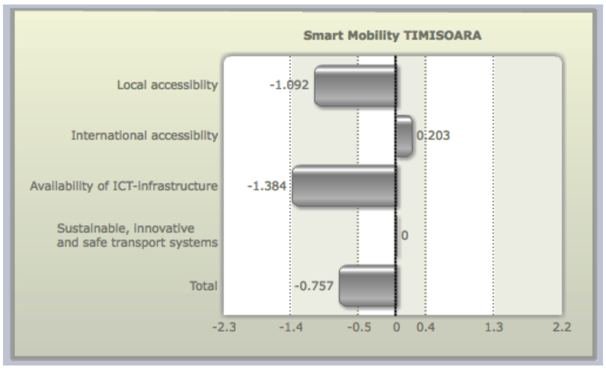


Figure 86 Results for Smart Mobility

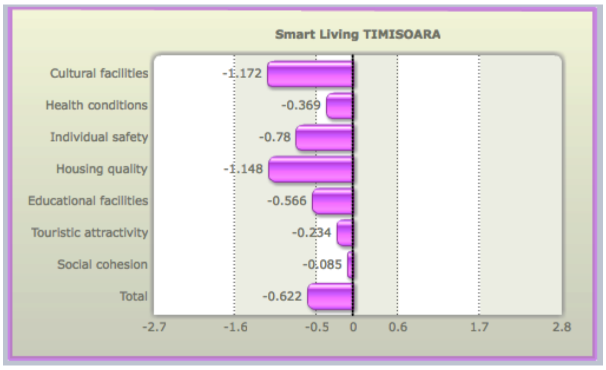


Figure 87 Results for Smart Living

The last document considered by the present research is the Local Strategy Report for Climate Changes in Timisoara (Strategia Locala Privind Schimbarile Climatice in Municipiul Timisoara), elaborated by the Denkstatt Organization in 2010 for the City Hall.

The analysis were done for seven main sectors of activity that can be influenced by the City Hall decisions which are Transport, Energy, Residential, Institutional, Waste Management, Green Spaces, Water and Industrial.

For each sector a detailed analysis in terms of CO_2 emission was done. A percentage of reduction was established by 2020 as well as a series of measures were suggested to be taken.

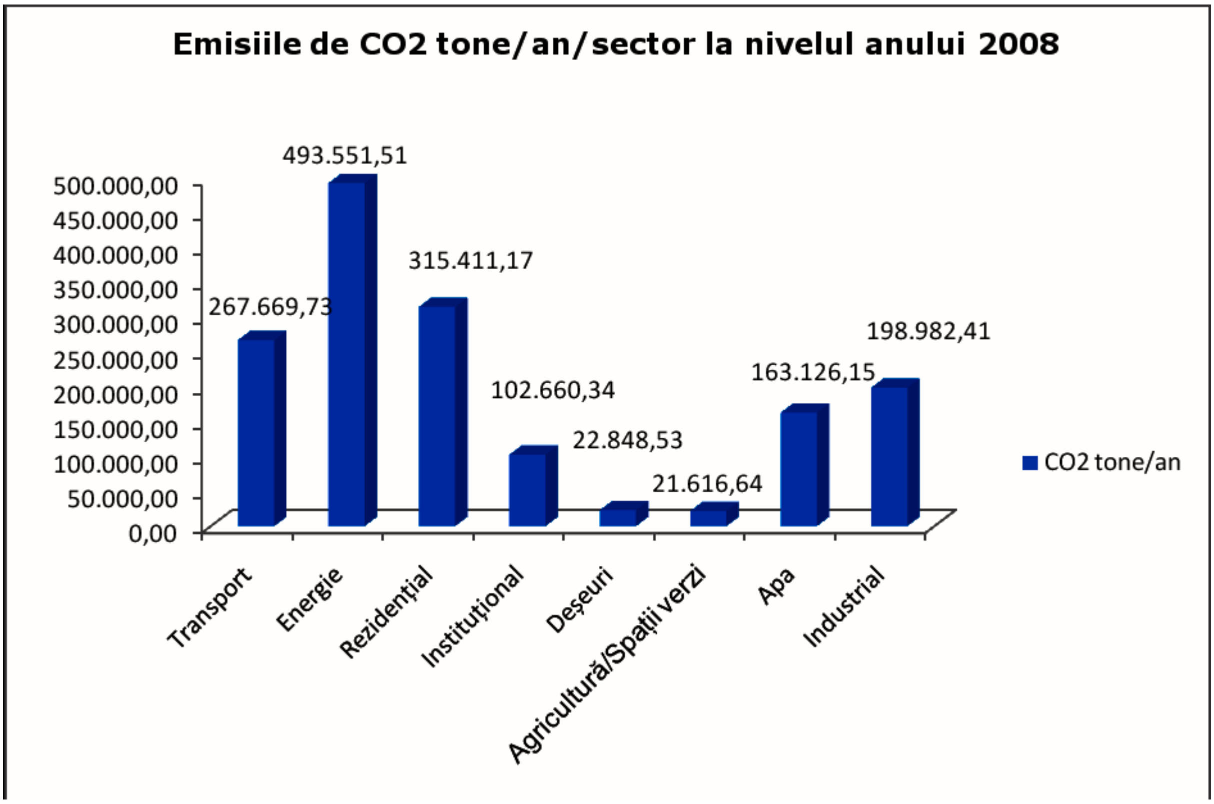


Figure 88 CO2 Emission per year per sector in 2008 in Timisoara

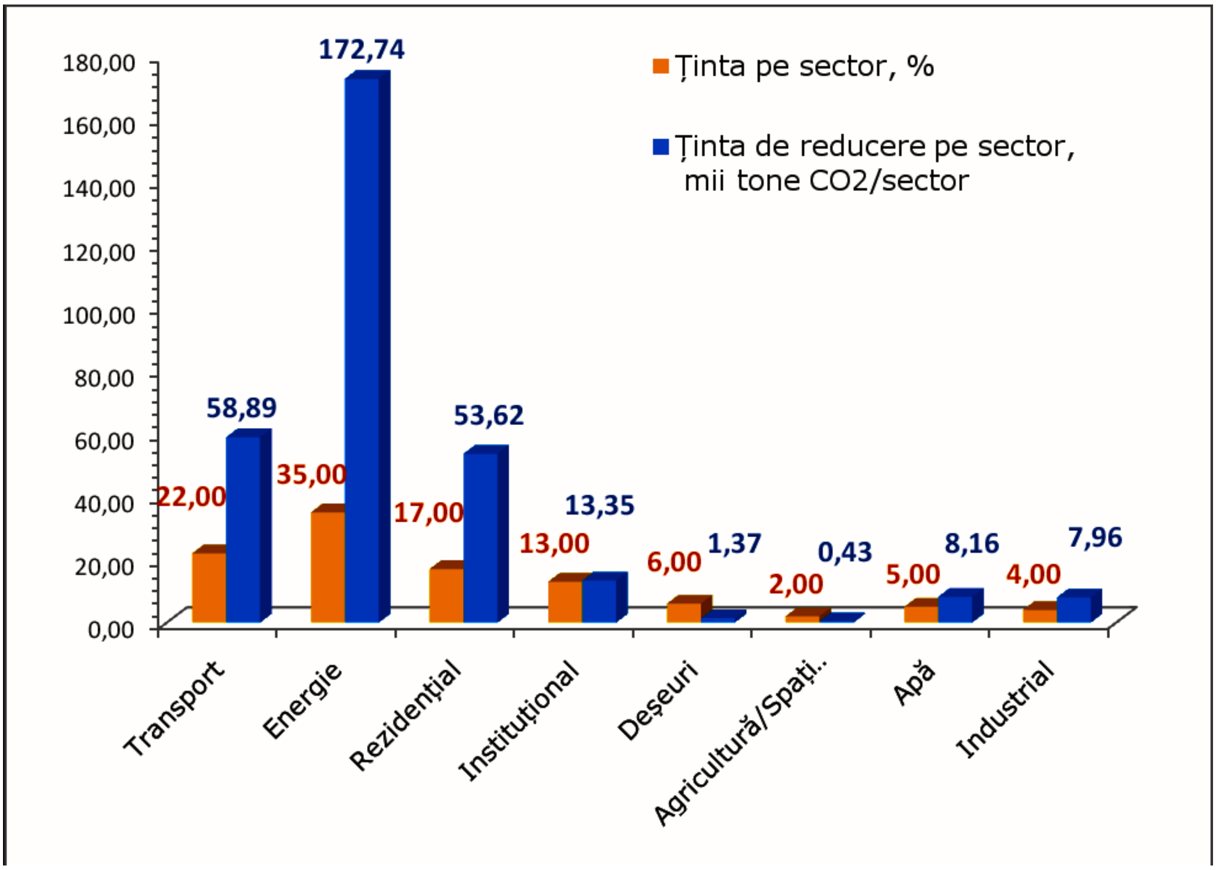


Figure 89 Reduction targetted by 2020 for all activity sectors in Timisoara

Coming to the coclusion of sustainability chapter after so many examples and analysis; one can analyse Timisoara's capacity of improvement in terms of new design visions, starting with the enrgy consumption analysis function of the morphology of the city and its connection.

In the end, the curiosity and complexity of the following inquiries will be the perpetuum mobile of the paper in question: Is the city "recyclable"? Can the old urban forms, evolution dynamicity and principles of spatial arrangement be of any help for the future sustainable development? Are the dead spaces and former industrial areas the key to city methamorphosis?

Chapter III. Integrated Urban Development

III.1. An outline of the method of analysis

The information presented in the previous chapter helped clarifying the direction of the design approach. Where exactly is Timisoara's problem and how it can be solved will be detailed below.

One has chosen the method of analysis elaborated by prof. Massimo Tadi and PhD student S. Vahabzadeh Manesh and called Complex Adaptive System. A theory in which the city is seen as an assembly of four components: voids, volumes, transportation and functions; and its functioning are seen as a holistic process. Each sub-system works at its own scale but at the same time having a big influence on the other components. The analogy can be made with the human body, which proper functioning depends on the well-being of all component systems and apparatus, or a natural ecosystem which functions only when all components are in equilibrium.

Geddes mentioned in 1918: "Since City Life, like organic and individual life, exists and develops with the harmonious functioning of all its organs, and their adaptation to all its needs, the endeavor has been made to provide, and in growing measure, towards all of these, and so not only to work in, with or for each as a specialism, but also to con-specialise each towards the fuller life of the whole…"

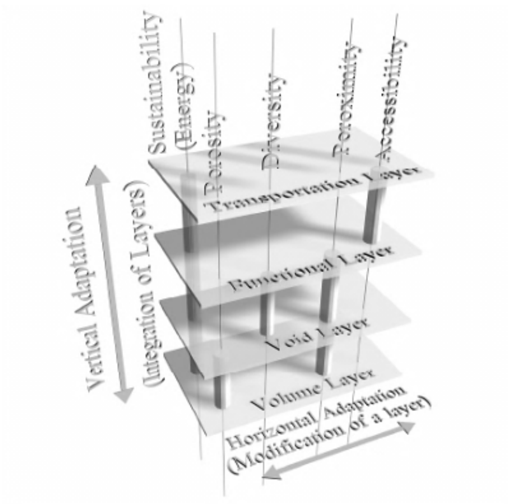


Figure 90 Horizontal & Vertical Integration

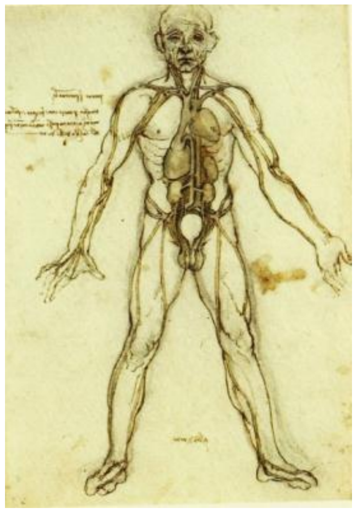


Figure 91 Leonardo da Vinci, Uomo anatomizzato

The transformation intervention will be applied at different scales: the region (city or town), the neighborhood (district or precinct and corridor) and the site (block or buildings and street).

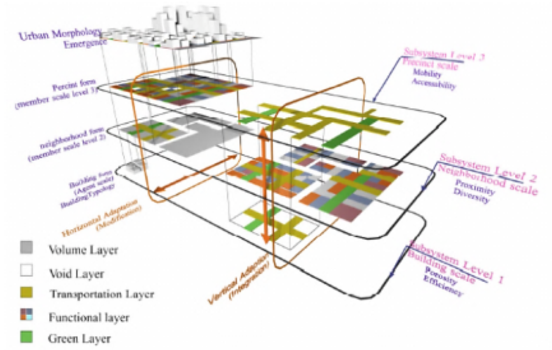


Figure 92 Intervention scales adaptation

Figure 93 The three scales of urban analysis

III.2. The urban analysis of the city

III.2.1 Geographical characteristics

Timisoara, one of the most important cities of the Western part of Romania is the capital of Timis County, more precisely it lays at the intersection of the parallel 45°47' North latitude with the meridian 21°17" East longitude, located, as a mathematical position, in the Northern hemisphere, at distances almost equal between the North Pole and the equator, and in the Eastern hemisphere, in the time zone of the Central Europe. The local hour of the city (considered as meridian) is 1 hour 25' 8" ahead of the meridian 0, Greenwich, and 34’52’’ arrear of the official hour of Romania (the hour of Oriental Europe).

Located strategically, it is within 700km radius from 14 European capitals.

Timis County has borders with Serbia and Hungary. With a surface of 8696.7km^2 it occupies 3.6% of the country surface, being the first largest county in Romania. On 1^{st} of January 2010 the population of the county was numbering 678,795.00 inhabitants (311,440.00 in Timisoara) with an average density of 78.1inhabitants/km^2 – 62.2% lives in urban areas and 37.8% resides in rural area. Out of the total, 48% represents the male population and 52%comprises the female population.

The majority of the population is of Romanian ethnicity (83.4%) and of orthodox conviction (78.9%). But there are also other nationalities – 7.5% Hungarians, 2.4% Gypsies, 2.1% Germans, 4.6% others (according to the census of 2002); as well as other religions: 10.6% Roman Catholic, 4.2% Pentecostal, 1.9% Reformat, 4.4% others (according to the census of 2002).

Figure 94 Timisoara in Europe

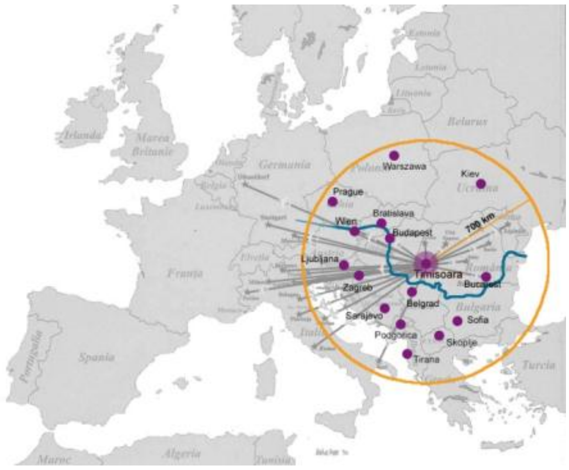


Figure 95 Timisoara in the 700 km radius

The relief of the city located to the SE of Pannonia Basin, in the divagation area of rivers Timis and Bega, is quite constant. The evenness of the field, Campia Timisoarei, is interrupted only by the rivers' bed with an average altitude of 90 - 95m and the N-NE highlands of Giarmata Vii – Dumbravita with and average height of 100m.

From tectonic point of view, Banat is a region with several seismic centers, Timisoara being considered a seismic hotspot located exactly above a shallow depth focal center (5 – 15km). Even so, the magnitude of the earthquakes rarely reaches 6 units on Richter scale (1991 12th of July M=5.7). the type of the earthquakes characteristic for the area show short term horizontal and vertical movements of the impulse and long periods of recovery in the same area. These types of shocks affect more rigid structures (masonry works, diaphragms, panels) and less for more flexible (frames of reinforced concrete or steel structures).

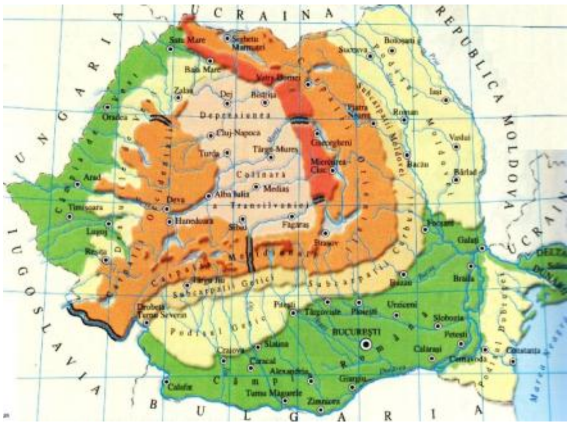


Figure 96 Relief Map of Romania

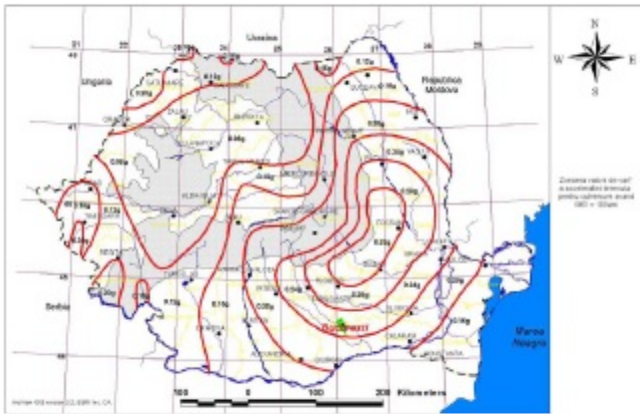


Figure 97 Seismic Map of Romania

Regarding the geological structures of the area, there are Quaternary deposits (clay, sand and silt) up to 200m in depth, under which there are successions of Roman deposits – up until 600 m in depth – and Dacian deposits in *facies lacustru* and swamp, who favoured the formation of numerous layers of lignite. They are followed by the Pontic and Sarmatian formations and from 1740m downwards, there is the site of the crystalline shield (granite).   The freezing depth – foundation depth in the area is considered to be 0.70m according to STAS 6054-77.

From climatic point of view, Timisoara has a moderate continental temperate climate, characterized by the diversity and irregularity of the atmospheric processes. The yearly average temperature is of 10.6ºC and the hottest month of year is July (21.1ºC), leading to an average thermal amplitude of 22.7ºC. Average temperatures of over 15ºC, is of 143 days per year, comprised between the 7th of May and the 26th of September. Found predominantly under the influence of the maritime air masses coming from the North-West, Timisoara gets a great quantity of precipitations, with an yearly average of 592m. Nonetheless, the regime of precipitations has an irregular character, with years with more abundant precipitations than the average and then again, with years with very little quantities of precipitations.

Due to its positioning in open plain, but at distances not very long from the Carpathian massifs and from the main valley corridors which separate them in this part of the country (Timis-Cerna corridor, Mures valley, etc.), Timisoara registers, from the north-west and west directions, a movement of the air masses which is slightly different than the general circulation of the air above the western part of Romania. The most frequent ones are the north-west winds (13%) and the west ones (9.8%), as a reaction to the activity of the anticyclone of the Azores, with a maximum extension in the summer months. In April-May, a greater frequency is also registered with the south winds (8.4% of the total).

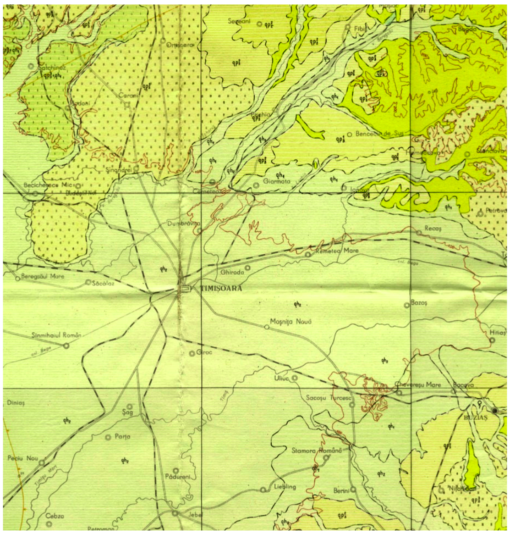


Figure 98 Geological Map of Timisoara Area

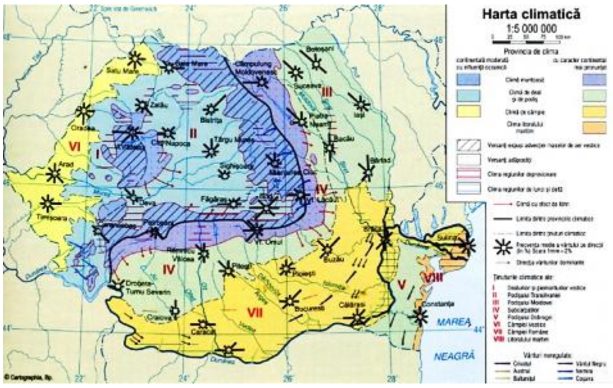


Figure 99 Climate Map of Romania

Hydrographycal resource of the territory of Timisoara is quite rich, formed by rivers, lakes and swamps. Most important ones are Bega and Timis. Regarding the underground water, the phreatic layer of Timisoara is at a depth of 0.5 to 4m, the depth water goes from 4 – 9m up to 80m in depth providing a reliable source of water necessary for urban consumption.

As geo-botanical resource, Timisoara is included in the anthropogenic forest steppe, being in the past an oak forest area. Close to the water courses the landscape is more varied, where the predominant species are softwood trees. The fauna is generally represented by few species of small mammals, generally rodents, but a very large number of birds, most interesting pheasant.

The data above together with the historical analysis from the second chapter sketch the big picture of the city state and the main direction in which the analysis should slide.

It is time for the “dissection” of the city in its component subsystems and to perform in-depth analysis of their real physical and moral performance capacity.

III.2.2 City State at present

As the main direction of this thesis is sustainable urban design, the coexistence of the urban morphology and energy consumption should be better understood. The Complex Adaptive System method provides the tools to start approaching the urban and local design in a different manner as it was done until present. The urbanization of the rural area, the sprawl of the cities will be no longer an issue on the agenda of the urban planners; instead urban transformation via sustainable neighborhoods will become the next hot topic.

Timisoara, at its turn, is the best candidate to go into this “rehab” program.

According to the Timisoara City Hall preparations for a new Master plan - 2012, a set of drawings that give diagnose for the city are available for public consultation. One analyzed the drawings splitting them according to the four layers of interest – transportation layer, functional layer, urban voids, and urban volumes.

As well as a detailed SWOT analysis was performed for each of the three layers defined at the beginning of the chapter: city, precinct and site.

Together the two analyses emphasized the design principles considering the sustainable approach.

Territorial unit	Area (km^2)	Area (%)
City	129,30	100,00
Precinct	3,64	2,82
Site	0,11	0,09

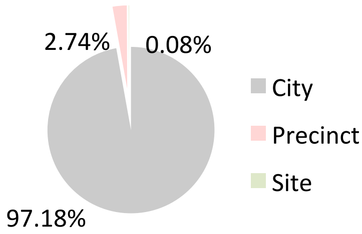


Figure 100 Percentage of Territorial Occupation: City, District and Site

Table 1 SWOT ANALYSIS CITY

TIMISOARA SWOT ANALYSIS - Understanding the context		
Sector	**Strengths**	**Weaknesses**
Geopolitical position	Close location to the border with Serbia and Hungaryat a distance of ≈ 700 km from 13 European capitals Important circulation node Coherent territorial structure with good social and economic interaction Seat of political and administrative power of county Favourable geographical conditions (clime, hydrological resource and soil)	Low natural resources Alternation of dry and wet years
Population Work force	High level of tolerance; low level of conflict between citizen High educational level; over country average More that 50% of population between 20-60 years old	Negative natural growth Migration of work force abroad due to economicalrestructuration Lack of working opportunities Increased tendency of unemployment rate State allowance that encourage social laziness
Heritage	Good fond of industrial buildings	Undefined administration for local heritage: State,Local Communities or

		County Council
	High cultural and historical identity Good preservation of cultural heritage	Special destination site inside built area: militarysite, jails, radio antennas
	High number of terrains with reconversion potential	Increased price rate of the sites with special equipment
	Un-build terrains 24.35%; built area of the city ≈ 50% of the total city area	Unbalance between real price of dwellings and their value
	Reserve of terrains with agricultural potential	Degradation of historical heritage in the city centre
	Valuable architectural heritage	Structural degradation of buildings due to increased traffic in city centre
Infrastructure Transport	Consequence in the urban planning-flexible urban structure, radial and concentric	Bad connection of the suburbs with the city via public transport
	Divers circulation and transportation routes (cars, railway, airplanes and naval)	Absence of the ring road for transit traffic
	Highest railway density in the country (90,5 km RW/ 100km territory)	Physical barriers: railway and canal
	International airport - highest number of clear days; modern technologies and equipment; increased number of internal and international flights	Poor technical conditions of all types of roads
	Bega canal - 44km of navigation	Congestion points that reduce the traffic flux
	Good territorial cover in terms of public transportation	Poor travelling conditions for the passengers
	Prioritize electrical public transport (accessible price)	Lack of management of Bega Canal - non functional
	Railway transport available in all moving directions	Bad conditions of the Costei dam that can causeflooding
		Expired life cycle of the means of public transport (trams - 100%, trolleys - 80%, buses - 15,54%)
Services networks	Water supply, electricity supply, natural gas and thermal energy supply network well developed across city area	Poor supply in the rural area around city
	Two sources of electrical energy - Portile de Fier, Mintia	30% of water supply network with overpassed lifecycle
	Natural gas supply from Transylvania Basin and pit gas from Banat Field	Sub-dimensioned water treatment plant and old equipment used
	Good centralized heating system capable of supplying more than required functioning 24/24 at 75% of working capacity	Low pressure of gas during winter as the city is end of network
	Main network of optical fibber for telecommunications	Poor telecommunication network in the rural area

	Modern telecommunication network (app 70%)	
Institutional infrastructure	Existence of institutions of interest for county level, municipal level and communal level	Lack of institutions in the V Vest area Insufficient means for a durable socio-economical development (exhibition halls, international schools, technological platforms, business centres, commercial and touristic centres etc.) Poor development of the business infrastructure
Economy	Strong economical pole (95% of the area economy, 60% of the county economy, 30% of the V Vest region, 3% of the country economy)	The economy of the area is under stabilizing trend
	Diversity of the economical structure	Decreased of the services export
	High development index for the zone (I[st] Category)	Expired economical structure, old and non functional equipment
	Large consumption market	Low level of development of the small and intermediary companies
	Increased export level in industry sector 73%, agriculture 642%	Fluctuations of personnel between different sectors
	Higher percentage of the private property over the public	Poor management
	Increased number of the small and intermediate businesses	Absence of a mechanism for selective stimulation of industrial activities and encouraging of the non pollutant industries
Education	High level of education (99%)	Autonomy of the education entities is low
	Well developed and diverse education network	Low flexibility of the education network
		Poor provision of equipment and materials for didactic activity
		Non attractive offers not aligned to the job market requests
Research	Research centres with tradition and qualified personnel Research objectives both scientifically and applicative	Improper equipment and low quality materials Low correlation between research and production
Culture and mass media	Important cultural centre of Romania with cultural tradition	Insufficient integration in the national or international cultural circuit
	Diverse cultural heritage	Lack of civil societies implication in the cultural life
	Diversity in the cultural offer: opera, philharmonic, theatres in Romanian, German, Hungarian, with dolls; art schools, libraries, museums, art galleries	Lack of material base for mass media on local scale

	Developed mass media: 17 newspaper (daily, weekly, monthly, in 4 languages), 4 radio stations, 2 local TV stations and 1 Territorial studio of national TV station, cable networks)	Number of licence of emission below the request Lack of a coherent cultural strategy
Health and social services	Balanced repartition regarding the consulted persons/medical cabinet and related to urban/rural distribution Existent health endows are covering the city needs Most modern cardiac centre in the Eastern Europe Increased number of health insurance companies Local public administration provides founds and services for social protection and encourages the NGO-s that provide social assistance	Excessive centralisation; difficulty in coordination at local level; old equipment Poor management Low number of recovery centres Highest cost from the country for the services Continuous change in legislation Insufficient services and qualified personnel Poor contribution of Civil Society and Church in solving the social problems
Environment	High biodiversity & high potential of natural resources Low pollution; landscaped green areas and water front Possibility of extension of green areas "Padurea Verde" in the NE part of the city and the green areas along Bega Canal plus the existence of the recreational areas in the suburbs (Ianova, Timis,Sanandrei etc.) Thermo-mineral water resources	Low index green space per inhabitant Low recreational spaces Absence of the ecological management of the wastes
Quality of habitable space	Average liveable area per capita over the countryaverage High diversity of dwellings (blocks of flats, detached)	Low percentage of dwellings under the local public administration 60% of dwellings poor conditions Tendency to functional reconversion of dwellings Lack of services (education, markets, green areas, playgrounds) Presence of incompatible functions with the residential area

Sector	Opportunities	Threats
Demographic and social processes	Increase population mobility Improve educational standards Increase the number of active population group (18-20 years) well prepared	Natural growth decrease Increase of inter-social conflicts Labour force migration
Economy	Development of a centre for promoting economical relationships between the members of CEFTA Financial agreements with IMF, EU and World Bank Implementation of national strategies for medium term; stabilizing of the national economy Improvement of the legislation in the labour field Reorganization of the public finances Simplification of the administrative procedures in order to encourage the local or foreign investors Acceleration of the privatization procedure 2020 European Strategy for development of regional and local policies Population pro active attitude for alternative energy use and zero footprint economy policy Increased role of city as a polarising factor in regional development by consolidating European cooperation in cultural and economical field Development of the "e-…"systems	Increased number of economical frauds; development of underground economy Decreased rhythm of the privatization process Agreements of economical facilities of other centres in the region
Major infrastructure	Possibility of new custom points with Hungary Planning of the Pan European circulation corridor no.4 Construction of new bridges (Vidin) Redevelopment of Bega Canal for freight naval transport	Insufficient funds for development of new majorinfrastructure network Conflicts of interest between different decisionalorgans (local, county, national)
Cultural	Starting the development approach for becoming European Cultural Capital in 2020	

Table 2 SWOT ANALYSIS DISTRICT

PRECINCT SWOT ANALYSIS - Operating environment		
Urban Infrastructure: functions, image/architecture, flux/circulation/routes	**Strengths**	**Weaknesses**
	Existence along waterfront of specially arranged leisure places	Poor connection of educational institutions with the waterfront
	Existence of pleasant public spaces as a result of artistic exhibitions	Restricted access to waterfront in some areas
	Diversity of commercial functions	Decreasing number of commercial activities and public services in Fabric
	Railway station and regional bus interchange	Increased number of neglected ex commercial spaces at the ground level of buildings
	Existence of agriculture markets that encourage local production of small entrepreneurs	Need of refurbishment of old residential buildings
	Wide public spaces with high potential to become focal gathering inter-social points	Some parks do not fulfil the functional requirements any longer
	Large number of landmarks	Historical buildings require refurbishment
	Majority of old buildings have an historical and architectural value that give identity and character to the area	Non unitary exterior image of the commercial functions; restoration works done by the owners on their own account
	Architectural details of the buildings are considered pieces of art	Junction points/transition points that are not used as urban node
	Bike paths presence in some area	Lack of bike paths along waterfront and poor network in the rest
	Good public transport network, especially tram	Low number of parking places; improper use on street lanes for parking
	Pedestrian bridge over Bega that are intensively used	Difficult accessibility for the disabled people
		Absence of public transportation stations on Bega shore
		Promenades along the canal are interrupted by different obstacles
	Opportunities	**Threats**
	Possibility to arrange along Bega of sports activity places (even related with water	Poor conditions of the existing sports facilities along Bega
	Large number of spaces ready for reconversion	Fabric: abandoned buildings in advanced state of degradation
	Public spaces with high potential to become interchange node	Fabric: existence of big open spaces between constructed fronts
	Bega use for transportation and connection of city centre with suburbs	Negative vistas of the big industrial areas
		Transition areas with high degree of mixed pedestrian-car traffic

Table 3 SWOT ANALYSIS SITE

SITE SWOT ANALYSIS - Assessment of the framework	
Strengths	**Weaknesses**
Intersection of two historical city centres	Ex-industrial area
Environment that has urban, water and park landscape	Excessive litter/graffiti/dumped objects
Diversity in the access points/streets	Crossed by European road
Defined roads/ paths/ bike paths	High noise level
Emerging sectors: sport, education, environment	High evidence of neglect
Reputation as a leading agriculture market destination	Concentration of transport infrastructure
Community support for redevelopment of industrial areas	Undersupply of cultural tourism product and experiences
Situated in admissible walking distance from city centre and other strategic places	Traffic congestions
Potential of large diversity in use	Lack of community facilities (sports events, cultural facilities, hotels, convention facilities)
Water vistas	Limited pedestrian focus
Historical buildings; samples of architecture style at beginning of the XX^{th} century	Unattractive built form on large percentage of area
	Lack of organized public space
	Lack of connection between public transport and interchange bus/train points
Opportunities	**Threats**
Proximity to railway station	Vicinity with the biggest industrial platform
Future connection point with the airport	Crime and safety
Hinge for future green network/active public domain	Failure to manage the transportation management
Potential social outputs: site as community resource defining the local identity and forming a part of individuals' life strategies	Social & urban fragmentation
Integrated transport system	Lack of functional diversity on N-S axis
Local craft market development	Lack of parking
Water connection with leisure suburb areas	Other retail/economic developments
Use of green network for pedestrian exploration	Jeopardizing the local character: "Fabric flavour", due to excessive redevelopment
Development of a convention centre for tourism increase	
Clean energy cluster	
Development of canal front: transforming barrier into connection opportunity (canal green corridor)	
Ex-industrial heritage walk (Badea Cartan Market to beer factory)	

III.2.3 Transportation Layer

The City Hall decision to elaborate a new master plan was triggered by a discussion exactly of this layer. More precisely, they realized that the actual configuration of streets and public transportation around the city together with an increased amount of personal cars, make the city non attractive and difficult to cross. The analysis of the three types of traffic - internal, penetration and transition – demonstrated that the biggest percentage of vehicles on the streets is due to internal traffic – 78%; 19% of traffic is due to penetration traffic from the suburbs and only 3% of it is due to transitional traffic.

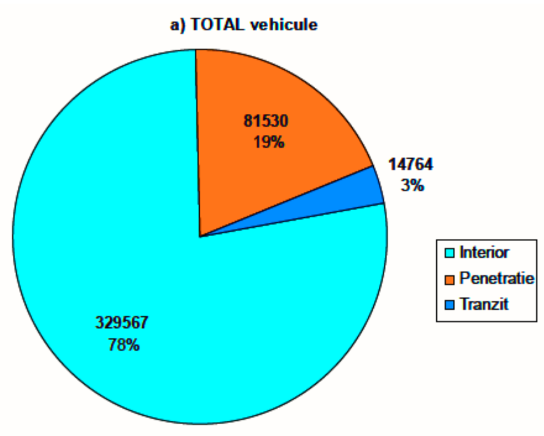


Figure 101 Percentage of traffic types

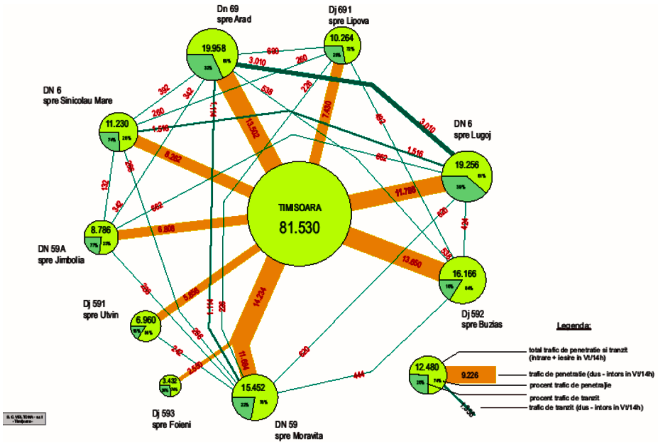


Figure 102 Penetration traffic from surrounding areas of city

The study also revealed that the biggest amount of the cars on the streets is the private ones – 83.4%; the public transport together reaches 5.4% of vehicles in the traffic (2.8% buses and 2.6% trams and trolleybuses). In terms of time variation during a day, the traffic is quite constant, having a slight increase during morning (8-9), midday (14-15) and evening (17-18) peak hours.

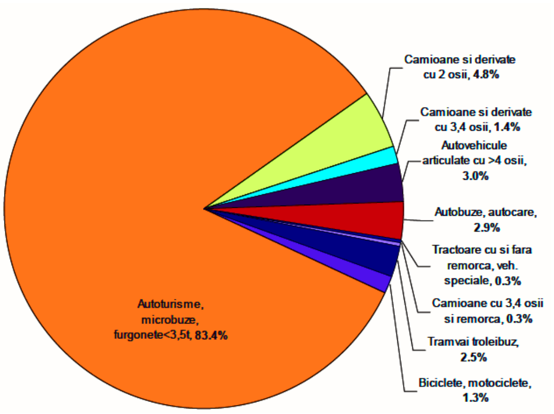


Figure 103 Distribution of vehicles type

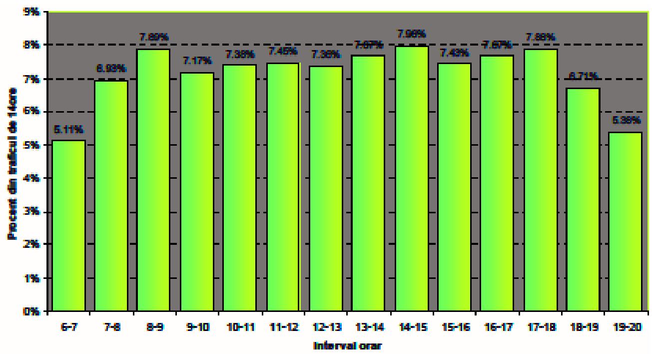


Figure 104 Time variation of traffic

To the factors mentioned above should be added the two big barriers that cut the city in two and slow down the traffic causing traffic jams and the most critical nodes of the circulation in the city: the railway line connecting East Train station with the North Train Station and Bega Canal.

Figure 105 Traffic critical nodes

Figure 106 Bega Canal

Even though the Public Transportation vehicles represent a small amount in the city traffic, their network is covering almost entire city with on hold projects to extend even more. In terms of sustainability, the electrical transportation has the highest proportion in the network – with 71 vehicles (86 in case of buses) and 11 routes (17 in case of buses), transports 49,673.00 passengers per day (28,648.00 in case of buses) – according to the RATT(Local transport company) report for 2008.

Figure 107 Timisoara Public Transport Networks

Figure 108 Bicycle lanes around Timisoara

Figure 109 Traffic Badea Cartan Market area


Figure 110 Crossroads in Fabric

The bicycles paths network according to the available information sums up only 19km and has no designated space in the traffic, being planned to share a portion of the pedestrian sidewalks or carriage way. Some of the renting points for bicycles are placed inside parks being difficult to be accessed by tourist or people that are not familiar with the neighborhood.

Figure 111 Bike path in Timisoara


Figure 112 Renting point for bicycles

Another critical issue is the lack of parking places (according the traffic report for General Urban Plan 2012: the total required number of parking places is 96,400.00; the actual capacity, including parking on streets and traffic lanes is 80,000.00 places; thus the deficit is of 16,400.00 places) and the inadequate parking all around the city: on the sidewalk, on traffic lanes etc.

Figure 113 Improvised parking place

Figure 114 Cars parked on sidewalk

Bega Canal, in the past used for navigation, nowadays is neglected despite its transportation capacity, being used only from time to time by people passionate by water sports and providing an area of leisure. Along Bega are aligned the most important parks of the city (two of them being recently refurbished due to European Union Founds – Rose Park and Children's Park)

Figure 115 Bega Canal

Figure 116 Water sports on Bega

In terms of the infrastructure; one observed the poor quality of the streets and sidewalks; aspect that transform some parts of the city in completely non walkable areas.

Figure 118 Road & Sidewalk in Fabric

Figure 117 Road in Rose Park area

Figure 119 Sidewalk along Bega

Figure 120 Rain warer accumulation on road

The analyses lead in the first phase to a conclusion under graphical form in terms of main directions of traffic and their importance.

Figure 121 Main axes of Transportation Layer

Figure 122 Importance of Transportation Routes

The roads (as well as cars) were the basis of new urban form since industrial revolution, but it can be seen that nowadays their capacity is overpassed and performance long ago expired. The new sustainable urban form is the salvation. Starting with change in city transportation hierarchy (public transport instead of private automobiles) it will be possible a different shaping of the neighborhoods and definition of public spaces. The “car-ocracy” should come to an end, moving from drive-in to bike-in and reshaping the inert green into a moving one.

III.2.4 Functional layer

The city's dynamicity depends strongly also on the distribution of functions across its area. Together with the transportation layer the functions define the accessibility of the district.

The preliminary analysis for the new urban plan defined the layer as the quality of urban life and it is classified in two categories: quality of urban life at city scale and at neighborhood scale.

For the city scale it was considered the three areas of accessibility: zone 1 – 1665m diameter circle, comprises mainly the historical center Cetate and the largest number of places with cultural, educational and entertainment destination; zone 2 – 3101m diameter circle, including again an important educational area, retail spots of large importance and the two main train stations (North and East); zone 3 – 5894m diameter circle, accessible in terms of the two train stations and important health services, as well as some retail destinations. But the third zone tends to be the most deserted in terms of complexity of functionality (in this case excluding the residential areas and the industrial platforms). The highest density is encountered in the zone 1 border with zone 2, more distributed along North - South direction.

The tendency of function distribution on NS axis is confirmed also by the analysis at district level. The most complex neighborhoods (containing all 6 functions based on which the analysis was done: commercial, low education, high education, health, sports, green, agricultural markets and religious) radiate from the city center towards zone 2 and aligned on NS direction.

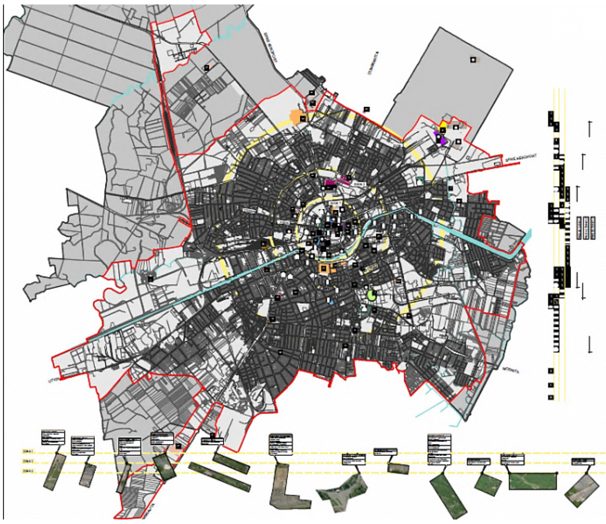


Figure 123 Life quality at city scale

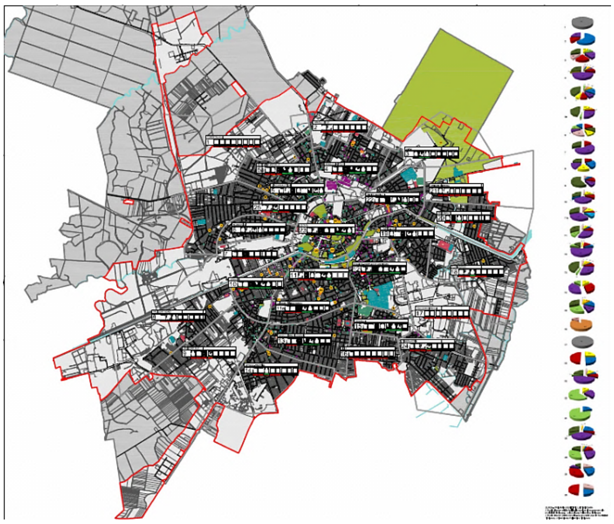


Figure 124 Life quality at neighbourhood scale

The socio-economical aspect of the life was analyzed also via a study done for the three historical neighborhoods, considering for each of them a certain number of buildings: Cetate (175 buildings), Iosefin (119 buildings) and Fabric (120 buildings). The results indicate that the city center is the most vibrant in terms of activities and functionality.

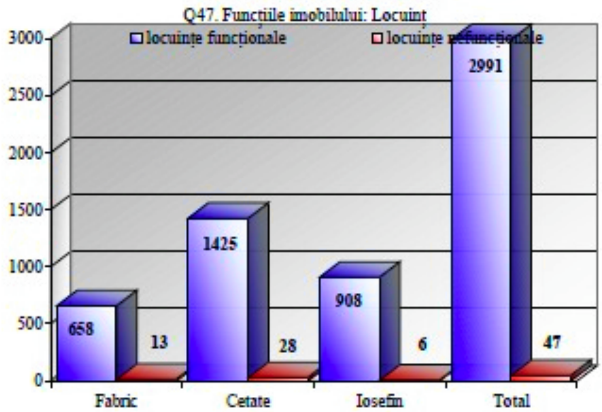


Figure 125 Residential function per neighbourhood

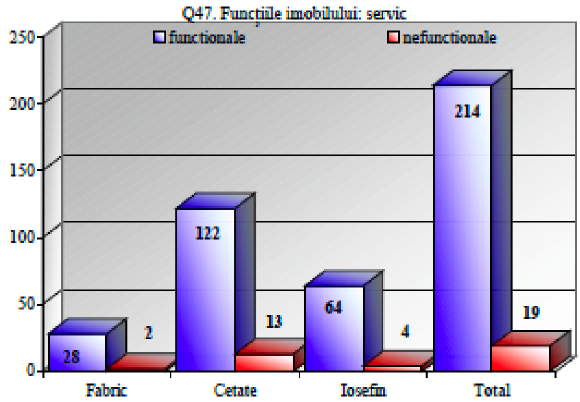


Figure 126 Services function per neighbourhood

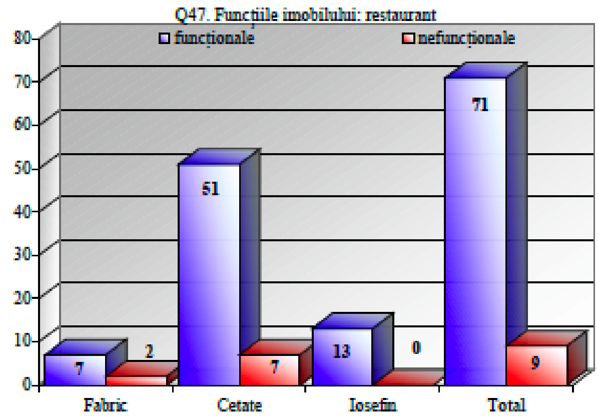


Figure 127 Restaurant function per neighbourhood

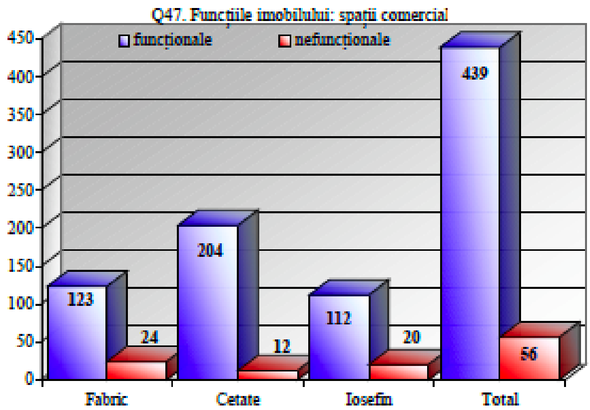


Figure 128 Commercial function per neighbourhood

The historical evolution of the city correspondingly confirms the function distribution, as the three most important areas Cetate, Iosefin and Fabric contain the biggest number of historical building of cultural importance and the highest number of elements determinant for the definition of urban form importance (main urban poles and centers of interest).

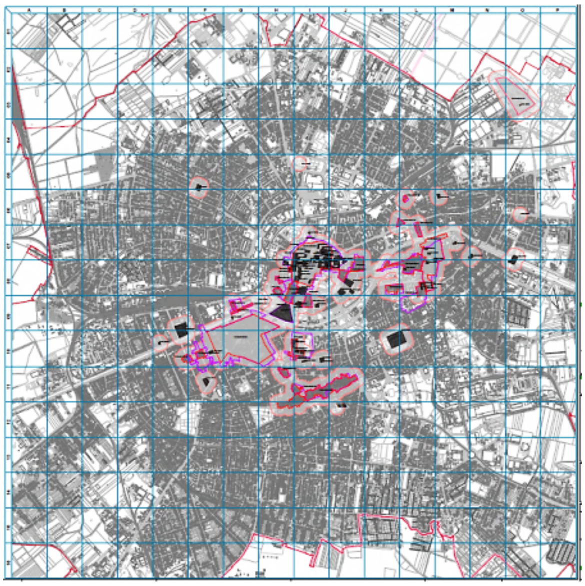


Figure 129 Cultural heritage of Timisoara

Figure 130 Urban silhouette of Timisoara

One's conclusion on the analysis above: city center is the beating heart of the city with the largest number of functions and activities, easy accessible and walkable.

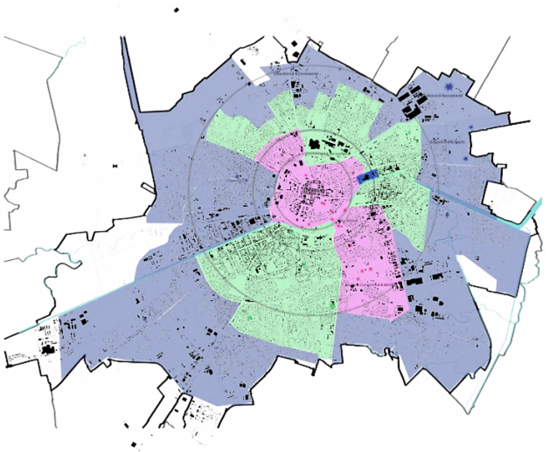


Figure 131 Functionality hierarchy in the city

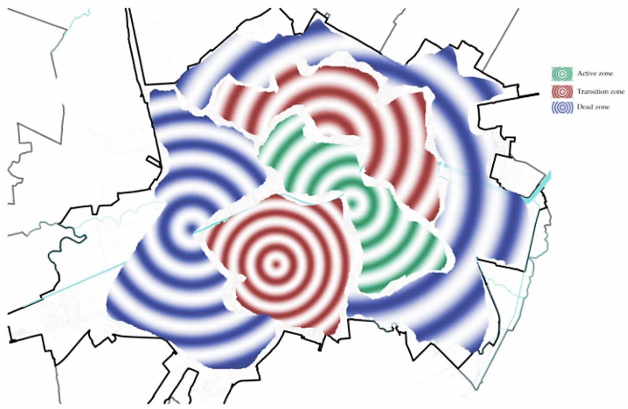


Figure 132 Dynamicity zones in terms of functionality


Figure 133 Children's Park along Bega in Cetate area


Figure 134 Agricultural Market in Fabric

Figure 135 Timisoara North Station in Iosefin


Figure 136 City center with shops, restaurants & theatre

At present the ancient fortification – Cetate – is like a HUB of the city and the North South axis is the leading element in city functionality definition. The new project will break the pattern; creating new North –South and East – West lines of importance hinged in a new HUB area: Fabric ex-industrial neighborhood.

III.2.5 Urban voids layer

The public spaces are the social and economic interaction places. Places that define the hospitability of a city, its safety and its cosmopolitanism.

Until now, one can see that the connection between the spatial framework and individual activities encounters some difficulties. The public squares, as the green spots (like gardens and parks) are quite numerous and well enough spread around the two most important zones of interaction of the city, but the links between them lack fluidity and quality. The urban elements that support life aren't only the individual places distributed here and there; the environment should play a decisive role in constructing a sustainable and liveable city.

All around the world, the industrialization and growth in population lead to a rapid increase in demand for space, thus to dense grid layouts; open and public spaces were reduced to minimum and hygiene requirements virtually ignored. Lately, the values of open spaces and recreational functions became obvious. Ideal image of country side gave rise to “garden cities” (see London); the slogan “air, light and sun” became the proclamation of urban planners and architects of 1920’s. In 1933 the Athens Charter, was one attempt to solve the problem by demanding generous open areas for citizens, strengthening of individual functions and increase in order in the system and it formed the basis for urban planning objectives.

Timisoara, at the beginning of its development was a “garden city”. The grey period of industrialization and the political regime were not able to diminish this aspect. Thou, they had an influence on the character of other public spaces: streets and their influence on the private - public relationship.

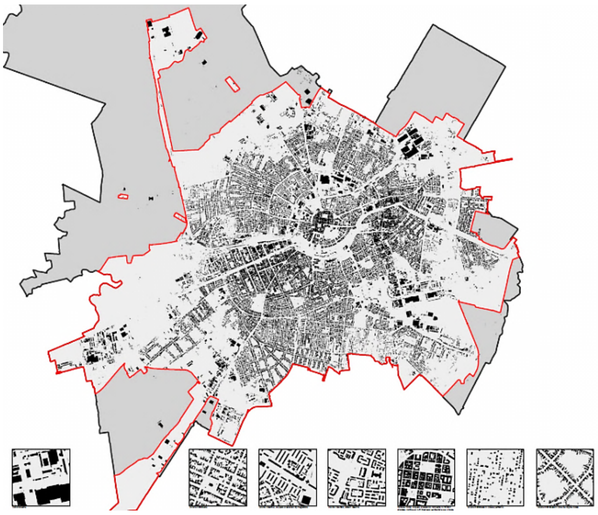


Figure 137 Solid Void Map of Timisoara

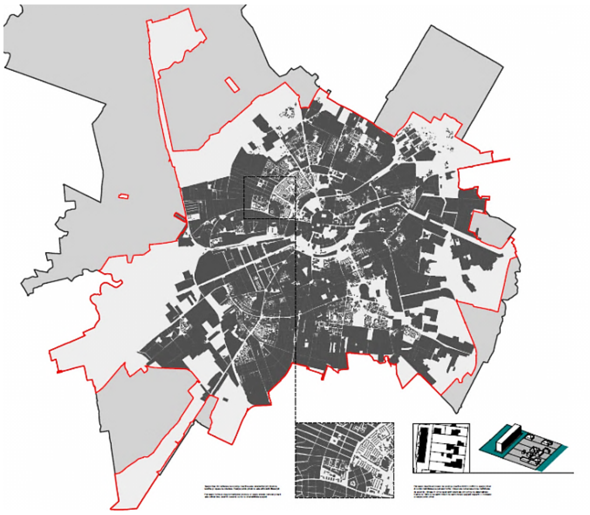


Figure 138 Public/ private space accessibility map

The parks belt along Bega and the main boulevards represent an important percentage of the open spaces across the city. In terms of the accessibility the city is more based on the compact parcels with an evident delimitation between public and private space, continuous street level, and low transition gradient from public to private. The risk of this organization is the creation of mono-functional quarters with low social coagulation degree. The other open parcels structure offers an easily accessible public space for use of the entire community and with a lower degree of street definition. It is a fluid space with high flexibility in its final use.

Figure 139 Urban leisure places

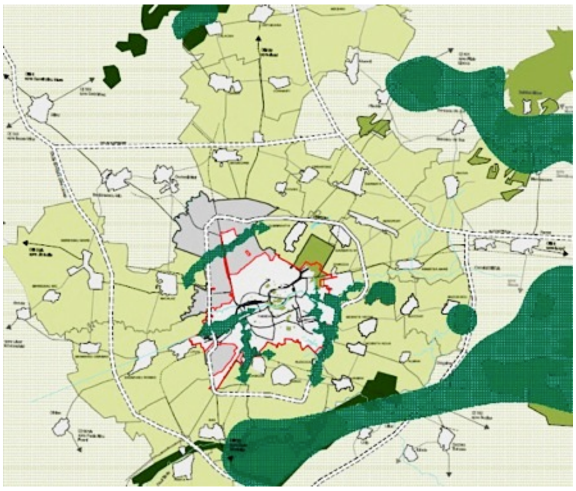


Figure 140 Metropolitain leisure places

The concentration of green spaces used basically for leisure activities is high both at urban and metropolitan level. Their connection is not well defined in terms of alternative modes of transportation except the private cars. Also, as seen in the second chapter Timisoara's evaluation as a Smart City shown a good quality of green spaces, being classified fourth out of 70 cities. The average rate of green space per capita is of 16.09m^2.

Quality of urban space is based on an oscillatory equilibrium between spontaneity and regularity, on a combination between public control and private initiative and it can result in a success or in an error, stimulating or paralyzing.

Today, one goes back to the Aristotelic concept of integrated environment: city as instrument to reach the perfection of humans ('social animals") existence. Thus, the public open space is fundamental in creating a new city for the future.

Figure 141 Urban and metropolitan voids map

Figure 142 Schematic representation of voids map

The conclusion is to transfer the accent from the existing steady green (the oasis) to the moving green. The new connection between these oasis and the metropolitan green areas via bike paths, roller path and walkable trails, defined by pockets of activities: children playground, sports ground, fitness ground, picnic areas, coffee shops etc.

It is the time to move from Webber's characterization of urban place from 1964: "…connection between community and propinquity: the urban place was being replaced by the nonplace urban realm".

Figure 143 Street green

Figure 144 City square and green parcels

Figure 145 Playground area

Figure 146 Rose park

Figure 147 Street 3 August 1919 - Tram station

Figure 148 City square in Fabric


Figure 149 Neighbourhood green and street


Figure 150 Path along Bega

III.2.6 Urban volumes layer

Generally the urban volumes are shaped by the other three layers discussed previously. Timisoara was a closed city (the fortress) that became an open city at the beginning of the XIXth century but still with closed structures. The volumes were aligned along the main boulevards gaining their importance function of the importance of the road and enclosing open space accessible in a restricted manner.

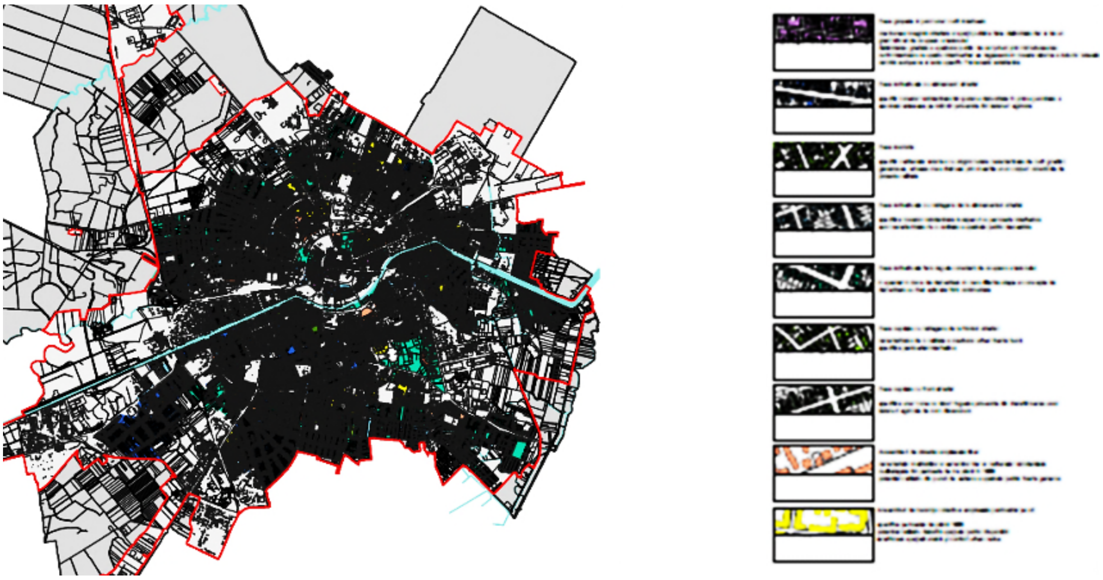


Figure 151 Parcels occupation map

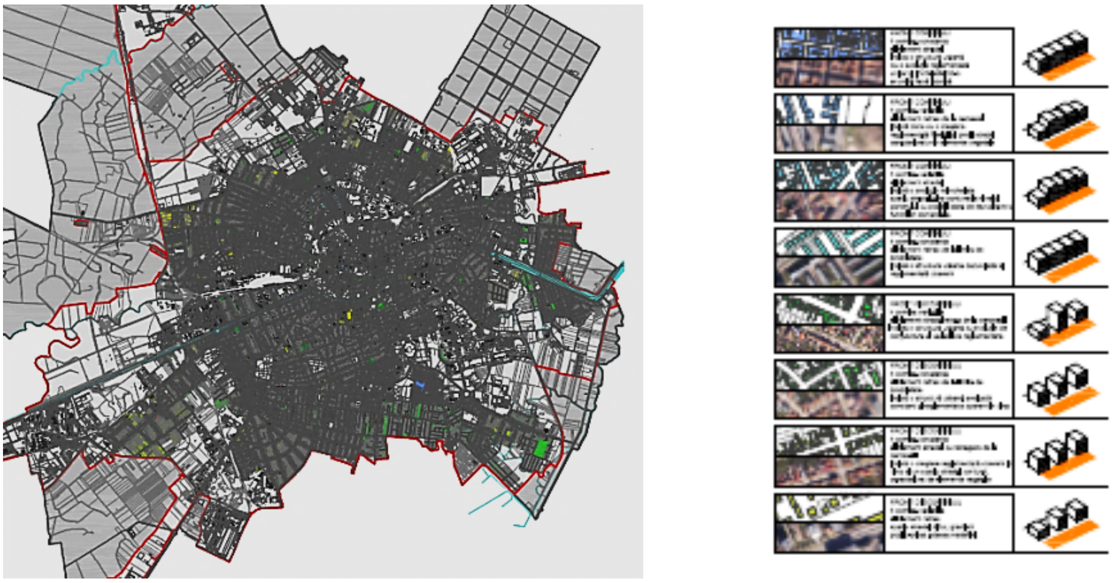


Figure 152 Alignment to the street map

As seen above the volumes have the tendency to cut the fluidity of the voids or at least to restrict it to follow certain patterns. The dialog between the public voids and the private open spaces is decided by the volumes and their permeability; in this way also diminishing the porosity and diversity of the city.

In terms of density of the volumes (built up spaces), the highest coefficient of land use is in the city historical nuclei of evolution. Urban blocks are strictly related to the evolution pattern of Timisoara.

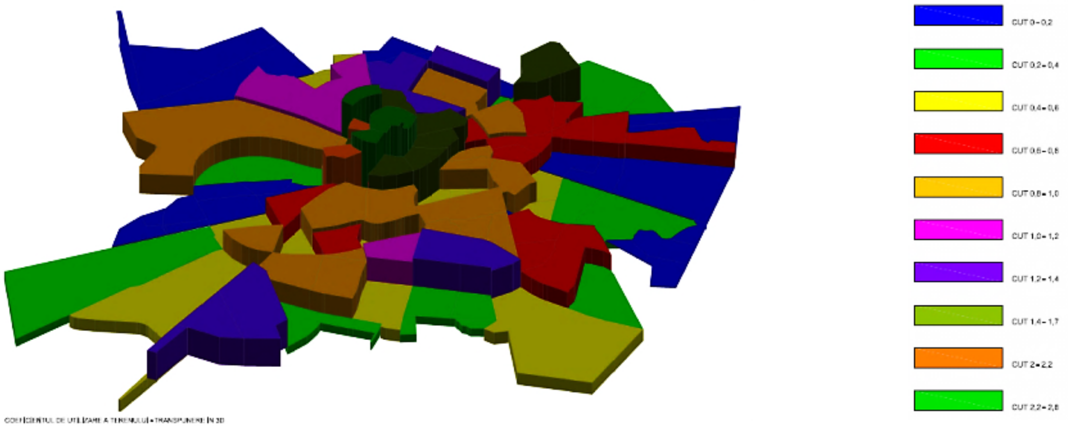


Figure 153 3D map of the distribution of coefficient of land use

Still, the continuity of the buildings facades can be a positive aspect if the street level is used for public purposes as the town space was used during medieval time: ground floor for work and commercial activity, the upper floors for living. In this way an interesting symbiosis can be done between the volumes and the voids running along, creating a ''win-win" situation for all involved parts.

The volumes belonging to the historical areas defined the skyline of the city – predominant horizontal; 2 story buildings being the most common – encountering anomalies (10 floors residential buildings) in the residential neighborhoods built during socialism and some of the new office buildings.

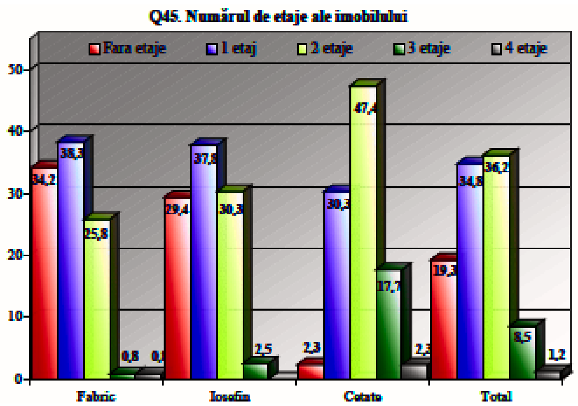


Figure 154 Distribution of building floors in historical city


Figure 155 City scape - Revolution Boulevard

The final conclusion of the analysis is schematically represented below showing the volumes distribution function of the historical evolution and the porosity.

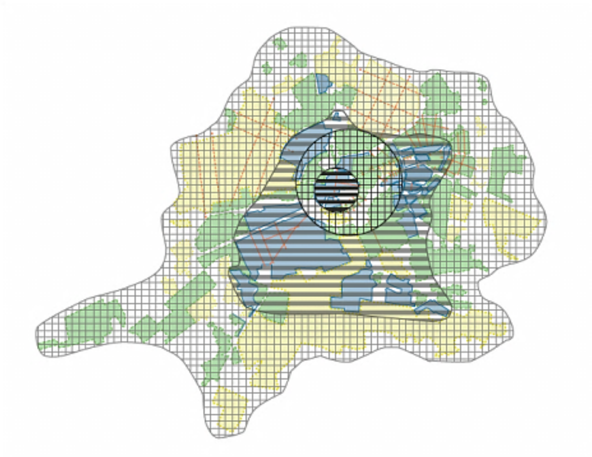


Figure 156 Volumes map function of pattern evolution

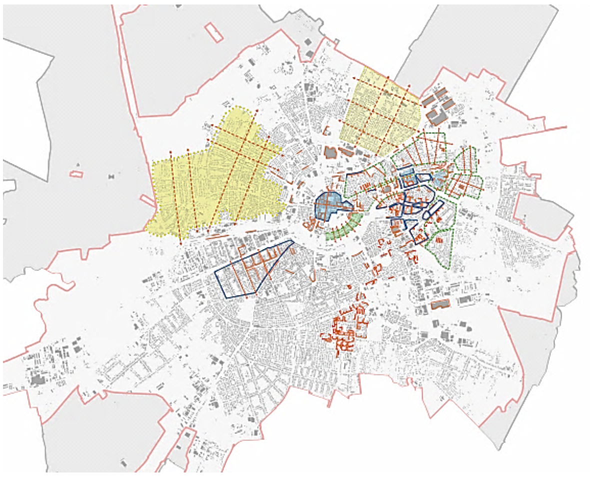


Figure 157 Volumes map function of porosity of the city


Figure 158 Historical urban blocks in Cetate


Figure 159 Historical urban blocks in Fabric


Figure 160 New urban blocks


Figure 161 New urban blocks

III.2.7 Urban points of interest

Going over the four urban layers and analyzing their good and bad aspects, one can indicate the layer that will be the catalyst in the city regeneration and transformation. The transport layer is the most critical one and needs the biggest conversion considering also the sustainability approach. The layer is going hand in hand with the voids and functionality layers which end up defining and reshaping the volumes appearance and importance in the city allure and life.

In the next stage the layers are combined two by two or three by three or even all together and the exploration is jumping from local to global scale, back and forward to see how the approach of the sustainable neighborhood can influence city design or building design.

To be able to perform the procedure accordingly, the intermediate scale is defined. In the transportation layer the interchange HUBs will play an important role. They will create the new hierarchy in the transport network providing accessibility to all of them and facilities for all of them. The area under study and its surroundings are examined for seeing the feasibility of roads junction points of interest, with big capacity to become HUB points.

Figure 162 City and future project area

Figure 163 Points of interest in the study area

The points of interest run along North-South axis located as follows: East Train Station, NE corner of the project area and inside Fabric neighborhood.

Considering an encompassing zone around the project area, two more points of interest are located; one at the intersection with Cetate district and the other at the junction of the main EW axis with the third ring road – good place for defining the park and ride station.

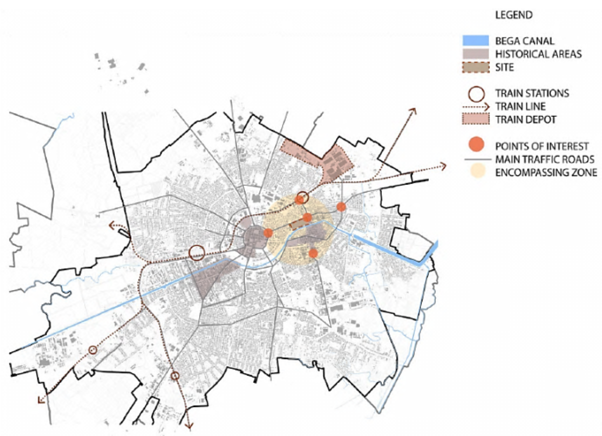


Figure 164 Points of interest on E-W axis

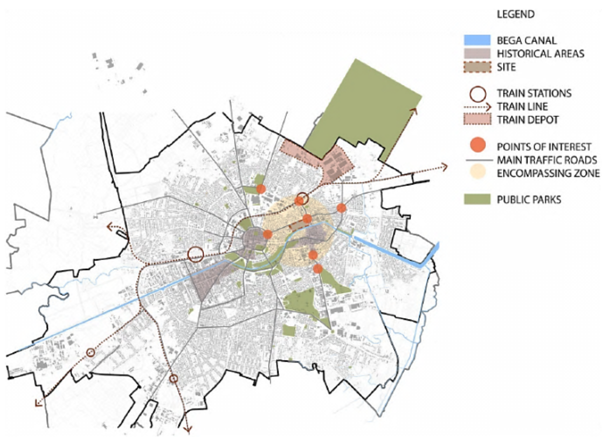


Figure 165 Points of interest considering green spaces

Observing the green spaces in the area of interest, additional points can be defined. Connecting all the points, one comes to the definition of the intermediate scale.

Figure 166 Intermediate level map: District area inside the city scale and including the site scale

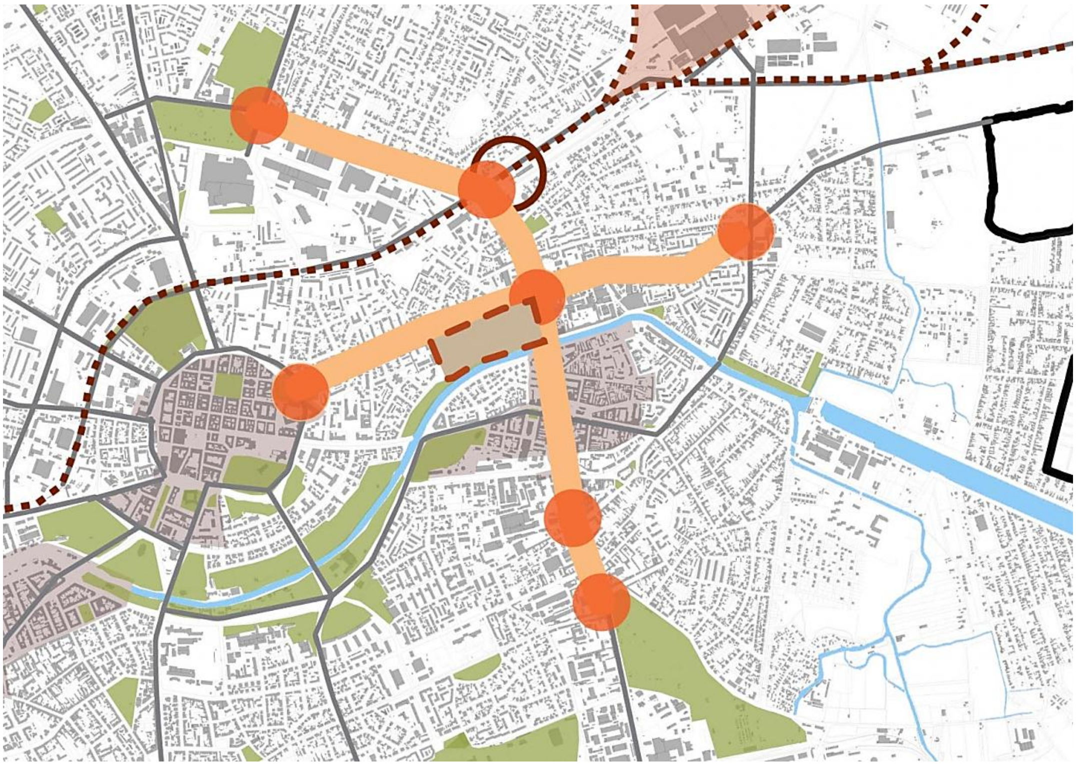


Figure 167 District and site scale after the analysis of future strategic interchange points

As previously mentioned the transportation layer plays the catalyst role in the metamorphosis of the city. The mobility is important for the city functioning, thus the first direction to be followed is a new type of mobility: the moving green or sustainable urban mobility.

The XVIIIth century Western Culture model, based on Descartes' anthropocentric perspective (Man an agent equipped with autonomous reason), adhered to the belief in progress consisting in development of new technologies as means of constantly improving the quality of life.

In the XXth century, the philosopher Rudolf Steiner introduced the concept of anthroposophy (Nature of human being) in which the spiritual research should be evaluated at same basis as results of natural science. The movement encouraged the reorientation to harmony between man and nature. Its expression in architecture was under organic, self – sustaining ecology prototypes – examples of sustainable architecture.

Considering the "back to nature" approach and the necessity of mobility, as well as development of new eco technologies, the project will be developed following the parameters of sustainable urban mobility.

What makes SUM so attractive can be understand only comparing it with the traditional transportation:

Table 4 Traditional vs Sustainable Trnasportation

Traditional Transport Plan	Sustainable Urban Mobility Plan
Short term vision	Long term strategic vision (20-30 years)
Focused on city	Cooperation of city with region
No consideration for sustainability	Balance between social equity, environment quality and economic development
Transport and infrastructure focus	Integration of policies into practice (environment,

	land use, social inclusion)
No cooperation between authorities levels	Strong cooperation between levels (district, municipality, agglomeration, region)
Focus on broad objectives	Focus on achievement of measurable targets and impacts
Historic emphasis on road schemes; infrastructure development	Decisive shift in favor of measures to encourage Public Transport, walking and cycling as well as quality of public space and land use

The strategies of SUMP are:

- Better quality of life: more attractive public spaces, improved safety and security, mixed land use planning
- Environmental and health benefits: improved air quality by reduction of greenhouse gases emission, less noise pollution
- Improved mobility and accessibility: reduce congestions, infrastructure for non-motorized modes, link regional development to the city, efficiency of Public Transport
- Improved city image

In the Smart cities evaluation, Timisoara scored a good result at smart Green chapter with a high resource of green spaces, parks, street trees alignments, and green surface per capita in general and registered a poor result at smart Transport, thus the idea to develop the smart mobility under the name of Moving Green. A city that lacks a SUMP management offers a high possibility to be reshaped starting with the big scale and going in depth up to building horizontal and vertical movement scale.

Figure 168 Timisoara Moving Green Concept

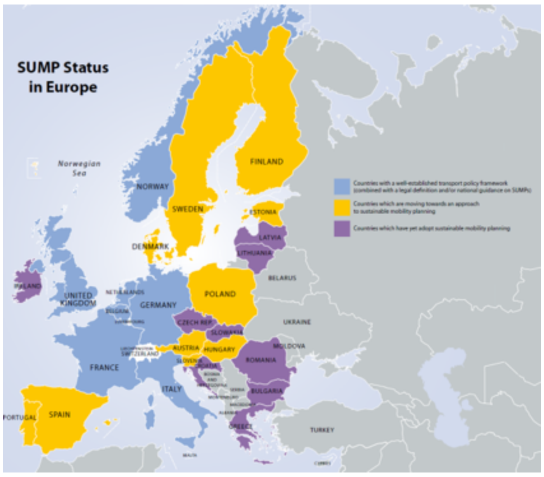


Figure 169 EU Statistic on SUMP status in Europe

Facing the challenge of managing urban mobility and consolidating a public space model that is diverse, compact, efficient and that provides social cohesion led to develop a Sustainable Mobility Plan, which integrates different mobility networks in private vehicles, and public transport, and by bicycle or on foot, and their interconnections. It includes aspects linked to mobility, such as the use of public space, noise, atmospheric emissions and energy consumption.

To initiate a debate on sustainable mobility one has to grasp the fact that urban mobility is one of the basic policy variables designed to fight climate change. A model of sustainable mobility would limit the emissions of traffic-generated gases into the atmosphere and, at the same time, resolve some problems associated with traffic (noise, occupation of space, energy consumption, etc.).

The economic crisis across the Globe also made the cities look with different eyes at the urban development. The enormous economic shock made them to reassess their economic priorities and recognising that unbalanced growth makes an area extremely vulnerable to external global forces such as recession. The new mantra is now “resilience” not growth – a less heroic but ultimately a more balanced and sustainable future, one might argue.

The implementation strategy plan for the Timisoara SUMP is going to be developed in 3 Steps: City, District, Block scales; each containing several phases. The priority to be followed for each step - Immediate term: Reorganization of private car traffic; Short-medium term: Improving the quality of public space; long term: New car park and freight distribution infrastructure.

For better functioning of the city from car traffic point of view, one looked at the global scale for a solution in terms of ring roads. There are examples all around the world where the ring road approach made the city more fluid and much easier to be crossed: Barcelona and its Ronda De Dalt or the very impressive ring road project in Jaipur, Munich “City Balcony” or Lahore grandiose developments.

Figure 170 Ronda de Dalt, Barcelona

Figure 171 Jaipur Ring Road Development

Figure 172 Munich Ring Road

Figure 173 Lahore Road Developments

Timisoara, since the beginning of its modern development of XVIIIth century looked at the radial concentric approach. The first ring road was the old fortress walls. Nowadays the ring roads are incomplete and not used at their proper capacity. The solution one analysed comprises 3 proposals in order to better understand the mobility mechanisms and sustainability advantages.
As an urban thoroughfare it will interconnect major city districts thereby acting as a principal relief road for inner city neighbourhoods and residential areas. For companies the circular ring road can become a

coveted business location and one of the city's top addresses. However, for residential area next to the circular ring road cutting through entire neighbourhoods to avoid the major nuisance, open and green spaces oasis should be considered in a stage of more detailed design.
Proposal one goes with more or less the concentric ring roads with very little connection among them and with the city street network. The city historical centre – Cetate – will be in general pedestrian, except for the eco tram line crossing it, thus the function of the first ring road will be only pedestrian and for bicycle use. Ring 2 and 3 will carry the domestic and the public transport, as well as allowing a penetration of transport from metropolitan area, while Ring 4 will be used only for heavy traffic. It should be considered a very well developed traffic management system as well as for the future a tax system for the cars accessing ring 2.

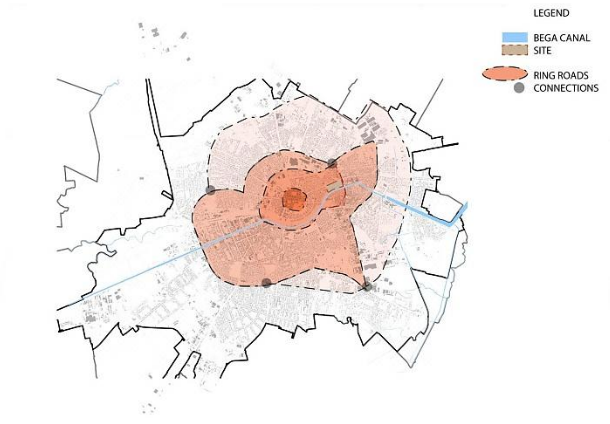


Figure 174 Ring Road Proposal 1

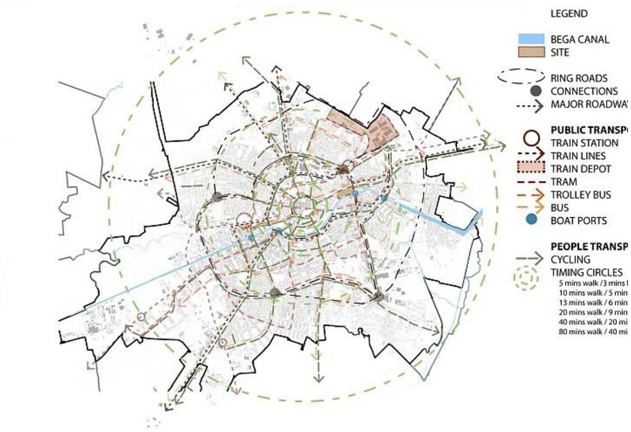


Figure 175 RR Proposal 1: Networks & Connections

Considering this configuration the traffic will be distributed evenly in the four cardinal directions, lightening up the actual heavy WE axis. The “Moving Green” network will wrap around the city in a balanced way and such that to provide a good linkage with the leisure areas surrounding Timisoara.

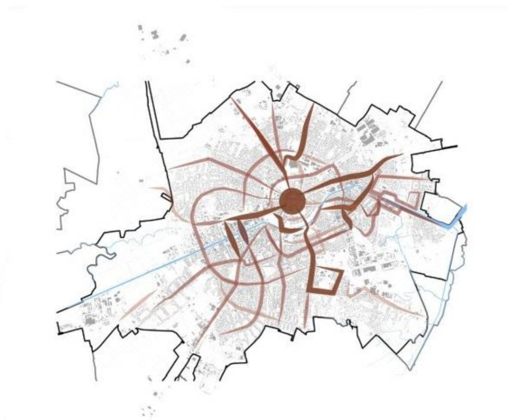


Figure 176 Weighted traffic

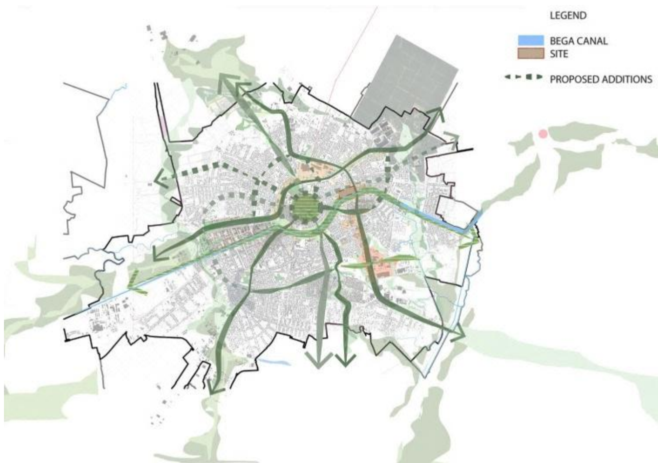


Figure 177 Green network

Global proposal 2 adopts the broken ring roads approach and is looking in introducing a green belt around the city to avoid sprawl and noise pollution from the heavy traffic located at the exterior of the city.

Figure 178 Ring Roads Proposal 2

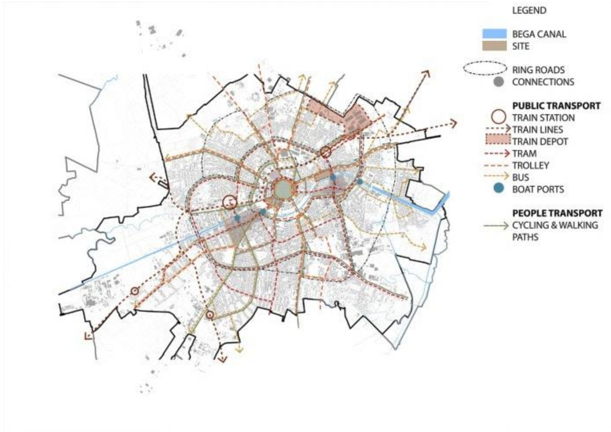


Figure 179 RR Proposal 2: Networks & Connections

This solution provides step by step shift from a car based culture to a more sustainable public transport oriented one. The final result shows a lighter traffic all around the city and a very strong connection to the green outskirts.

Figure 180 Weighted traffic

Figure 181 City and the Green Belt

Proposal 3, considered the most optimum solution for the study, looks at a mixed method: the first two rings being closed and only for domestic circulation, the outside two for penetration and heavy traffic. The city centre road will be used for pedestrian and bicycles only having no connections with the other rings. Ring two has two interchange points with ring 3, which has two discontinuities that allow the connection of city districts. The heavy traffic ring has several break ups that allow for the heavy traffic not only transit the city but also to penetrate through.

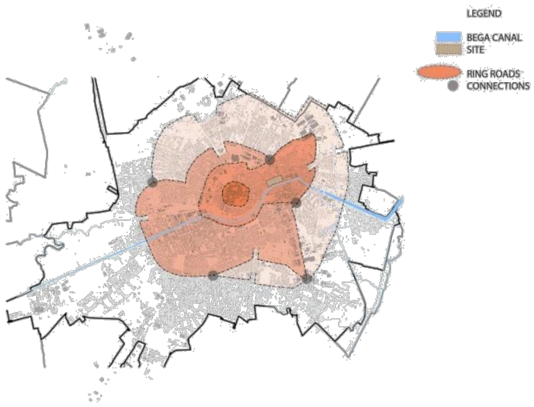


Figure 182 Ring Road Proposal 3

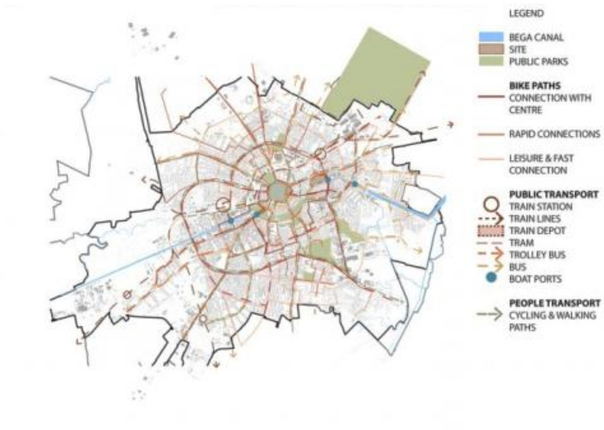


Figure 183 RR Proposal 3: Networks & Connections

The outskirts of the city will allow the development of the green belt – the eco-leisure ring road that will function also as a barrier for the city to sprawl and for the noisy environment attenuation.

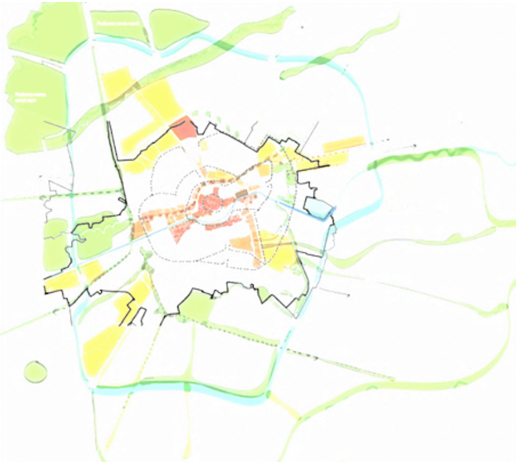


Figure 184 Green Belt and leisure areas

Figure 185 Moving green in case 3

The last solution, considered the most feasible, was analysed also from parking capacity point of view. The new sustainable city concept that shoots for a city without cars should provide good public transport together with secure and accessible parking points well connected with the interchange transport HUBs. The transport study already done for the city hall provides several strategic park and rides, to which one added several more nodes function of the ring roads “metabolism”.

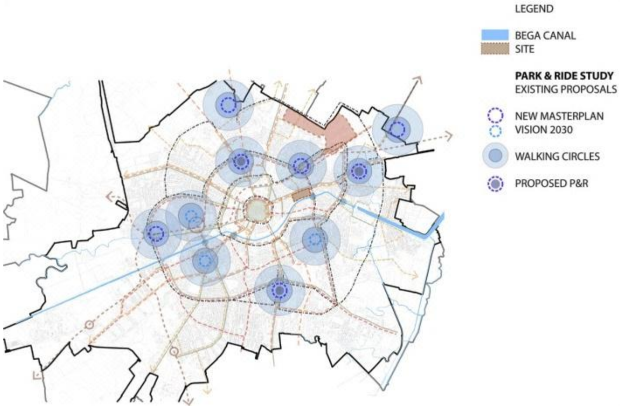


Figure 186 Park & Ride for Proposal 3

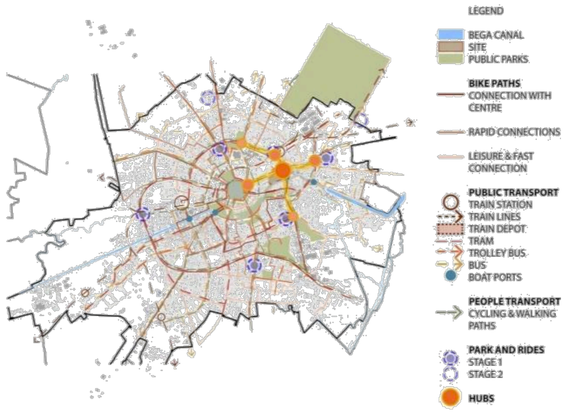


Figure 187 Final proposal looking towards district scale

The positioning of the park and ride stations are close to railway stations or discontinuity points in the ring roads, and connection with the most important public transportations means. This is the time when the jump is done to the district scale. The interchange points at neighbourhood scale are analysed function of the walkability and accessibility to public transportation and important functions in the district. In all three proposals the analysis was done at district level and the HUBs were established following a hierarchy of importance and PT means passing through within different walkable zones (10 minutes, 20 minutes and 30 minutes).


Figure 188 Proposal 1 HUB hierarchy definition


Figure 189 RR Proposal 1 HUB definition district scale

Figure 190 RR Proposal 3 HUB definition district scale

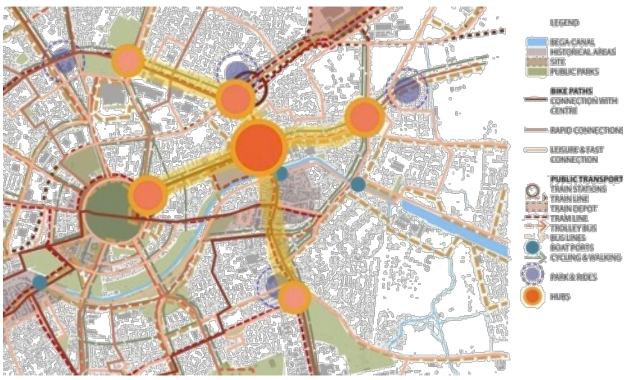


Figure 191 RR Proposal 3 HUB definition district scale

The site scale is becoming relevant as it can be seen from the district proposals of HUBs hierarchy. The most important interchange point is situated in the NE corner of the study site. How the city would be shaped starting from this small scale in terms of sustainable transportation and sustainable neighbourhood or city block is analysed in the following steps. The initial step will be to look on how the street section would be changed such that to allow the development of either previously mentioned entities or systems, as one considered them in the CAS approach at the beginning of the chapter.

Moving green as a practical solution attempts to create a sensation that the green existing network moves around the city. It is possible in the first instance by creating pedestrian friendly streets: efficient PT, trees and porticoes alignments such that to allow a pleasant shadowed journey, effervescent commercial and leisure activity at the ground floor of the buildings aligned with the most important roads. The streets should be safe and enjoyable by both pedestrians and cyclers, in this scope a division of the walk/bike lines would be implemented in the future street section configuration.

As the change is very difficult to be implemented instantly all around the city, one considered the district level and later one how it influences the urban block level.

Figure 192 Moving green - Street configuration District Level

The streets running NW and NE of site are in general congested but at the same time have a very important role from historical and connection point of view. It is not possible to look at these boulevards and not considering the SUMP approach.

Take Ionescu Boulevard or the NW axis present a large cross-section – 3lanes for each direction – and it is the artery that takes the densest amount of the penetration traffic from outskirts area.

Figure 193 Take Ionescu Blvd Current and Proposed

The proposal is to remove the cars from one lane for each direction and introducing on it the Bus Rapid Transit system as in Curitiba, Brazil or Bogota, Colombia. Keep the green strip in the middle and increase the vegetation on it with trees planting. Widen the sidewalk and divide it in three sectors: pedestrian, green and bicycles.

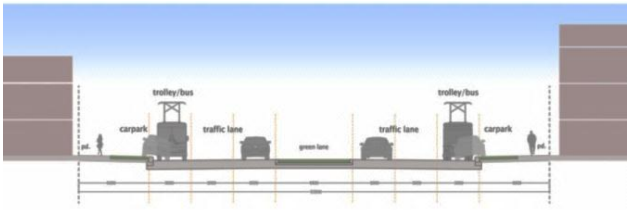


Figure 194 Take Ionescu Blvd existing (section 2B)

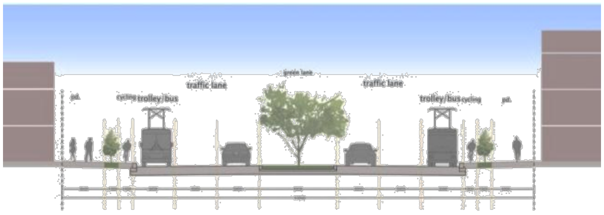


Figure 195 Take Ionescu Blvd proposed

The BRT system introduction in the earlier mentioned cities was a big step towards sustainable transportation and sustainable city as it is regarded as the safer, more efficient and more environmentally friendly public transport. BRT is a collective term for highly efficient bus-based transit systems for cities. It involves separate lanes for buses, high-frequency service, efficient ticket systems, and buses capable of carrying many passengers and bus stops with a high passenger capacity where it is simple and quick to get on or off a bus. It is comparable with rail-operated traffic in terms of travel time, service frequency, punctuality and capacity. But the investment cost is as low as 5% of what is needed for a subway system.

A BRT system contributes to both safer and more environmentally friendly traffic. The designation of separate bus lanes reduces the degree of risk that exists when buses and other vehicles, as well as pedestrians, are forced to coexist in dense city traffic.

The BRT solution also benefits air quality in cities. Emissions are reduced through the use of larger but fewer and more modern buses – hybrid models. Thanks to the separate bus lanes, the buses do not need to stop and accelerate so often, which also makes a positive contribution to lower fuel consumption and, consequently, lower emissions.

Figure 196 Bogota TransMilenio BRT system

Figure 197 Curitiba Hybrid bus for BRT

The initial stage will comprise the segment that connects the city centre with the international airport with a future extension around the city via also ring roads development.

As for the non - motorised transportation – bicycles – the actual situation as presented in the transportation layer section is poor. The bike lanes "eat" part of the sidewalk, have brusque interruption and have only a 19km length. For a sustainable city, this type of locomotion would be more than recommended, considering also the statistics and encouraging campaigns at the European level.

Figure 198 Campaign for cycling encouragement and mixed use developments

Non - governmental initiatives and local authorities' events already developed citizen taste for free non pollution movement. All that is missing is a strong and comfortable infrastructure and network.

Figure 199 Bikers march October 2009

Figure 200 Green light for Timısoara tour 2011

Figure 201 Skirt Bike : Girls on Bicycles 2012

Figure 202 Discover Timisoara on two wheels 2011

Fig…Skirt Bike: Girls on Bicycles 2012

Fig…Discover Timisoara on two wheels 2011

Badea Cartan Market area presents a street with a cross-section that varies changing at least four times. Being an area of intense human activity but at the same time at the intersection of two main roads, confronts almost daily the "tyranny of the car". The decision in one's design is to transform the area in a pedestrian market area, keeping only the tram lines. The transition will be done gradually, in steps such that to allow a redistribution of cars in parking areas situated in the nearest park and ride points to be developed and to reinforce the public transport at a point to be most rapid and feasible.


Figure 203 Badea Cartan Market area actual view


Figure 204 Perspective

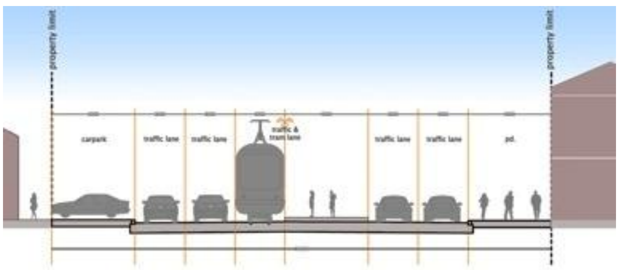


Figure 205 Badea Cartan Market existing

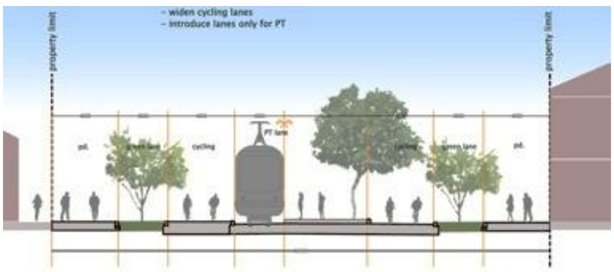


Figure 206 Badea Cartan Market proposed stage 2

The tram was the factor that enhanced the development of Timisoara and gave to it the modern European allure. It is the most ecological transportation mode and in Timisoara has the highest potential in passengers' transportation. No wonder one opted for making this locomotion mode the pulse of the future NS green axis of sustainable developments in Fabric area. Looking at important examples all over Europe, grass lined or paved tramways are silent, non - pollutant and very flexible transport, with a tendency to be used areas designed mainly for pedestrians. Even around the world the new developments are looking at implementing the Rapid Transit Lines having the trams as the principal key.

Figure 207 Barcelona Grass lined Tramway

Figure 208 Strasbourg pavement lined tramway

Figure 209 Gold Coast Rapid Transit line

Figure 210 Waterloo Region Rapid Transit 2017

A study for the Passenger Transport Executive Group (PTEG) found that light rail has generated levels of modal shift from road that bus upgrade schemes rarely match. Typically about 20 per cent of peak hour passengers using British tram systems previously travelled by car.

Regarding the SE and SW axis of the district, this oscillates around the studied site; the approach was more people oriented that transportation modes oriented. The decision for the canal axis was to remove completely the traffic creating mainly esplanades and organically shaped pathways.

Figure 211 Splaiul Prot Draghici actual view and perspective

Figure 212 Splai Protop Draghici exiting

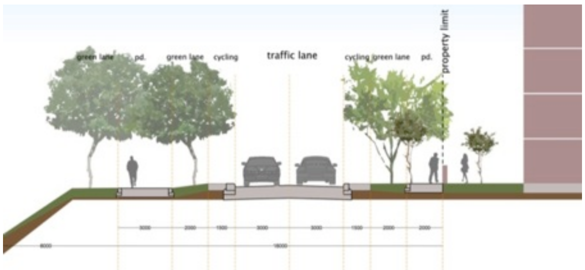


Figure 213 Splai Protop Draghici proposed

The great resource of green and blue that the canal frontage is offering reinforced the wish to develop a pedestrian oriented area. The major architects of nowadays look at the sustainable development of the city via these kind of green and leisure pockets of activities.

Figure 214 Slussen Development, Stockholm, Norman Foster

Figure 215 Perque de Ribera Bilbao

The street to the SW side of the study area is a border with the Police District Station, characterised by large number of chaotically parked cars and almost no safe accessibility for pedestrians. The proposed solution is to remove the parking permit and to introduce safe bicycle and pedestrian paths.

Figure 216 Street D. Gusti actual view and perspective

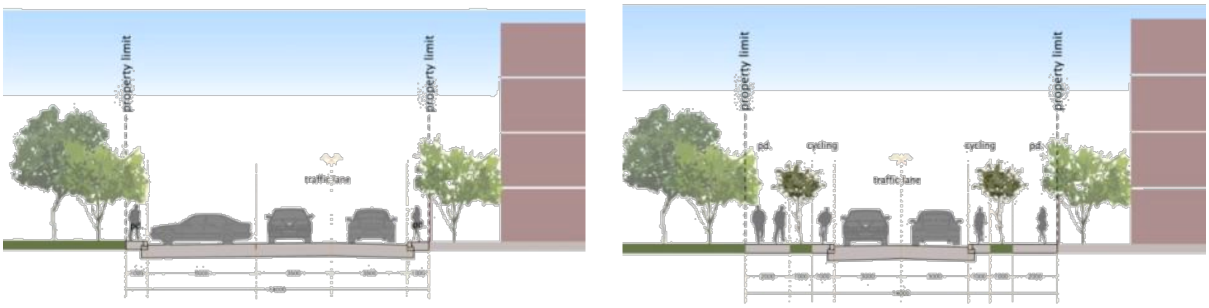


Figure 217 Street D Gusti existing and proposed

The proper rethinking and reorganisation of the city as per new principles and norms, do not take into consideration just design criteria or spatial arrangements. The energy scenario has key role in the future smart cities. Starting with the actual situation one should consider the energy projections for building, neighbourhood, city, and region, country and world eco functionality. Energy efficiency labelling, renewable energy sources, promotion of clean and efficient technology including carbon capture and storage.

How exactly the energy scenario is related to the urban redevelopment and why the transport layer should be the first one to “suffer” is analysed as follows.

It would be seen that the Region (Europe), Country (Romania) and city (Timisoara) analyses reveal quite same results and trends. Increase in energy consumption in the services and transport sector and a decrease in the domestic and industrial energy consumption; as slowly the mobility and the frenetic human activities and global consumption becomes more and more important for the economic wealth.

Energy consumption trends: by fuel and by sector**.** Outlook on European Energy Based on demographic and macroeconomic assumptions

FIGURE 54: FINAL ENERGY DEMAND BY FUEL TYPE

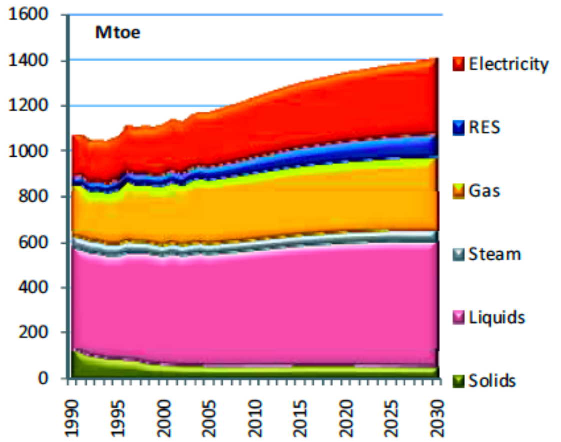
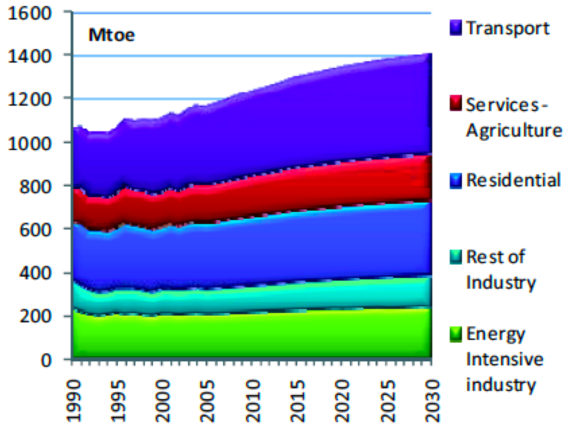


FIGURE 3: FINAL ENERGY DEMAND BY SECTOR



The baseline scenario indicates an increase of final energy demand by all sectors driven by economic growth. The transport sector displays the fastest increasing rate in energy consumption and slowest improvement of energy efficiency. The energy demand for industry remains important but it is driven by sustained activity and restructuring visions. While residential and services display the fastest improving energy efficiency due to improved thermal integrity and use of more efficient appliances.

FIGURE 21: ENERGY CONSUMPTION IN INDUSTRY

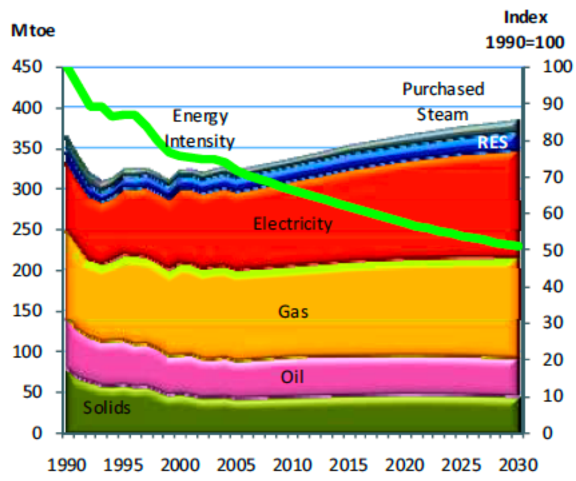
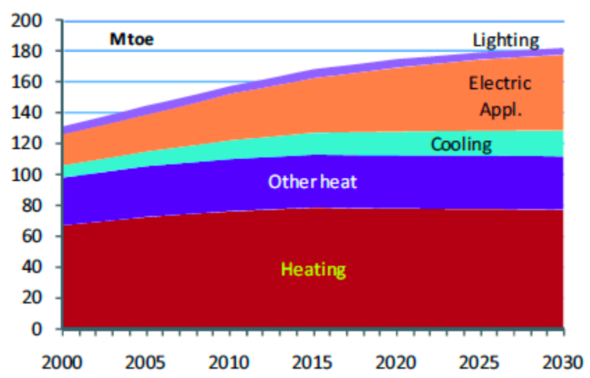


FIGURE 38: FINAL ENERGY CONSUMPTION IN SERVICES BY TYPE OF USE



With the enlargement of the EU economy, the industry started restructuration, seeking higher productivity and better quality with less energy consumption. Energy is an important input to industrial production and the progressively conversion and use by means of more advanced equipment led to steadily decreasing energy intensity of industrial activity.

The Service sector for the last 15 years was the fastest growing activity in the EU economy (specially the market services and trade). New services have emerged, such as leisure services, information technology and telecommunications, driving further the development of service sector. This trend had consequences for energy consumption: the energy needs per employee increased, the infrastructure larger and more energy demanding but also the energy efficiency is improving.

Figure 42: Energy Consumed by Use in Residential Sector

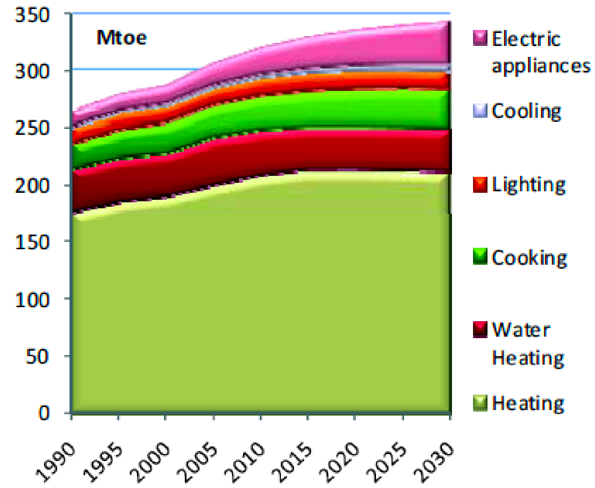
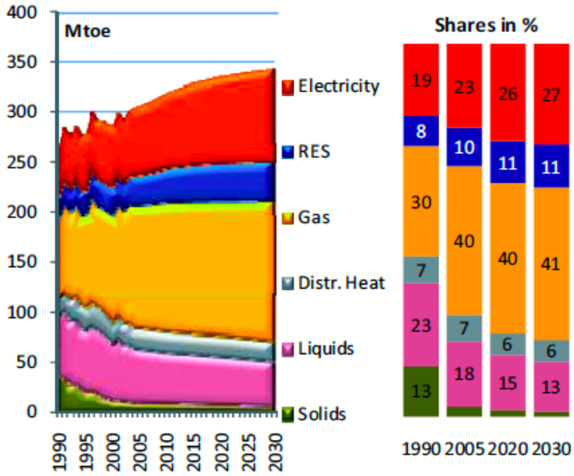


Figure 43: Energy Consumption in the Residential Sector



The residential sector requires energy especially for space conditioning (heating and cooling) as well as for cooking, water heating, and lighting and for electrical appliances. The consumption is shaped by the characteristic of energy using equipment and their efficiency. The biggest increase was registered in electricity consumption as per increasing use of electrical appliances.
Technological progress in energy efficiency and retrofitting of houses for energy purposes had an important impact on the energy consumption trend in the household sector. Statistical information shows that the average energy consumption per dwelling remained stable or even slightly declined; partially influenced by the increase of the average floor space per dwelling.

Figure 46: Energy Consumption in Road Transport by Vehicle Type

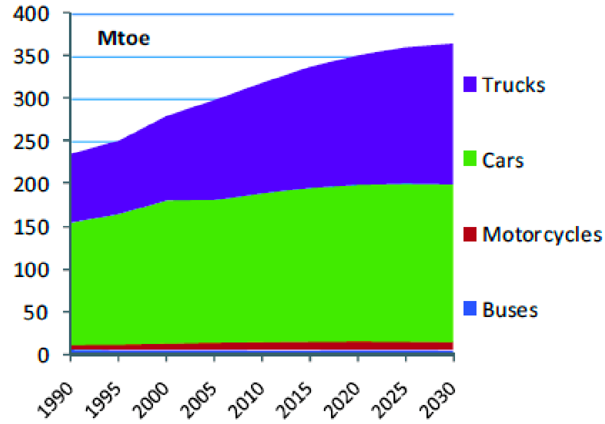
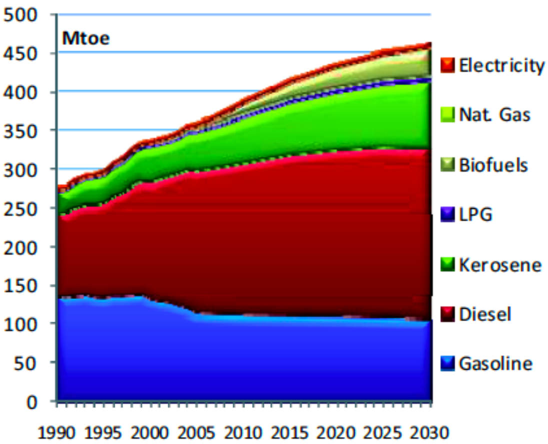


Figure 51: Energy Consumption in the Transport Sector



The transport sector proved in the last decade that is one of the most important sectors for the development of energy consumption and environmental emissions. High dependence on oil products is raising two concerns: security of fossil fuels with increased demand for transportation and concerns on climate change combined with long standing problem of congestion, noise and urban pollution. Latest analysis have shown that the significant increase was registered for freight traffic in comparison to the passengers one that was quite constant, and in terms of modes, the road transportation (cars) is still holding the first position, the constant one being the navigation and the loser the railway sector. Energy efficiency of cars improved at a quite slow pace; still the new trends look to a significant reduction in CO2 emission and introduction of alternative fuels.

Energy consumption trends: by fuel and by sector. Statistical values collected at the country level.

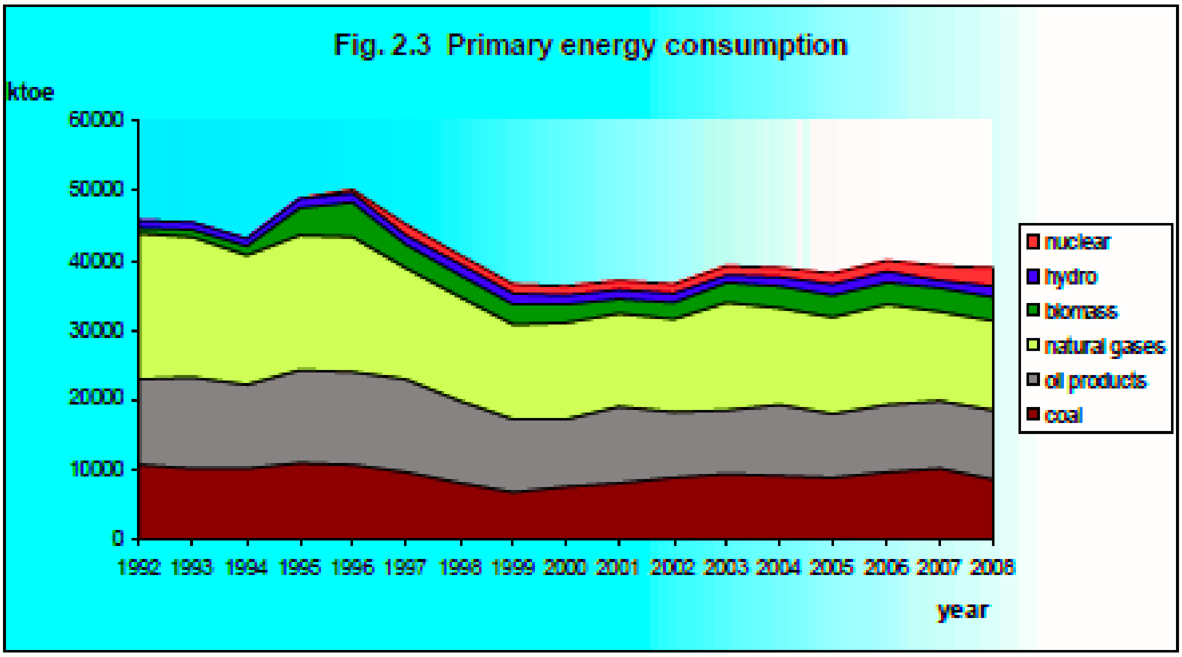


Fig. 2.3 Primary energy consumption

Year 2006 values: share in energy consumption by fuel
37% natural gases; non carbon energy – nuclear, hydro, wind, solar

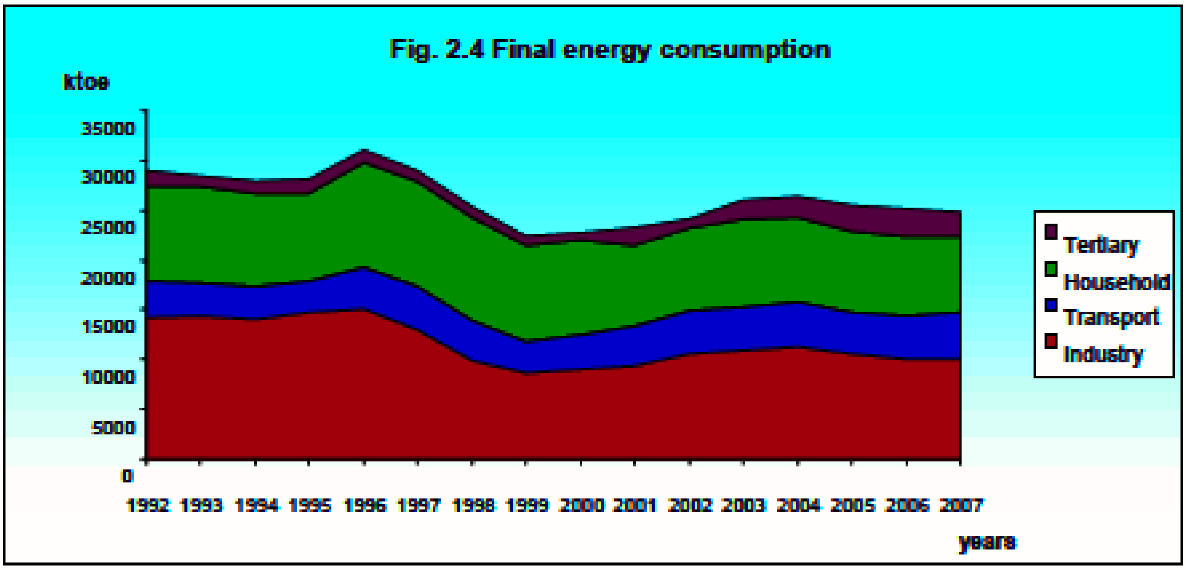


Fig. 2.4 Final energy consumption

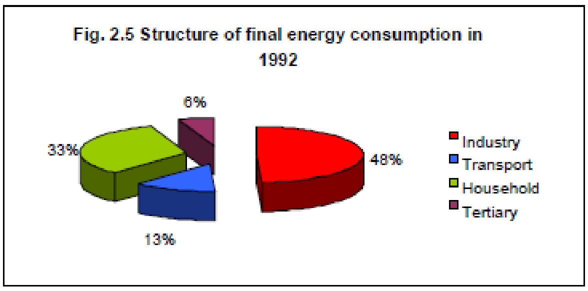


Fig. 2.5 Structure of final energy consumption in 1992

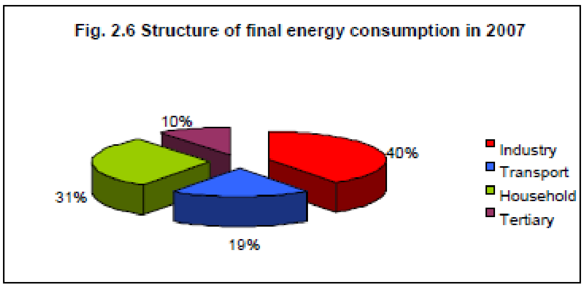


Fig. 2.6 Structure of final energy consumption in 2007

It can be seen that the evolution of the energy consumption changed from 1992 to 2007. The consumption in the industrial sector and population consumption registered a certain decrease, while the service sectro, a very dynamic one, increased its consumption.
Th European Union policies and directives imposed are following the trend of reduction of energy consumption by energy security; sustainable development and competitiveness.
Measures to be taken:

- Industry: efficient energy management; information campaigns; long terms voluntary agreements
- Transport: modernization of railway transport; public transport quality increase such that to be preponderantly used by people; increase traffic and parking efficiency; increase development of rail transport within urban transport; use of bio-fuels; pollution tax for motor vehicles
- Residential: rehabilitation of building envelope; increase efficiency of thermal installations and lighting; energy metering; use of renewable energy sources
- Public sector: increase efficiency and reduction in public lighting consumption and water supply installations consumption; green certificate improvement; support for utilisation of RES for producing heat and hot water for the use

As the industry branch is more or less influenced by economy trends, it was seen that in the centralized economy, the country economic development was based on industry development and big energy consumptions. The criteria of energy efficiency were not important. Passing to the market economy, many of the enterprises went bankrupt and encountered difficulties in management the resources and production which led to low energy intensity, reduced almost by 50% from 1992 to 2007.
Still it is believed that at national level this sector presents a capacity of 30%-40% energy saving via sustainable economic development, which means economic growth without increasing energy resources consumption.

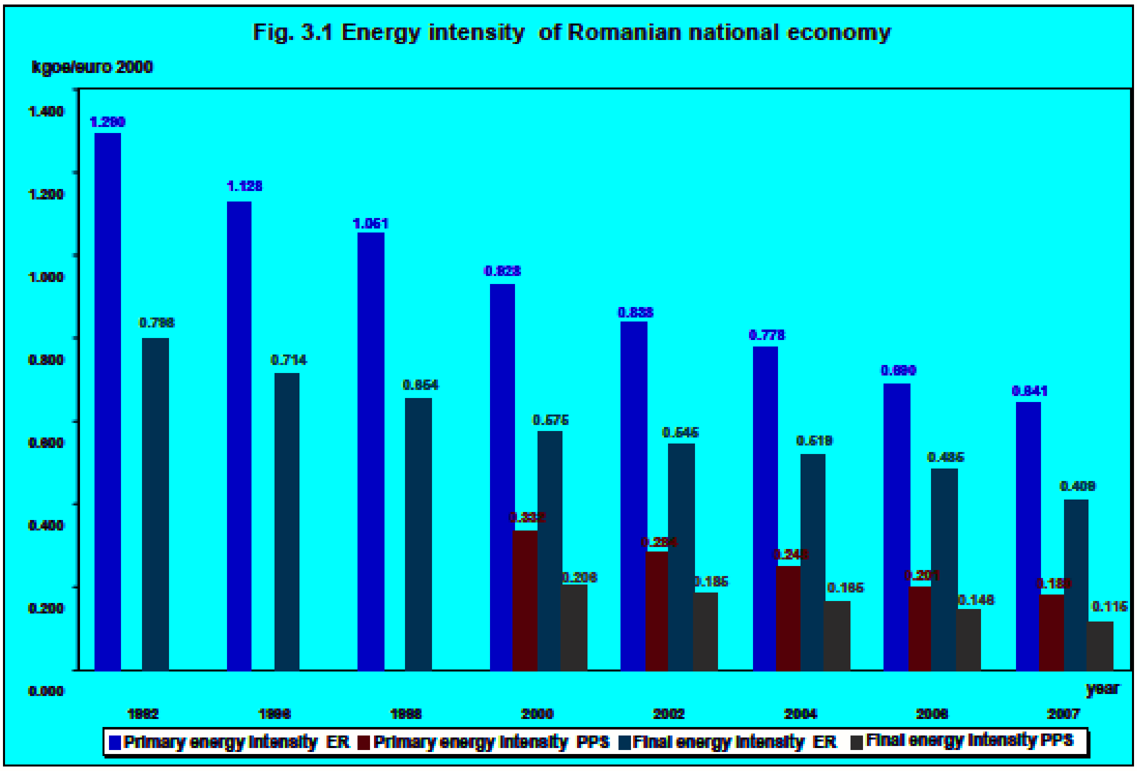
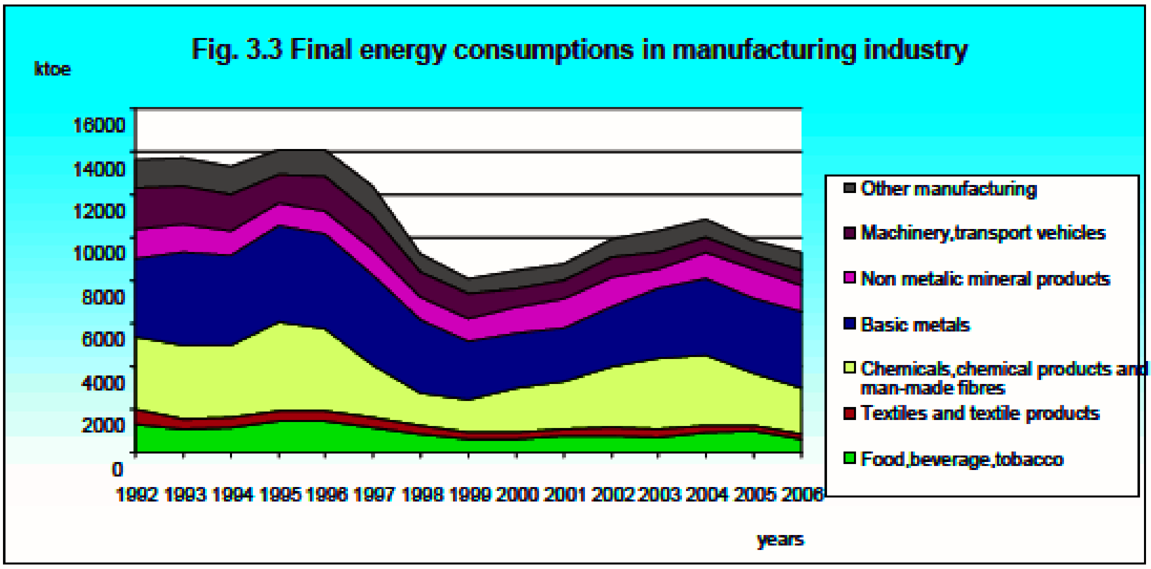
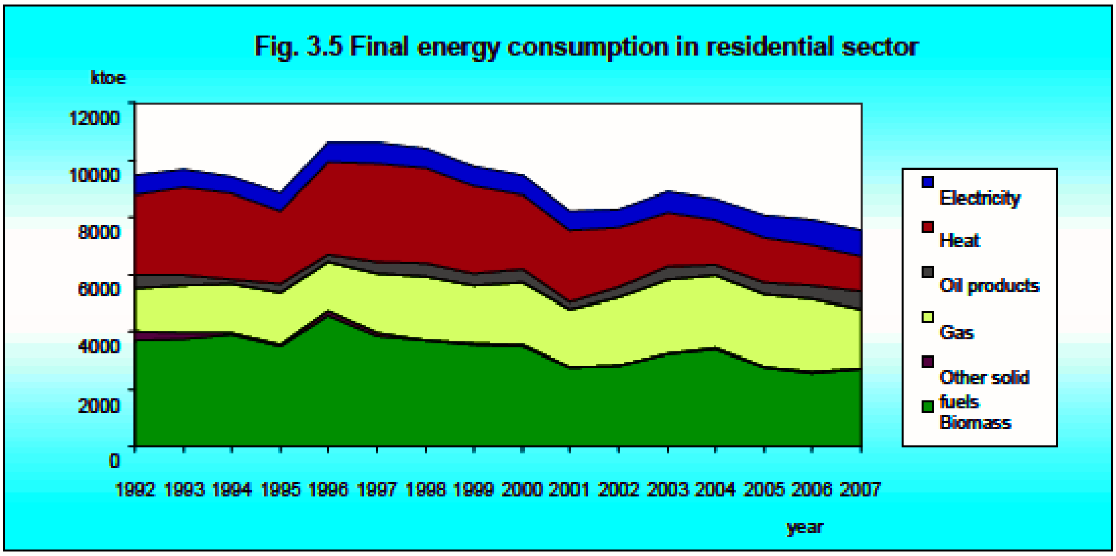


Fig. 3.1 Energy intensity of Romanian national economy

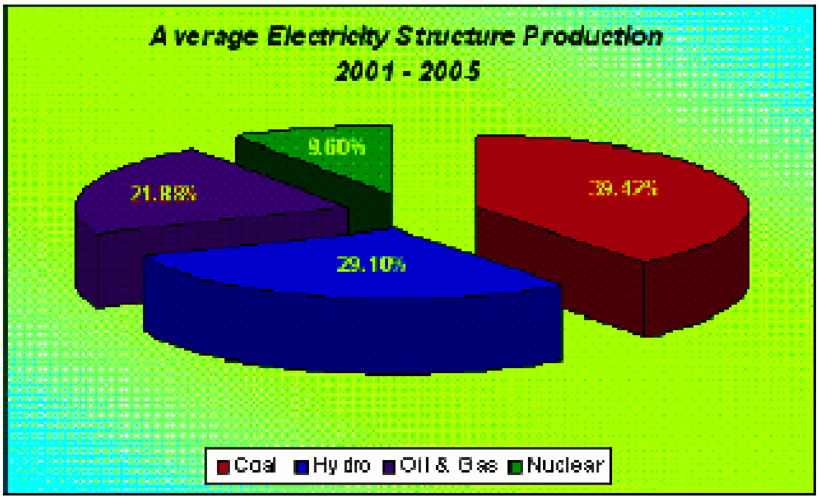


As for household sector the energy consumption function of final use is:



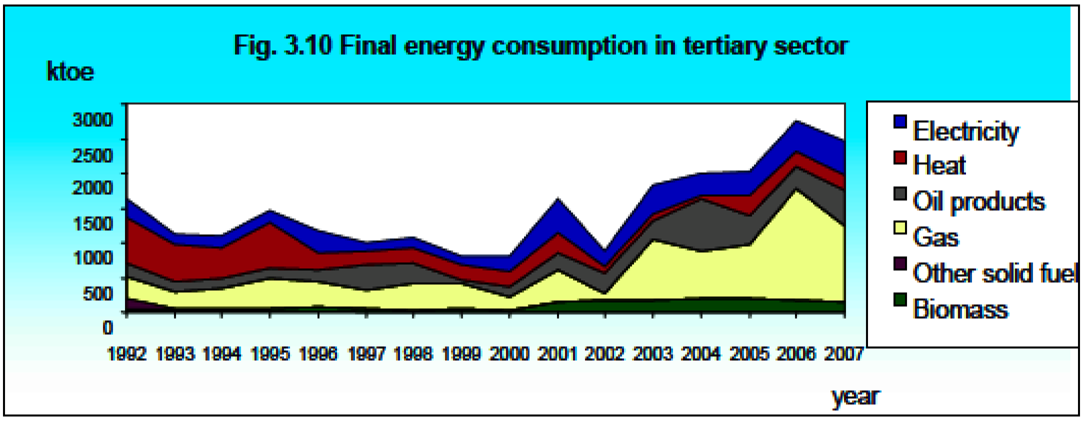
With the new European norms and models the efficiency of the newly built houses increase starting with 2006, this being one of the factors that reduced the energy consumption in the residential sector.

The structure of energy consumption is mainly based on firewood and biomass because of the traditional heating devices (like stoves). Also the installations based on natural gas are very popular (both for heating and cooking). Electricity consumption share within total consumption is low in comparison to European levels; electricity not being used for space heating and for cooking or hot water preparation.



Centralized heating is still very popular; even it registered a decrease from 30% of total consumption to 17% within 15 years period. The main cause of reduction in consumption of centralized heat was the strong relation of district heating systems with former industrial complexes, for which the heating sources were the cogeneration plants, and which stopped their operation during the economic crises after 1990. Also the increase of the bills for the centralized heating due to low efficiency and big losses determined many inhabitants to install apartment plants burning natural gas.

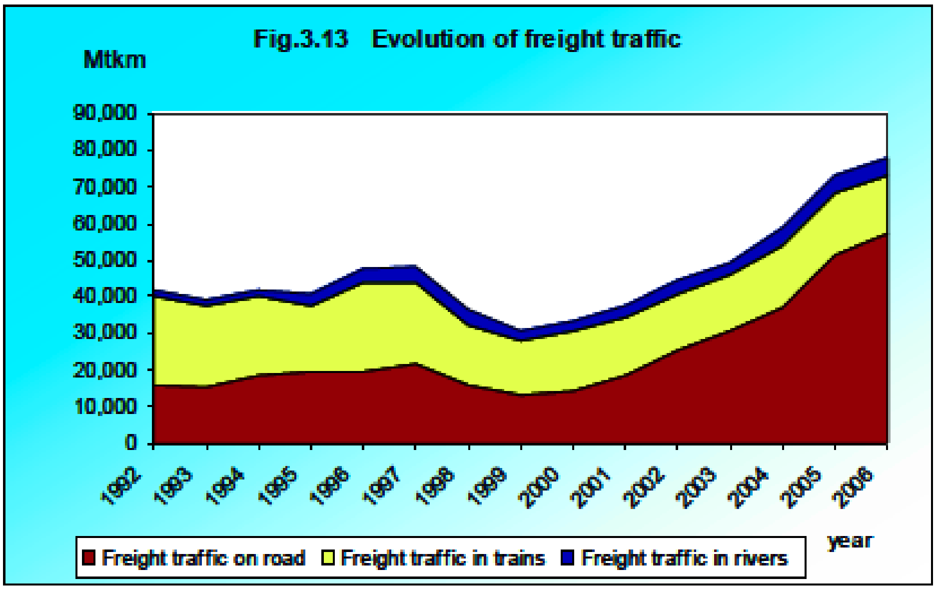
Services registered a fast evolution starting with 1994, specially the trade branch, whose share amounted to 10% of the GDP in 2010. Development led also to an increase of energy consumption in the tertiary sector:



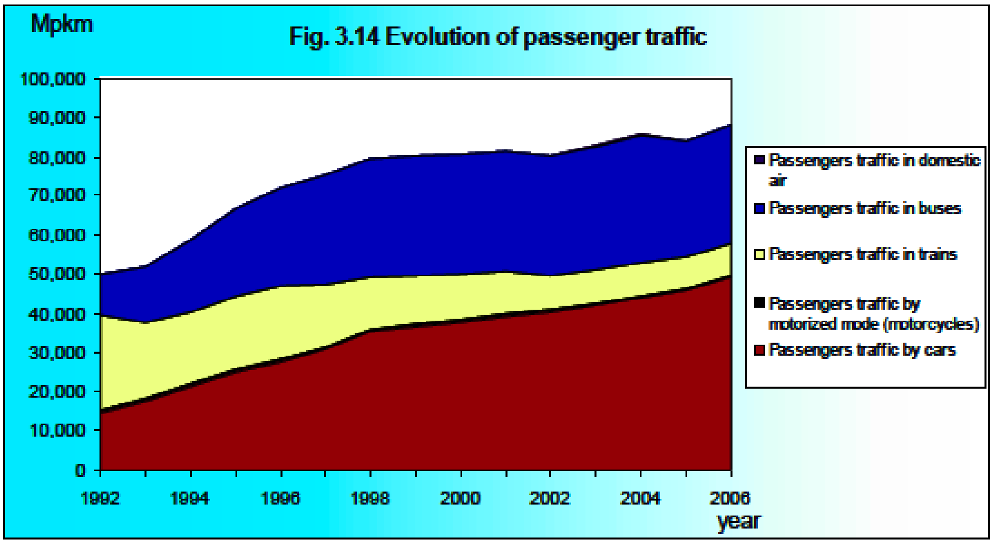
Strongly influenced by household sector one can see that there was a decrease in consumption of heat for district heating, important increasing trend in natural gas consumption and electricity – increasing no of household appliances.

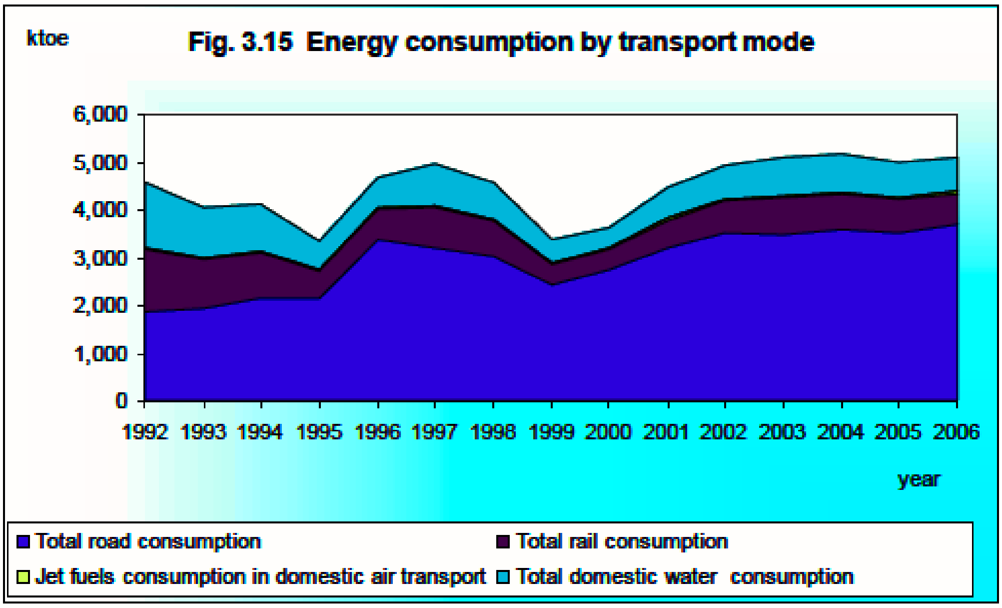
As for evolution in the transport field, strong after 1990, had two main causes: elimination of restrictions against fuel procurement and acquisition of means of transportation.

Connection to the international markets determined an increase in the freight transport.



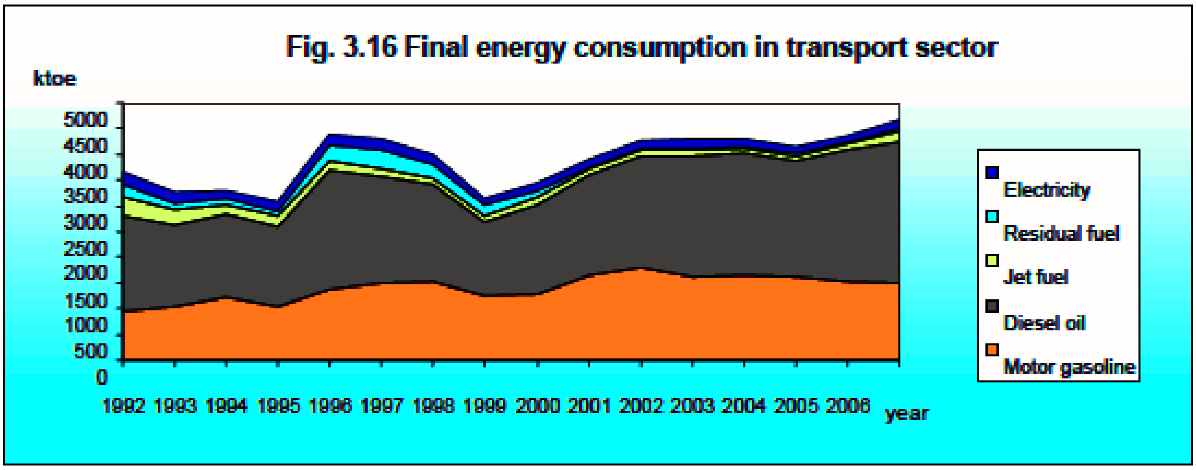
The passenger traffic, as per general increase in citizen mobility, was influenced by western American model of car dependence, even if the public transport was developing as per European model.





The consumption for the road transportation doubled (from 43% to 70%), while the railway transportation consumption decreased by half (from 29% in 1992 to 13% in 2006).

The final energy consumption evolution by energy forms in transport sector:



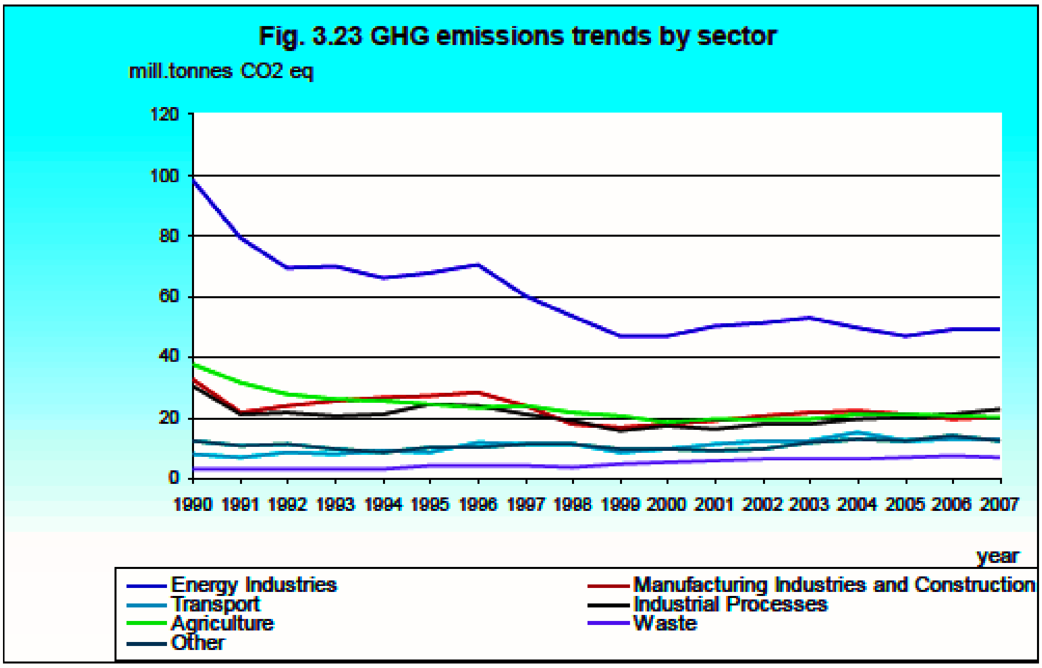
Trends in Greenhouse Gases emissions

(mil t CO_2 eq)

Year	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Total GHG	243.0	180.7	135.5	140.5	146.7	153.5	155.4	149.4	153.8	152.3

(%)

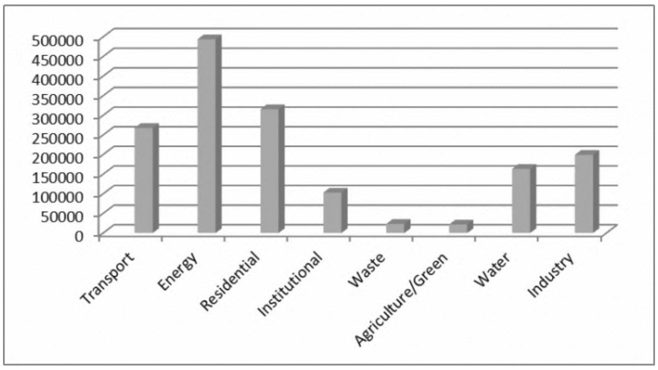
Year	Total	CO_2	CH_4	N_2O	Fluorine compounds
1989	100	68.51	18.46	11.85	1.19
2006	100	70.85	18.55	10.20	0.39



At the city scale the CO_2 emission and energy consumption evaluated for the reference year 2008.

Table 5 CO2 emission by sector per year in Timisoara

Timisoara Climate Strategy			
Main sectors for the action plan:		**CO2 emission**	**units**
1	Transport	267.669,73	tone/year
2	Energy	493.551,51	tone/year
3	Residential	315.411,17	tone/year
4	Institutional	102.660,34	tone/year
5	Waste	22.848,53	tone/year
6	Agriculture/Green	21.616,64	tone/year
7	Water	163.126,15	tone/year
8	Industry	198.982,41	tone/year
TOTAL		**1.585.866,49**	**tone/year**
Total/inhabitant		**5076**	**tone/capita**



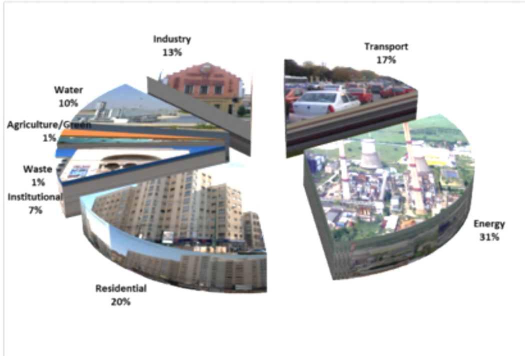


Figure 218 CO2 emission charts

TM Consumption (MWh/year)/sector		
Transport	869.079,34	21,34%
Energy	1.029.626,30	25,28%
Residential	1.215.182,84	29,84%
Institutional	457.084,21	11,22%
Water	8.856,63	0,22%
Industry	492.400,68	12,09%
TOTAL	**4.072.230,00**	
TOTAL/inh	**12,82**	

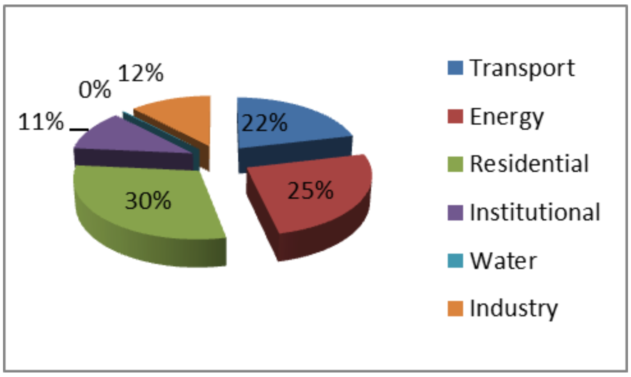


Figure 219 Energy consumption by sector per year in Timisoara

It can be seen that at the city scale the trend tends to adopt the European directions, meaning that the transportation and the services will slowly overtake the hegemony in the energy consumption field. Still, in Timisoara the household sector has significant energy consumption due to the traditional heating systems.

Table 6 Energy Sector emission and energy consumption for 2008

Evaluated data	Reference year 2008
CO2 total emission/energy sector (tone)	**493.551,51**
Target	**35% reduction CO2 emission by 2020**
Gas consumption for heating (MWh/year)	1.133.006,00
Coal consumption for heating (MWh/year)	366.134,00
Electrical energy produced (MWh/year)	47.601,00
Electrical energy supplied (MWh/year)	21.219,00
Thermal energy supplied (MWh/year)	1.250.707,00
Thermal energy produced by cogeneration (MWh/year)	421.172,00
Thermal energy produced during peak periods (MWh/year)	829.535,00
Energy produced by alternative sources (MWh/year)	2.856,00

Table 7 Residential sector emission and energy consumption for 2008

Evaluated data	Reference year 2008
CO_2 total emission/residential (tone)	315.411,17
Target	17% reduction CO_2 emission by 2020
Inhabitants no	312.400,00
Neighbourhoods	13
Residential buildings	128.279,00
No buildings connected to Local heating system	15.482,00
Electrical energy consumption/capita (kWh/year/capita)	706,30
Natural gas consumption for residential (kWh/year)	994.523.800,00
Electrical energy consumption (kWh/year)	220.659.039,00
Total area of the city (km2)	129,30
Total livable area of the city (m2)	5.117.402,00
Total livable area of the city - private (m2)	198.925,00
Total livable area of the city - public (m2)	4.918.477,00

Table 8 Institutional sector emission and energy consumption for 2008

Evaluated data	Reference year 2008
CO_2 total emission/institutional (tone)	102.660,34
Target	13% reduction CO_2 emission by 2020
No of schools	25
No of high-schools	29
No of kindergardens	36
No of hospitals	24
No of concert halls	7
No of sport centers	7
No of social services	2
No of students	42623
Natural gas consumption (kWh/year)	422.000.000,00
Electrical energy consumption (kWh/year)	33.772.339,00
Electrical energy for street lighting (kWh/year)	1.311.870,00

Table 9 Industry sector emission and energy consumption for 2008

Evaluated data	Reference year 2008
CO_2 total emission/industrial (tone)	198.982,41
Target	4% reduction CO_2 emission by 2020
Electrical energy consumption/industrial (kWh/year/capita)	967,00
Electrical energy consumption (kWh/year)	302.800.680,00
Natural gas consumption (kWh/year)	189.600.000,00
Green house emissons on county region (tone CO_2/year)	1.803.968,00

Table 10 Water sector emission and energy consumption for 2008

Evaluated data	Reference year 2008
CO_2 total emission/water (tone)	**163.126,15**
Target	**5% reduction CO_2 emission by 2020**
Length water network (km)	616,80
Length sewerage system (km)	499,90
Water consumption (m^3)	38.700.000,00
- residential	32.895.000,00
- industrial	5.805.000,00
Waste water (m^3/year)	52.600.000,00
Waste water per residential sectore (m^3/year)	44.710.000,00
Waste water per industrial sector (m^3/year)	7.890.000,00
Mud production at treatment plant (tone/year)	56.575,00
Treated waste water (m^3/year)	52.660.846,00
Electrical eng consumption for surface water treat (kWh/year)	4.626.620,00
Electrical eng consumption for waste water treat (kWh/year)	4.230.000,00
Total quantity of treated water (m^3)	23.000.000,00

Table 11 Agriculture and green sector emission and energy consumption for 2008

Evaluated data	Reference year 2008
CO_2 total emission/green& agric sector (tone)	21.616,64
Target	2% reduction CO_2 emission by 2020
No of trees	206.000,00
No of trees per capita	0,56
Oxigen per capita (kg/capita)	8,80
Trees age (%)	99
between 1-20 years	45
between 21-40 years	40
between 41-60 years	9
between 61-80 years	4
between 81-100 years	1
Green spaces surface per city (m^2)	5.070.000,00
Green spaces per capita (m^2)	16,09
Agricultural areas (ha)	3.913,00
Total no. of animals	42.332,00
Total no. of inhabitants	315.000,00
Additional info on green area	
Parks total surface (ha)	87,59
Parks share (m^2/capita)	2,78
Square total surface (ha)	12,97
Square share (m^2/capita)	0,41
Green spaces (street+bloks) total area (ha)	328,58
Green spaces (street+bloks) share (m^2/capita)	10,30
Street aligned green space (ha)	170,90
Neighbourhood green (ha)	157,68
Forest strip area (ha)	25,00
Forest strip share (m^2/capita)	0,80
Green Forest (ha)	50,70
Green Forest (m^2/capita)	1,61
Green per neighbourhood	
Cetate (Green/Total area = 52%)	520.629,00
Fabric (Green/Total area = 45%)	827.754,00
Elisabetin (Green/Total area = 38%)	674.582,00
Iosefin (Green/Total area = 35%)	256.455,00
Mehala (Green/Total area = 48%)	490.673,00
Fratelia (Green/Total area = 39%)	176.651,00
Freidorf (Green/Total area = 44%)	105.237,00
Plopi (Green/Total area = 37%)	52.882,00
Ghiroda Noua (Green/Total area = 32%)	46.600,00
Ciarda Rosie (Green/Total area = 43%)	94.305,00

Table 12 Transport sector emission and energy consumption for 2008

Evaluated data	Reference year 2008
CO_2 total emission/transport sector (tone)	**267.669,73**
Target	**22% reduction CO_2 emission by 2020**
Bicycle paths length (km)	19,00
No. cars for private transportation	128.467,00
No cars for commercial transportation	14.420,00
Total no of vehicles	142.887,00
No. public transport routes	34
Bus	17
Trolleybus	6
Tram	11
Travel distance per year PT (km/year)	10.218,00
Bus	4.356,00
Trolleybus	1.802,00
Tram	4.060,00
No of transported pasangers	93.216,00
Bus	28.648,00
Trolleybus	14.895,00
Tram	49.673,00
Average no of transported pasangers	236.211,00
Routes length (km)	415,38
Bus	214,00
Trolleybus	56,00
Tram	146,00
Average travel distance for PT (km)	27.188,00
Total no of vehicles available for PT	193,00
Bus	86,00
Trolleybus	36,00
Tram	71,00
Petrol supply (l/year) (no transit)	35.667.296,00
Diesel fuel supply (l/year) (no transit)	51.031.856,00
GPL supply (l/yea)r (no transit)	6.942.644,00
Petrol supply (equivalent MWh/year)	323.145,70
Diesel supply (equivalent MWh/year)	500.112,19
GPL supply (equivalent MWh/year)	45.821,45
TOTAL FUEL (MWh/year)	**869.079,34**

Having the clear image of the energy consumption at different regional and local scales, one performed the energy calculation for the transportation sector according to the new master plan of the city. As previously mentioned the analysis is done at the site-district interaction zone – major roads that will dictate the changes first locally than globally from sustainable point of view.

The energy performance of the location from transportation point of view was developed considering the vehicular and passenger fluxes. The study area was divided in traffic areas and all the parameters were evaluated accordingly.

Figure 220 Traffic division


Figure 221 Pollution level areas

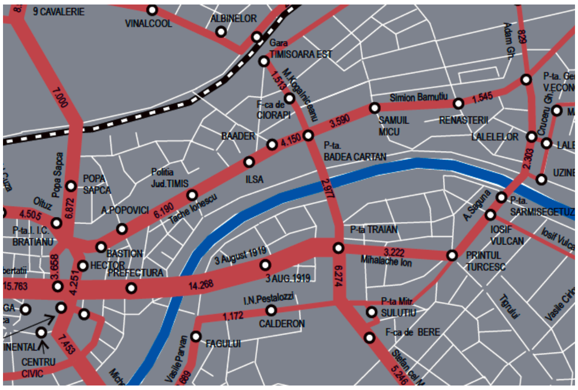


Figure 222 Passenger flux

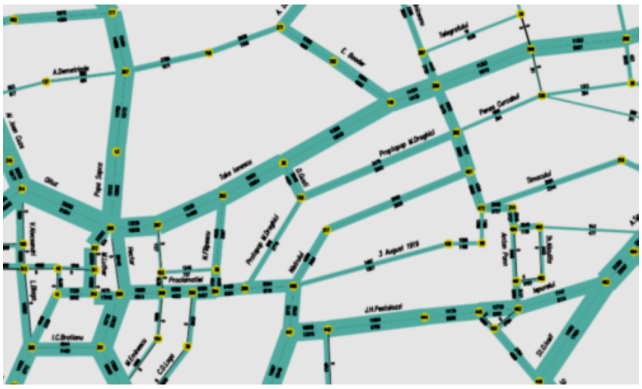


Figure 223 Vehicular flux

Table 13 Pollution and transportation fluxes analysis in the study area

Traffic zone	Origin Destination estimation		Zone main function	Pollution degree	Passengers flux estimation for 2 peak hours				Vehicles flux for 14 hours for 2 directions of circulation			
	No. inhab	No. Work & study			North	East	South	West	North	East	South	West
25	392	141	services	high	-	3254	-	6509	8347	25569	3001	19255
30	1568	186	residential	high	-	-	2081	3254	-	-	11014	25569
43	1470	855	res+services	medium	-	6872	4505	6509	-	27333	46466	38052
37	6097	2659	residential	medium	-	-	6190	6872	-	-	27589	27333
102	5626	2737	residential	medium	-	1513	4150	-	16539	1057	24653	-
34	4704	1923	res+services	medium	-	-	3590	1513	25519	-	19202	1057
42	1813	1652	services	medium	4505	4505	15763	-	46466	26140	14904	9477
38	2798	2677	services	medium	6190	-	14266	4505	28849	10272	13324	26140
36	2744	1959	services	high	4643	-	-	-	23780	311	4566	10272
35	4508	1559	residential	medium	3590	-	-	-	19202	-	600	311
40	1176	2710	services	low	-	8298	8499	-	16395	35718	28575	25173
41	833	3682	services	low	15763	7453	-	-	14904	39137	16395	10383
39	882	3785	services	low	14266	2689	9143	7453	13324	24057	35718	39137
100	3283	4905	services+res	medium	-	6247	1172	-	7038	5845	22052	18539
99	6017	1874	residential	medium	-	2333	-	6247	19965	39393	16605	5845
33	3136	89	residential	medium	-	-	-	2333	3106	-	2670	2734
88	7763	918	residential	medium	1172	-	-	-	24283	3459	16279	26817
89	1715	8180	work	high	1172	5246	-	-	20938	18103	-	3459
90	2156	2329	res+work	high	-	4442	-	-	-	36254	1588	3589
98	5587	1423	residential	medium	3222	-	-	6247	16605	-	-	22861
97	1127	1001	res+work	medium	-	-	-	4442	-	-	-	35959
101	3430	370	residential	medium	-	-	-	-	-	-	-	-
					tram	bus			<10000	<20000	<30000	<40000

As per implemented solutions for traffic improvement in the area the energy calculations give the following result.

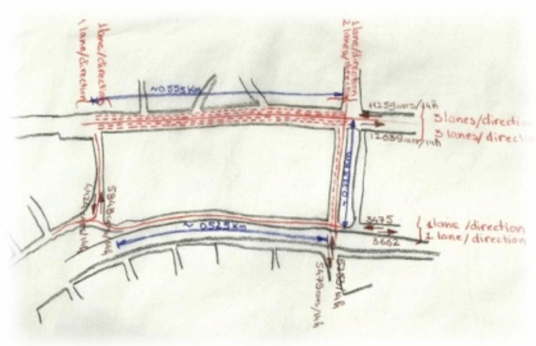


Figure 224 lanes and lengths of the routes

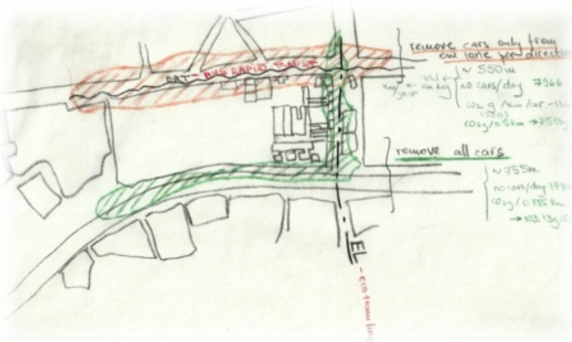


Figure 225 interventions to be done

Table 14 Transportation critera

Transport criteria			
Total CO_2 emission per year (2008)	**267.669,73**	tones	for the City
Averege CO_2 emission/car/km	**136,60**	grams	
Measures to be implemented:			
Take Ionescu	*remove cars from two lanes/introduce BRT*		
length (km)	0,55		
cars/day	7.966,00		
gCO_2/distance	75,13		
Total reduction in g CO_2/day	598.485,58		
Emission reduction tones CO_2/year	218,45		
Badea Cartan/Bega Side	*remove all cars/keep eco tram line in market area*		
length (km)	0,76		
cars/day	17.869,00		
gCO_2/distance	103,13		
Total reduction in g CO_2/day	1.842.829,97		
Emission reduction tones CO_2/year	672,63		
Total reduction in CO_2 emission	*Tones/year*	*% of city*	
	891,08	**0,33**	

Table 15 Calculation for reduction of CO2

Estimation for 8 years		
City infrastructure length (km)	582	100,00%
Intervention length (km)	1,31	0,23%
City average cars/day	29.995.698,00	100,00%
Site cars/day	51.539,00	0,17%
Removed site cars/day	25.835,00	0,09%
TM 2020-reduce car traffic 20% (cars/day)	5.999.139,60	20%
TM 2020 - Intervention length (km)	304,19	52,27%
TM 2020 - CO2 emission reduction (tones/8years)	249.282,31	93,13%

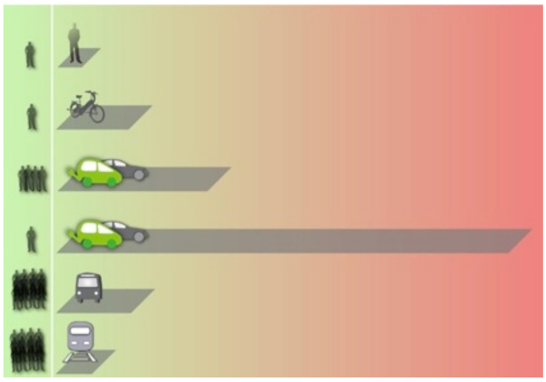


Figure 226Equivalent urban space occupancy for different modes of transport

The energetic performance of the study site emphasizes that the transportation is the catalyst in the change of the city allure from functional point of view and reaching the first level of sustainable development (with the actual trend of sustainable transportation and reduction of dependence on private cars will reduce the CO2 emission level from 2008 almost to zero).

Figure 227 Future Vision of the city

The transport network is efficient only if it works well with the other three layers - open space, functionality and volumes - as a smart and sustainable urban development.

The policies of such type of development are starting to have a shape and can be itemized in:

- First level policy option: improve non-motorised and public mobility framework and reduce CO2 emission in the transportation sector: start locally and spread globally;
- Encourage pedestrian and bicycle motion via comfortable and walkable green active paths;
- Develop Public Transport: prioritize the lanes for rapid bus transit, use eco transportation, introduce traffic management system;
- Reduce chaotic car parking and encourage park and ride network development;
- Analyses of energy saving potential;

- Second level policy options explore the economic, social and sustainable development of neighbourhoods:
- Mixed use development encouraging small and medium developers to start a business
- Local production of vegetable, fruit and energy
- Open spaces development for all ages and tastes with possibility of high social interaction
- Measures that will involve both private and public sector

The open spaces and the functionality distribution map at district level were elaborated such that to understand how the complex adaptive system can improve its performance and how the “moving green” introduced in the transportation layer is coping with the functions.

The analysis is looking at the diversity and walkability of the functions around the district prior and after the sustainable transportation introduction.

Figure 228 Existing oasis of green 10 minutes walkability and additional moving green

It can be seen that the green corridors add activities all around the site not necessary defining them specifically. They are activities that encourage movement and eco-friendly attitude of the inhabitants.

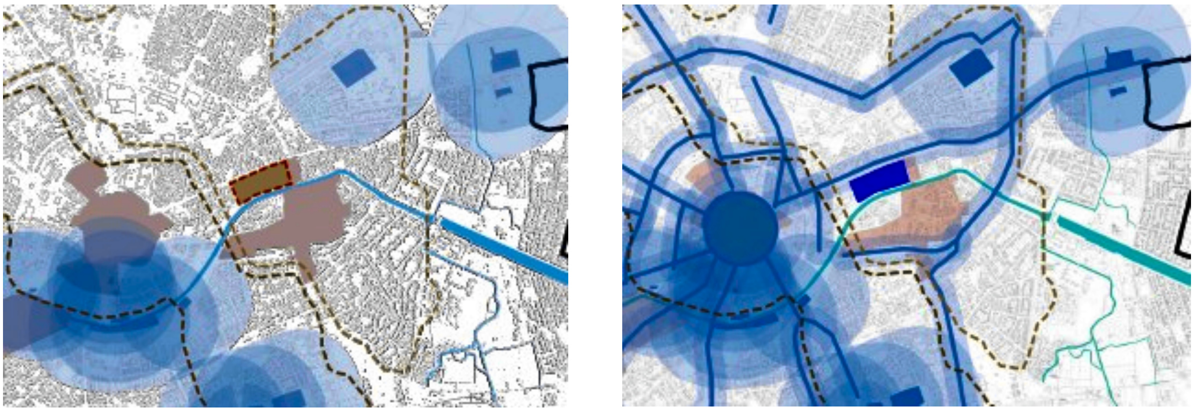


Figure 229 Existing sports facilities and addition moving green - bicycle paths

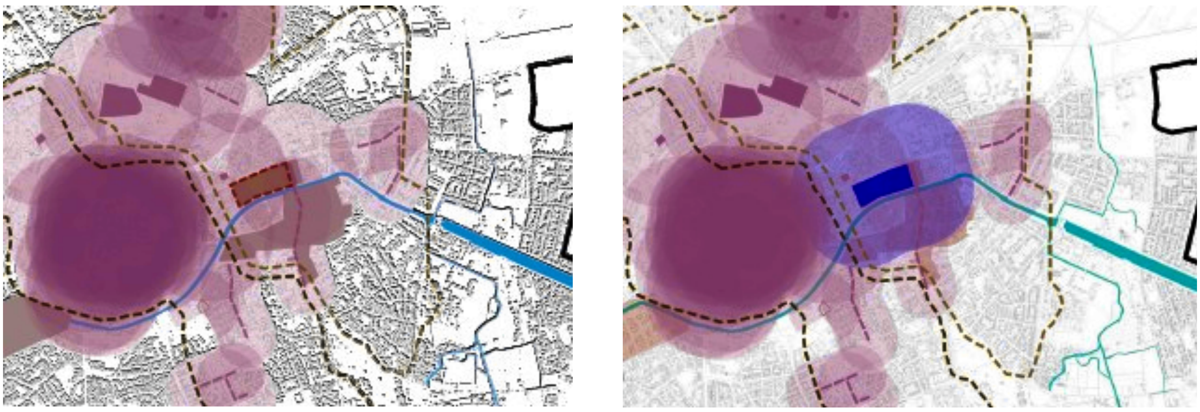


Figure 230 Commercial and markets facilities and additional commercial area

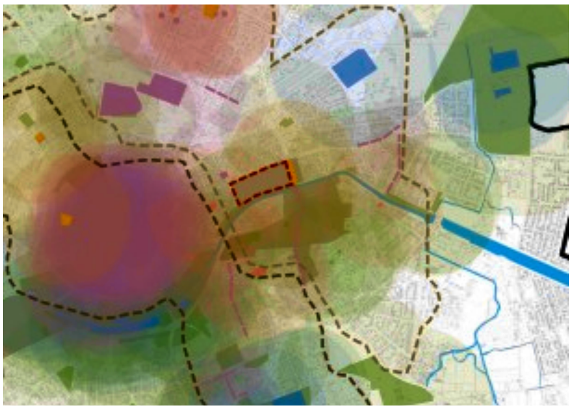


Figure 231 Summary of the existing functions

Figure 232 District scale master plan - combined functions and transport

The area presents potential for commercial, leisure and sports activities due to already existing most important agricultural market and the proximity to the canal and park. Fabric is one of the cultural nuclei of the city but it has more an importance from the industrial “revolution” point of view. Consequently, it will be interesting to study how the new development can influence also the cultural and the social life of the district.

The Silk way (spice trade), was a significant factor in the development of the civilizations all over the world as well as the consolidation of the main networks among settlements and nations. Though silk (spices) was certainly the major trade item from China, many other goods were traded, and various technologies, religions and philosophies. The Silk Road represents an early phenomenon of political and cultural integration due to inter-regional trade.

The sustainability way should work as the Silk Road worked in the ancient times. The isolated non - functional communities, clusters and districts within a city should be integrated and made part of a whole.

What is exactly the sustainability way driving force at urban level? Multifunctional eco - friendly neighbourhoods with strong social inclusion in strong relation with the efficient mobility as pedestrian and bike paths and very efficient public transport are the force. “Merchandising” the new technologies and eco – visions can lead to a cultural and economic unity and reduce the vulnerability of the city evolution throughout upcoming challenging years.

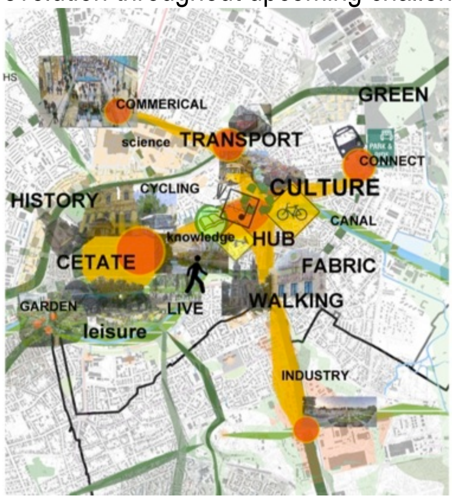


Figure 233 District and HUBS

Chapter IV. Architectural Design

IV.1 Project Settings

The study area is placed in a district mainly characterized by private residential houses build at the beginning of XIXth century as a consequence of city expansion and industrialization. The industrial settlement was covering more than 90% of the study area – former wool factory. The main street is a wide boulevard characteristic for the concept implemented for the decentralization of the old fortress and its connection to the new centres of activity – industrial centre Fabric. After the demolition of the abandoned factories, the area was included in the areas to undergo serious transformations – as per new GUP.

IV.1.1 Past conditions

Figure 234 Arial view of the study area 2008

Figure 235 Wool factory ILSA

Figure 236 Municipal Police and sports field

IV.1.2 Present situation

The parcel vicinity and limitations:

- North - West: border with Take Ionescu Boulevard
- North - East: border with tram depot and new residential development

- South - East: Street Protopop Meletie Draghici
- South – West: Street Academician Dimitrie Gusti and old residential building

Figure 237 Ruins on study area

Figure 238 Skyline in study area

Figure 239 Historical buildings facing markets

Figure 240 Tram depot

IV.1.3 Future Changes - Zone Urban Plan 2002 & New Developments

The study area is located in the administrative territory of municipality of Timisoara, in the north-east part of the city. According to the ZUP (zone urban plan), elaborated function of the local urban development strategy, and following building policies (regulations) were established:

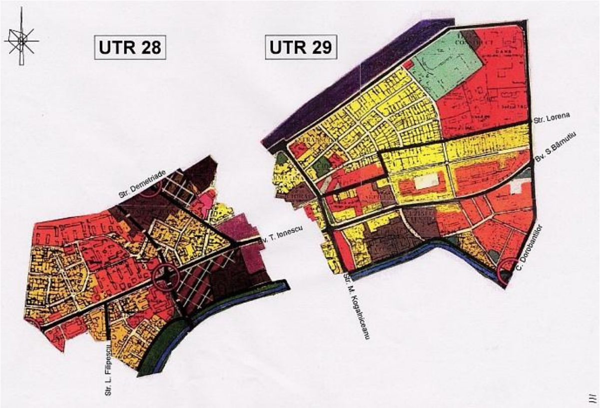


Figure 241 ZUP for study area as per GUP of 2002

- Zone 1-3 : Residential & Services; Type (B+GF+4F); POT – max 40%; CUT – max 2.4
- Zone 2 : Green area
- Zone 4 : Residential & Services; Type (B+GF+7F); POT – max 40%; CUT – max 3.2
- Zone 5 : Residential & Services; Type (B+GF+6F/14F); POT – max 70%; CUT – max 5
- Zone 6 : Services & Mixed Use Builidings; Type (GF+60F)
- Zone 7 : Residential & Services; Type (B+GF+12F); POT – max 40%; CUT – max 5
- Zone 8 : Services; Type (GF+20F)

Starting with 2003, a Real Estate agency elaborated a new project for the area: "New Timisoara" neighbourhood; a mixed use development: commercial centre, office building and a very large sector of residential buildings.

Figure 242 Proposed future developments

One block of the residential buildings was executed and another building is under construction progress.

Figure 243 Actual Developments

IV.1.4 Site analyses and new sustainable district design guidelines

The new approach of the design is oriented towards improving social and environmental grounds by bringing into discussion the energy saving and energy efficiency models.

The sustainable district is a place with a high degree of social cohesion, balance and integration, security and stability in the city and its neighbourhoods, with small disparities within and among neighbourhoods and a low degree of spatial segregation and social marginalization; with sustainable, non-pollutant, accessible, efficient and affordable transport for all citizens at the urban, metropolitan and interurban scale with interlinking transport modes, where non-motorised mobility is favoured by good cycling and pedestrian infrastructure, and where transport needs have been reduced by the promotion of proximity and mixed-use schemes and the integrated planning of transport, housing, work areas, the environment and public spaces; with a high quality of life, high-quality architecture and high-quality functional user-oriented urban space, infrastructure and services, where cultural, economic, technological, social and ecological aspects are integrated in the planning and construction, where housing, employment, education, services and recreation are mixed, attracting knowledge-industry businesses, a qualified and creative workforce and tourism ; is characterised by a compact settlement structure with limited urban sprawl through a strong control of land supply and speculative development.

Firstly the potential of the site from urban integration point of view was assessed. How it connects to the city, how the city grids can be brought in, what are the transportation modes and many other aspects of the urban city characteristic were efficiently schematized.

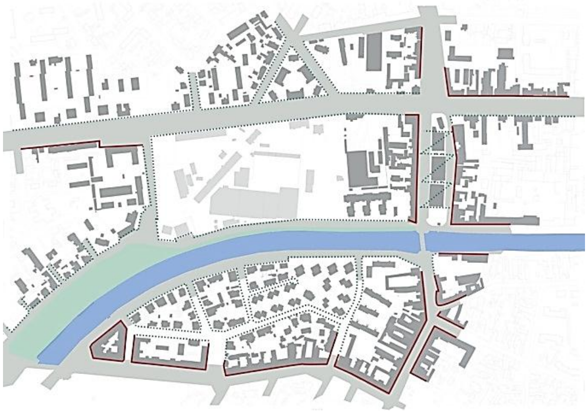


Figure 244 Street fronts, volumes and voids

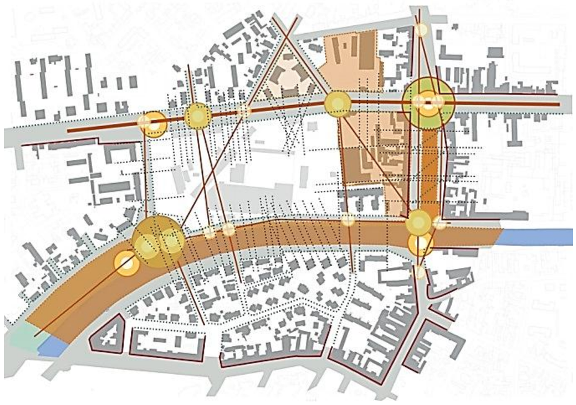


Figure 245 Street patterns and connections

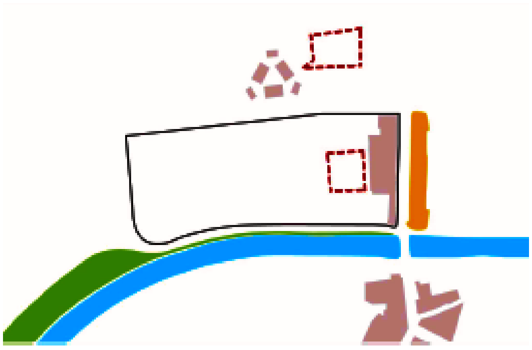


Figure 246 Existing function on site

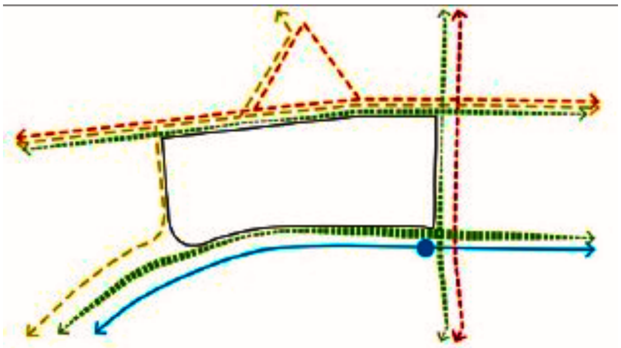


Figure 247 Transportation means

Figure 248 Proposed volumes, voids connections

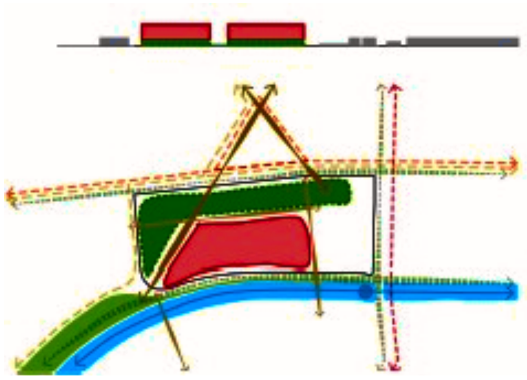


Figure 249 Assumption for public/ private are distribution

The mass distribution on the study area was dictated by the networks, edges and urban historical patterns. The NW and SW edges are the active, rapid ones with important public transportation networks, while the NE and SE are the more slow private ones facing the canal and park. The consideration for the function distribution in terms of accessibility will follow the fast-slow area distribution. The buildings that will face the boulevard will be for retail and offices while the buildings facing the green area will be for more private or semi-private use. But in general the ground floor area of all the future developments will be permeable for social activities: sport, shop, leisure and cultural activities.

For better understanding the functionality distribution in a sustainable neighbourhood a scale and design approach comparison was done.

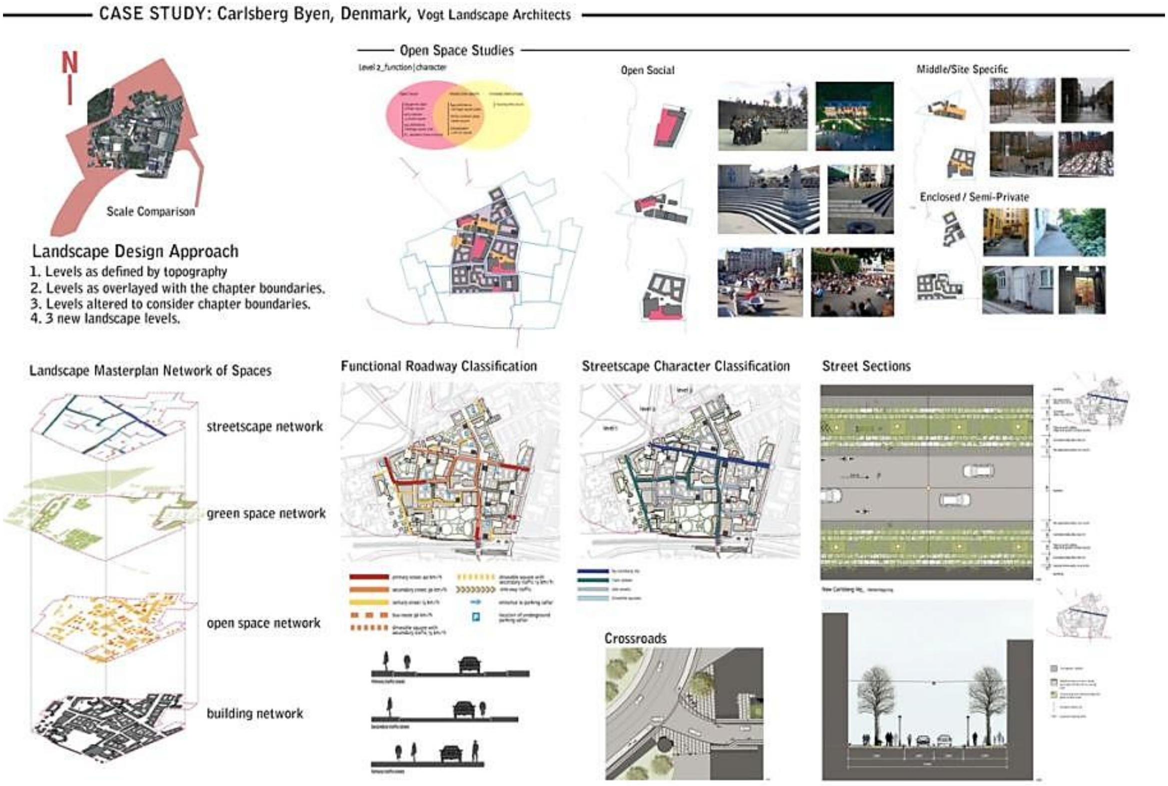


Figure 250 Study Case 1

The conclusion of the analysis:

- prioritization of the pedestrian movement and Public transportation
- emphasize the public open spaces interconnected by pedestrian access

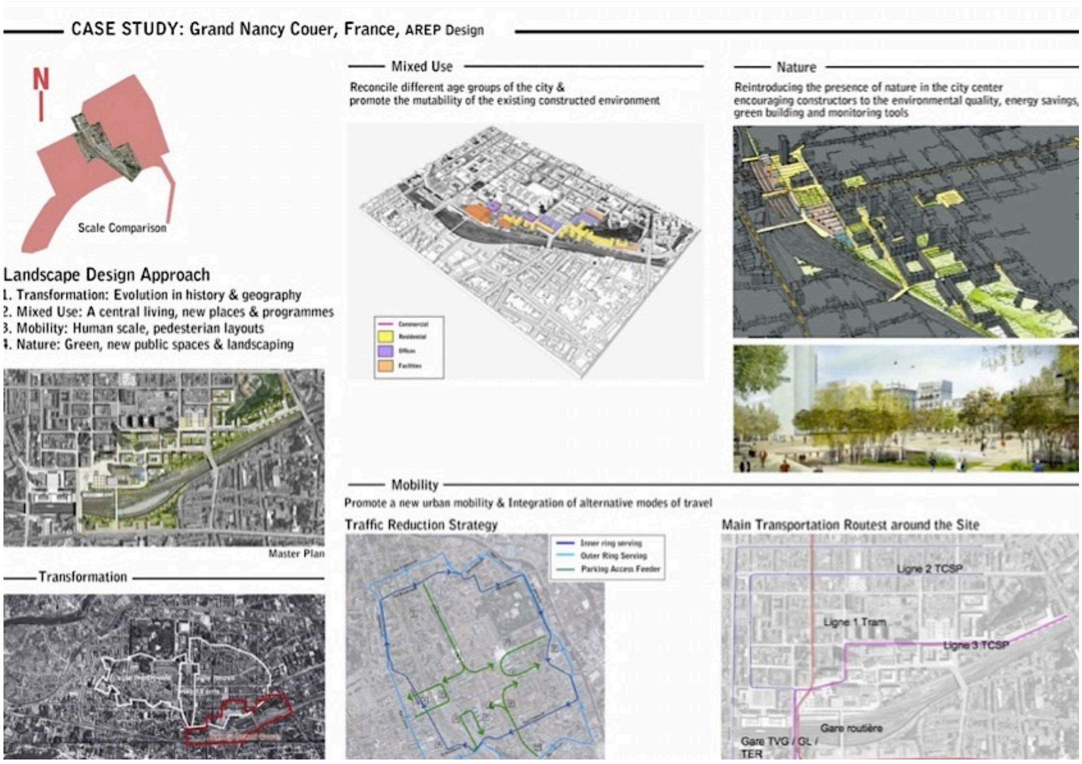


Figure 251 Study Case 2

The conclusion of the analysis:

- prioritization of the pedestrian movement and Public transportation
- emphasize the public open spaces interconnected by pedestrian access
- division of functionality in relation to linear site with facilities provide at either ends
- traffic reduction circles, with access from four sides
- public transport around the site, not intersecting with the site

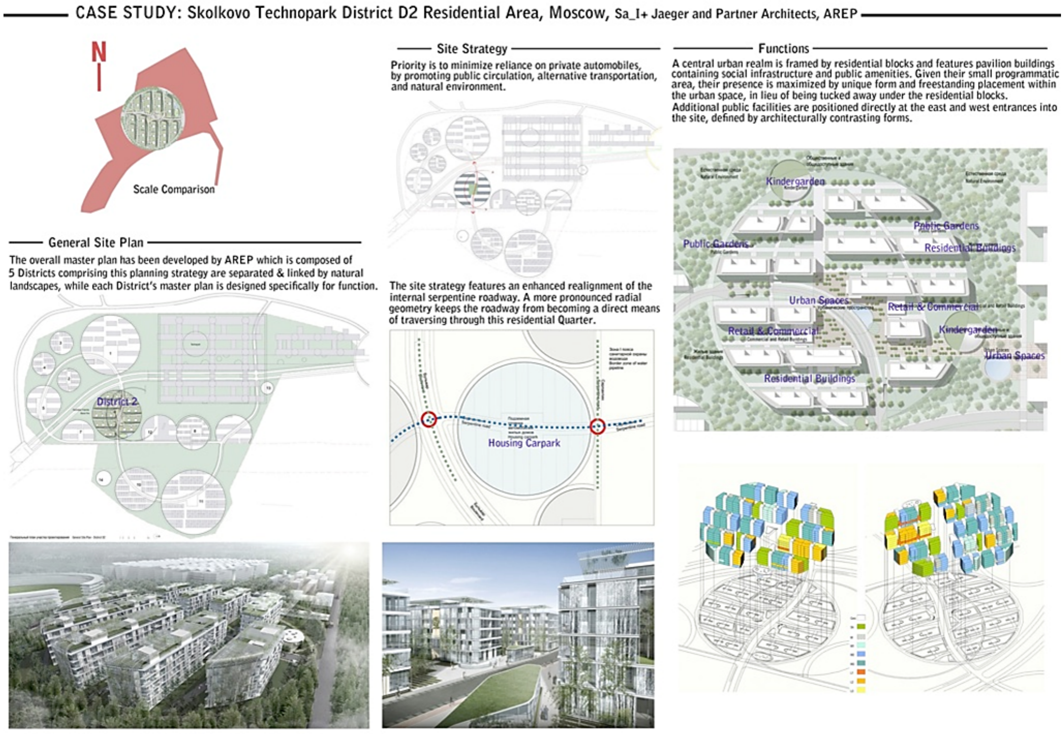


Figure 252 Study Case 3

The conclusion of the analysis:

- prioritization of the pedestrian movement and Public transportation
- emphasize the public open spaces interconnected by pedestrian access
- distribution of functions with commercial/retail along main access, residential offset
- slowing of major traffic through/around site

Urban neighbourhoods are complex entities. Buildings and other obstructions shade views from facades to the sky and sun, thus influencing radiant exchanges (short wave, long wave and visual). These radiant exchanges, together with the anthropogenic gains, evapotranspiration losses and the production/dissipation of turbulent kinetic energy influence the hydrothermal microclimate (temperature velocity and air pressure). This urban microclimate influences pedestrian comfort, building energy demands and to a degree irrigation water demands. Therefore the building shaping was done considering the sun path, wind path and vistas towards green landscape as well as the permeability and functionality.

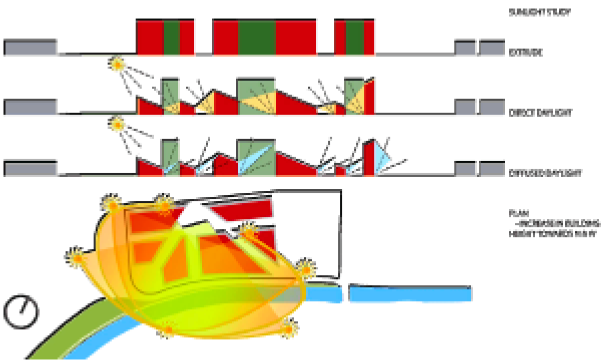


Figure 253 Sun path

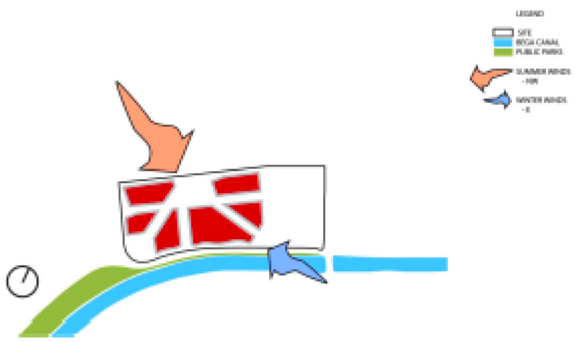


Figure 254 Wind directions

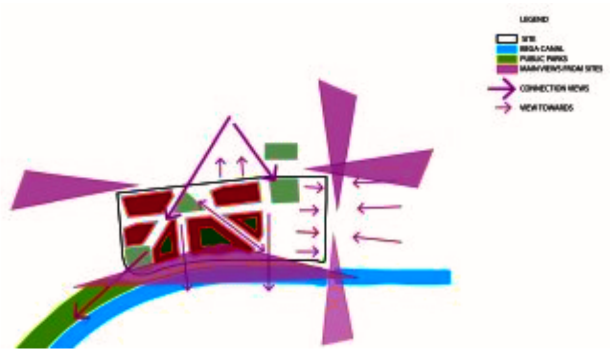


Figure 255 Views

Figure 256 Functionality / permeability of the development

The analysis was performed at the same time by simulating the volumes disposition on site: Option one – rigid bodies with quite regular distribution


Figure 257 Extruded volumes


Figure 258 Relation with private/ semi private spaces


Figure 259 Smart orientation function of sun


Figure 260 Mixed - use development approach

Option two – stronger relationship with the surrounding context, more organic approach in defining the shapes

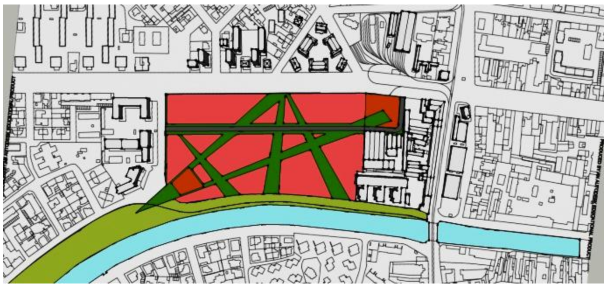


Figure 261 Mian axis


Figure 262 Extruded volumes


Figure 263 Orientation for sun


Figure 264 Mixed use development approach

For the two options were "weighted" from functional and aesthetical point of view based on the 3D studies as well as the general masterplans.

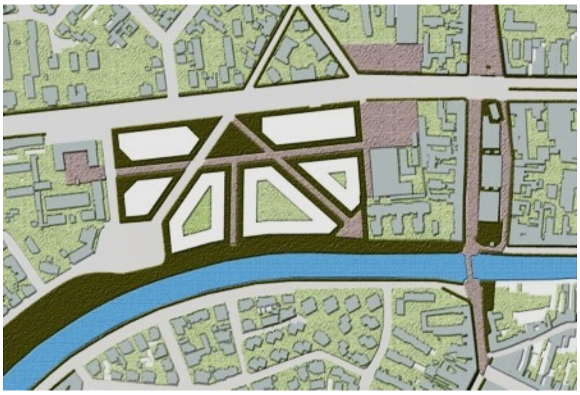


Figure 265 Masterplan option 1


Figure 266 Masterplan option 1

Considering that the future development will be more like a "role – model" to be followed, the second option was considered more appropriate for the detailed design process.

The final decision on the looks redirected the attention to the notion of sustainable district and to the question: What makes this project sustainable so far?

Several traces were taken and the following conclusions were drawn:

- As per Zonal urban plan – POT 40% and CUT 2.5 – 5
- As per LEED sustainable design principle: open space min 20% out of it 25% vegetated; commercial development 5575m^2 per acre
- As per EU normative: sustainable transport; climate change measures; social inclusion; natural resources; socio-economic development

- Density and compactness increase
- Mixed use developments

Table 16 Sustainability parameters

Location	Area	POT	Acres
Site total area	113.000,00	100%	27,93
Site built up area	34.145,00	30%	8,44
Open space	78.855,00	70%	19,49
Green space	17.800,00	23%	4,40

Use	Area	Acres
Developed area	34.145,00	8,44
Commercial space	17.185,00	4,25
Needed	47.006,34	100%
Provide	23.658,04	50,33%

Density and compactness increase			
city density	inh/km^2	2452	100%
district density	inh/km^2	4841	197%
site density	inh/km^2	7681	313%

Mixed use			
district activity	residents	17.670,00	60,63%
	workers	11.475,00	39,37%
site activity	residents	868,00	14,03%
	workers/passenger	5.317,00	85,97%

It can be seen that generally in the design approach the sustainability parameters were considered and the use of local land resources was optimized to maximum.

The LEED requirement in terms of commercial development is not completely fulfilled, but it should be mentioned that as commercial were considered strictly only the retail areas; there are thou still spaces with commercial destination within other areas, like hotel, leisure and offices.

IV.2 Planning. Project. People

IV.2.1 Detailed design of the site buildings

The detailing of the buildings configuration and functions helped defining more exactly which of the constructions will be of greatest significance and will function as the heart of the district.

The building located at the SE corner of the site, at the intersection of several historical, transportation and green axis will to become "the statement" of the sustainable neighbourhood.

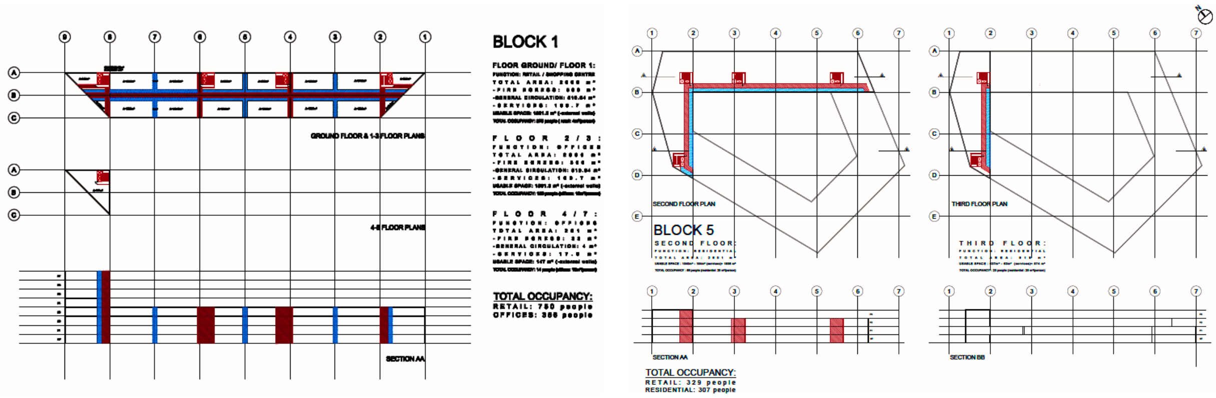


Figure 267 Building Studies

IV.2.2 The right choice. Libraries. The history's repeating!?

In the ancient Greece the human activity was more public than private. The cities were seen as open cities and the most important place in the city was the Agora – the gathering place or the assembly. Also it was used as a market place, giving birth to the two verbs: *agorázō* - "I shop" and *agoreúō* - "I speak in public". The equivalent of Agora in ancient Rome was the Forum –"place outdoors" – used as marketplace, square in the middle of open stalls (stoa) generally located along a road. One of the most important buildings in the Forum was the basilica – roofed hall used for business and disposing of legal matters. Both city entities - agora and forum - were having a strong social cohesion character, the heart of public life.

Figure 268 Greek Agora in Athens

Figure 269 latin Forum in Jersah Jordan

With the increasing power of the Christianity the public activity become more "intimate", orientated towards the silent and spiritual enclosure of the churches. The big city community started to be divided in smaller sub-societies each loyal to its church and preacher. It was no longer a place of debate and contradiction; it was a place of submissiveness and general common opinion.

Figure 270 School of Athens by Rafael

Figure 271 Preaching in the Church by L. Van Leyden

With the industrialization and increasing power of consumption as well as with the new globalization trends the church influence slowly decreased, thus the church being no longer the main gathering and socializing place. “THE” place to go and to be seen in is the shopping mall. The capacity to provide besides the shopping activity in a large number of different shops, they offer entertainment (cinemas, play area for kids) and services (communication like free WI – FI area, food courts available for different types of consumers, toilets, bookshops and newspapers kiosks, coffee shops, hairdressers, dry cleaning and dentist studios). No wonder that a large number of teenagers and family people spend their time in such places without even buying.

Figure 272 Iulius Shopping Mall Timisoara by day and night

But the alarming question that pops in is: Do these centers really provide a social cohesion and a harmonious development of the society? It is more than obvious that the new generations, appealed by the development of technology and consumerism tend to become ignorant and less preoccupied by the cultural activities. The education malfunctioning and the obesity high average at global and local scale are two parameters enough to start a “revolution” to change the course of the history.

A mélange of the effervescent agora activity and reflecting church activity, together with the mixed use approach of the shopping centers and culture revitalization concern will give birth to a place of important personal and social development for human beings.

As at engineering and architectural level the sustainable neighborhood design approach with an increase concern for the energy use is "THE" catalyst of urban development; the catalyst for the urban life prosperity and rejuvenation will be the new urban icon – Library.

Why Urban Icon and Why Libraries?

The conceptual grid of "urban icon" developed as a result of intersection of visual culture and urban history. The tendency to reduce complex institutions or ideas into simple visual symbols in the contemporary urban culture can already be considered an iconization. The rise of semiotics resulted in the capability to "read" cities as "text". But the interesting aspect was to see the relationship between the city's built up form and its cultural life, approach practiced by Lewis Mumford and Kevin Lynch and others. The aesthetic dimension of urban environment was always in the center of urban and planning history, but only recently the visual in urban culture started to be examined.

The urban history generally explains how cities have taken forms and functions that they have and how those elements operate within different systems and distinct epochs; the urban visual history asks how those urbanities see their urban world?

As a definition, icon means image, picture, illustration or portrait; in a more particular manner it can be defined as pictorial representation, something that resemble what they stand for, something authentic, an emblem or symbol whose form is implicated in its meaning: Eiffel Tower – France, Paris and its capacity to lead innovation, WTC – USA, New York and its capacity to rule the business world, Coliseum – Italy, Rome and its cultural vastness, etc. The urban icon is not the construction itself but all that it has come to represent as part of the global landscape; it is universal and more often positive than negative.

Figure 273 Eiffel Tower and WTC under Construction

The urban icons are the summary representation of a particular city, are "visually noisy" attention – grabbers and present a high quality of legibility of the location.

Just walking on Timisoara's streets, one can realize that the main characteristic of the city is the cultural one. Still there is no iconic building that visually can state this. Churches and old villas are scattered all around the city, a theatre that has an honorable place in the center square, the refurbished bastion with coquette restaurants; all states cultural and bohemian life but nothing states Timisoara the city of Romania cultural and enlightenment birth.

Can this role be taken actually by any existing building or the new business and retail centers? The idea of a city and even nation to identify itself with a business center or shopping mall is gloomy and improbable. So what exactly can represent Timisoara? In a glamour way called a “culture factory", in the traditional way known under the name “Library” with attachments. A creative social center that will reintroduce the use of books will explain and teach the technologies, innovations and arts, which will encourage social and leisure activities; it will involve all social and ethnic groups at almost all dates and hours of the yearly calendar.

IV. 3. Architecture and functionality in the library

IV.3.1 Timiosara’s “cultural incubators” - present and future.

The city library network is quite well distributed around the city and the county (355 libraries in Timis County in 2010 out of which 89 public) and it tries to cover all sectors of interest but still something is missing from the places to be considered appealing to be used by the entire society.

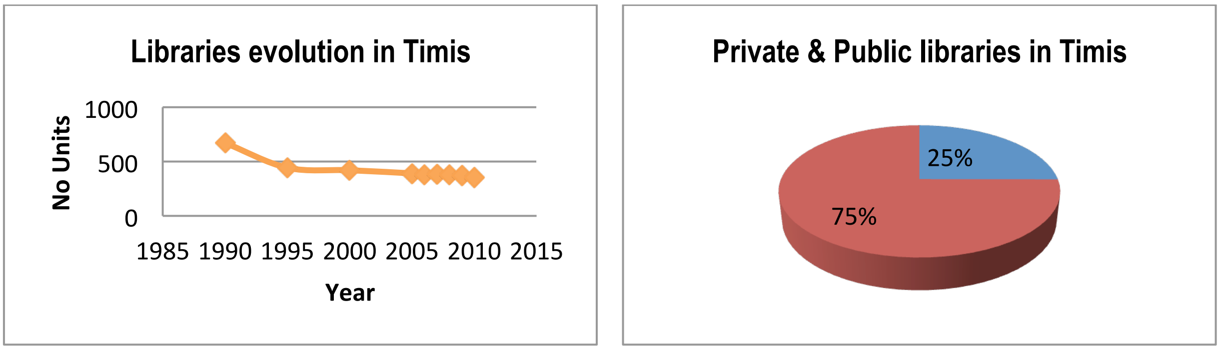


Figure 274 Libraries use in Timisoara

A short incursion in the Library World of Timisoara

Timisoara Municipal Library

Figure 275 Library distribution

Timiş county library was founded on 29 October 1904, as the public library with the scientific character of the city. She began work with the publications of 27.850 volumes. Today, the library offers its readers about 750,000 publications-books, periodicals and other documents, graphics and audio-visual, in Romanian language and languages. Annually, 15,000 units acquiring library, totalling 2,400 titles; Join over 17,000 readers, broadcast almost 500,000 volumes and record a frequency of over 200,000 readers. Through the structure of the collections it holds, Timiş county library has encyclopaedic in nature and is aimed at all socio-professional categories. Services are free. From the historical perspective, the area of Timisoara took contact with the idea of culture since medieval times; here existed the famous library of the monastery of Csanád, along with other monastic libraries.

The idea of public library, offering access to all those interested in reading or information, appeared in the late nineteenth century when Joseph Klapka founded, at Timisoara in 1815 the first public library borrowing, with the reading room of the Habsburg empire.

In 1870 worked at Timisoara three libraries with popular character, whose book Fund was available to residents of neighbourhoods Fabric, Elisabetin and Olivia.

By setting up Romanian Reading Reunion, in 1873, in the Fabric was open a library

June 30, 1903, the Local Judicial Commission shall set up a public library with scientific profile. On the recommendation of members of the Commission, the cultural associations and Reunions of Timisoara, next to the city's personalities donate to the new library set up, important publishing funds

29 October 1904 it is opened Public Library with Scientific Character of Timişoara, with a Fund of 27.850 volumes

1923 – the library fund increases with 1280 books bought and 77 donated; the first subscriptions to periodical publications are available – 29 magazines – European idea, Thinking, Romanian Life etc (Ideea europeană, Gândirea, Viaţa Românească).

On 18 December 1940 – Library moves its headquarters in Voltaire Street nr. 7

In 1952 the institution's headquarters is located in Freedom square. 3 (Piaţa Libertăţii)

Since 1968 there are opened first branches of current County Libraries Timiş

Figure 276 Municipal Libraries

Subsidiaries

Subsidiary Fabric-Vii

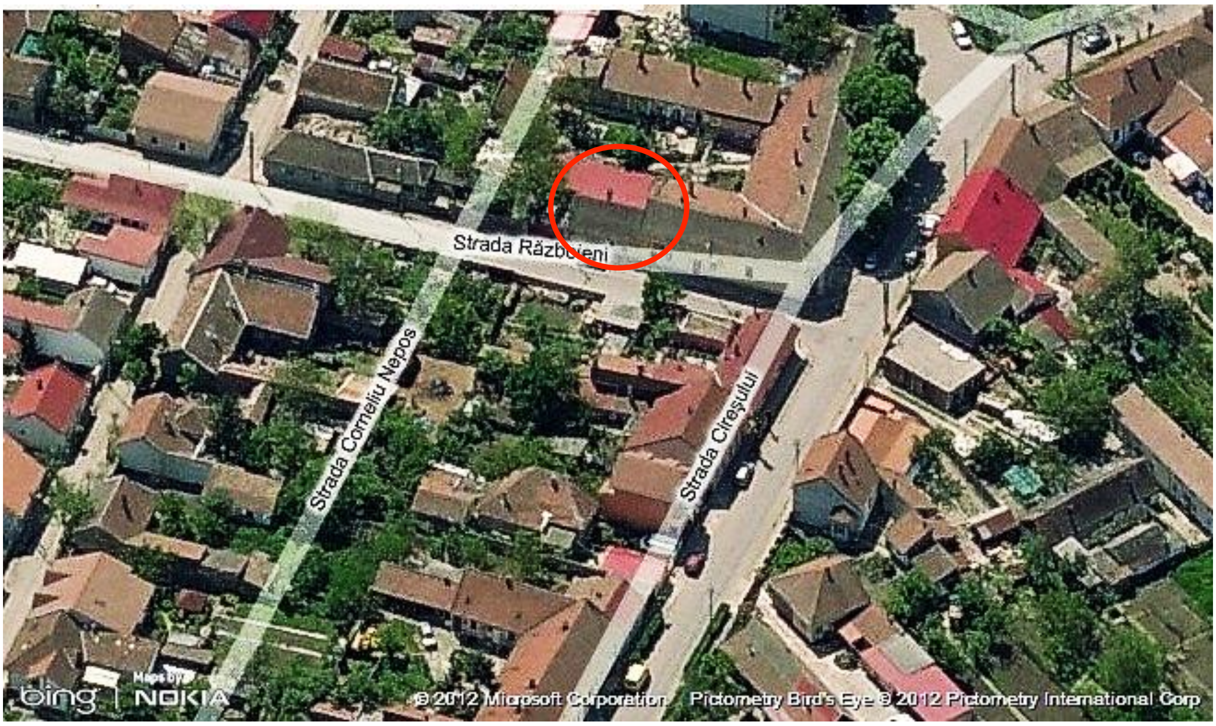
Within this business unit operates a "Chess Documentation Centre" that offers readers some 500 volumes of specialty in various languages. It organizes competitions for children and teenagers.

Subsidiary Fabric

Main activity is lending books.

<u>Subsidiary Fratelia, Subsidiary Mehala, Subsidiary Plopi, subsidiary Blascovici</u>
Main activity comprises lending services. No image available of the building hosting the library.

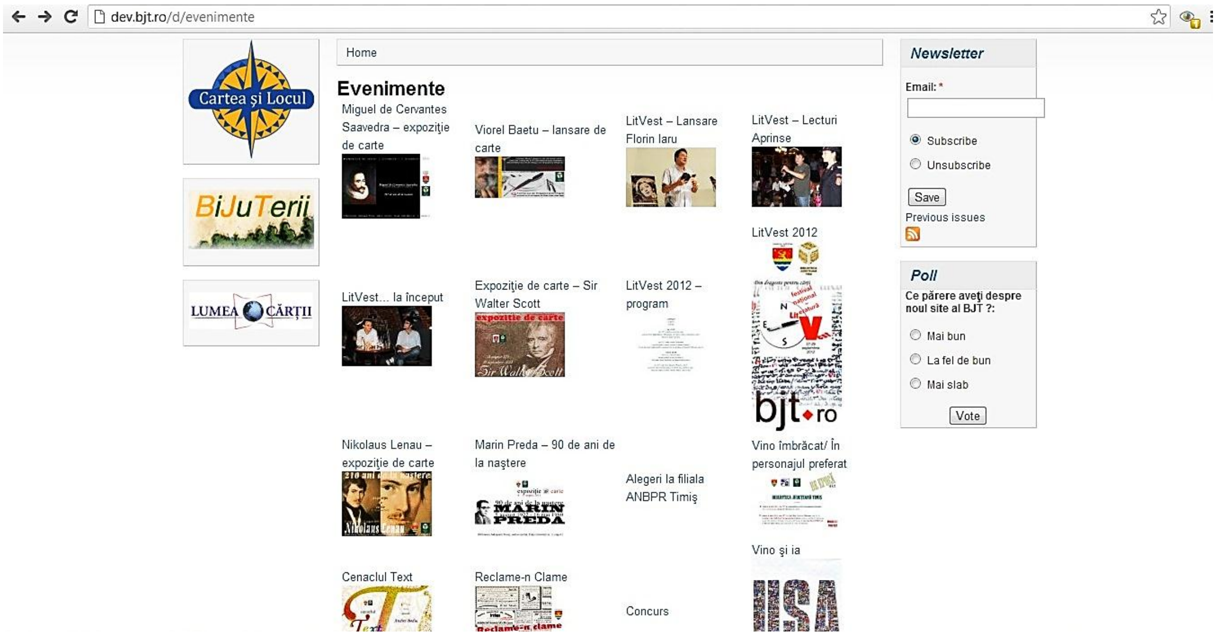
<u>Subsidiary Ronat</u>
Main service provided is books lending.



<u>Subsidiary Freidorf</u>
Main services provided are books consultation and lending.

Subsidiary Casa Tineretului
Located in the same building as a fitness centre it provides lending and consultation services.

Events & Activities



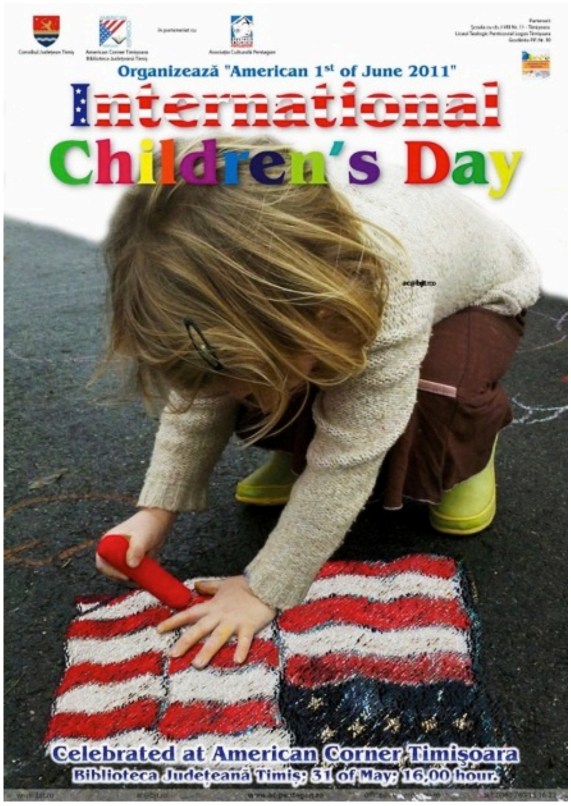


Figure 277 Events and Activities in libraries

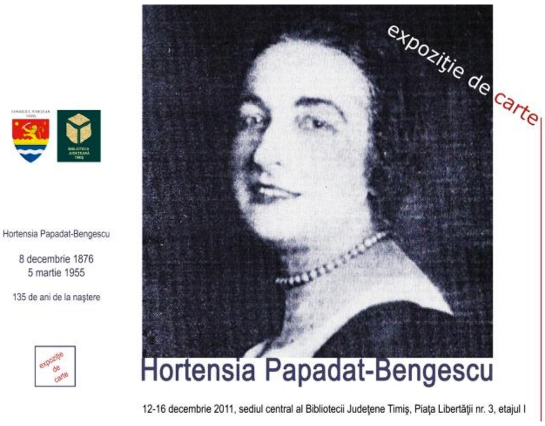


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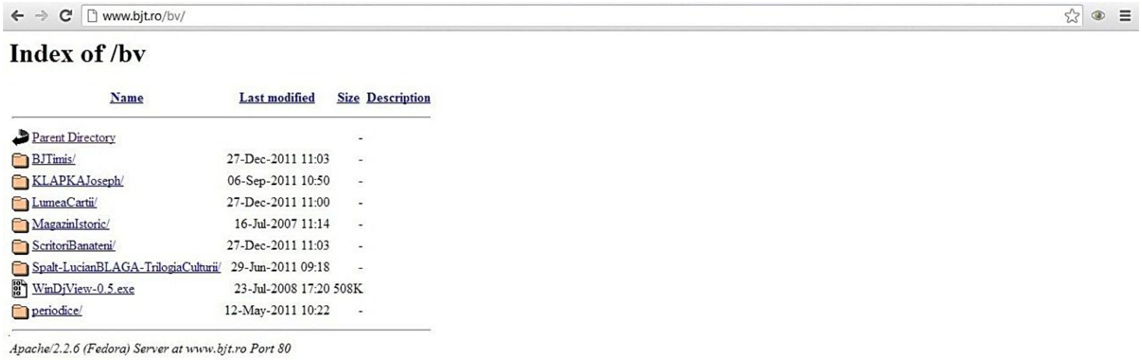
Figure 278 More events and activites in libraries



www.bjt.ro/bv/

Index of /bv

Name	Last modified	Size	Description
Parent Directory		-	
BJTimis/	27-Dec-2011 11:03	-	
KLAPKAJoseph/	06-Sep-2011 10:50	-	
LumeaCartii/	27-Dec-2011 11:00	-	
MagazinIstoric/	16-Jul-2007 11:14	-	
ScritoriBanateni/	27-Dec-2011 11:03	-	
Spalt-LucianBLAGA-TrilogiaCulturii/	29-Jun-2011 09:18	-	
WinDjView-0.5.exe	23-Jul-2008 17:20	508K	
periodice/	12-May-2011 10:22	-	

Apache/2.2.6 (Fedora) Server at www.bjt.ro Port 80

Figure 279 Virtual access to the library database

Interior Fit OUT

Figure 280 Interior library fitouts

Figure 281 Libraries in Use

Romanian Academy Library-Timisoara Branch

Timisoara Branch of the Library of the Romanian Academy works in a building which dates from 1891, destined initially to the Museum of History and Archaeology of the Banat. The edifice built in the style of German Renaissance belongs to National Cultural Heritage and was donated to the Romanian Academy in 1953. Previously, in 1941, the so-called Communal Library was holding the activity in the structure. The library of the Romanian Academy was founded and operating since 1953.

It is an encyclopaedic library, with an academic and research profile. It is part of the Romanian Academy libraries network and it is of national type. It works as a public library serving all categories of readers.

The library's heritage consists of 370 000 bibliographic units, books, periodicals, standards, patents, newspapers, audio-visual documents, described by traditional standards and on-line catalogue.

For pupils and students consultation of publications is allowed only in the reading room. Other categories of readers can borrow at home only novels. Loan at home is made only to persons with residence in the municipality of Timisoara.

Timetable: Mo – Thru 8:00 16:00; Fri 8:00 – 13:00

Areopagus Library

Areopagus library took birth as a donation from England. All 32,000 volumes are classified by topics. The subscribers have direct access to the shelter or may require a certain book. In this situation the search is done on the computer.

Subscription readers can borrow 3 books for a period of 2 weeks, with extensions for another 2 weeks. There is also the possibility to get a day pass, which allows access to the resources of the library, reading Hall respectively. Timetable Mo – Fri 10:00 – 17:00

Figure 282 More internal fitouts

Figure 283 Exterior and interior

Central University Library “Eugen Todoran”

Creating at Timisoara the University library was established by Decree-Law No. 660, on 30 December 1944, issued by King Michael I. The event occurred only in the autumn of 1948, with the establishment of the Pedagogical Institute of 5 years in Timisoara.

In 1995, it is acquired the ALEPH library software, particularly performing, which allowed full computerisation of services at B.C.U. "Eugen Todoran" and the creation of a database that contains over 150,000 titles.

In 1996, by H.G. 1297, it is approved the extension of the building of the central unit with a new body, with a total area of 5245 m2. The construction works started only in 1999, and advanced up to the roof. In 2004, the works were interrupted due to lack of funds.

Over the 11 years period, B.C.U., "Eugen Todoran" has founded ten branches besides the six existing. As an institution of culture, B.C.U. "Eugen Todoran" organized numerous scientific and cultural manifestations: 36 exhibitions, numerous book launches, and seven editions of the Symposium "book of Books", a seminar and three international symposia, a National Conference, five scientific sessions, two professional training courses and six courses of initiation in library science.

B.C.U Collections can be consulted by:

a. internal Readers: teachers, researchers, students, employees, PhD at the West University of Timisoara and teachers preparing theses degree at West University, researchers from the Academy scientific research. Internal readers can borrow books at home.

b. External readers, no tax: teachers, researchers and students from State universities in Timisoara, students in high schools for Olympic squads;

c. external Readers with tax: teachers, students and researchers at private universities and other specialists (teachers, engineers, lawyers, doctors, economists, political scientists, theologians, etc.) from Timisoara, the country or even abroad.

Timetable:

The loan and reading halls: Monday-Friday, between 8 and 20; Saturdays from 8 to 14 (and during the sessions of examinations, and Sunday, between 8 and 14).

Subsidiaries libraries: Faculty: Monday-Friday, between 8 and 16; and, where possible, between 8 and 20; Saturdays, from 8 to 14.

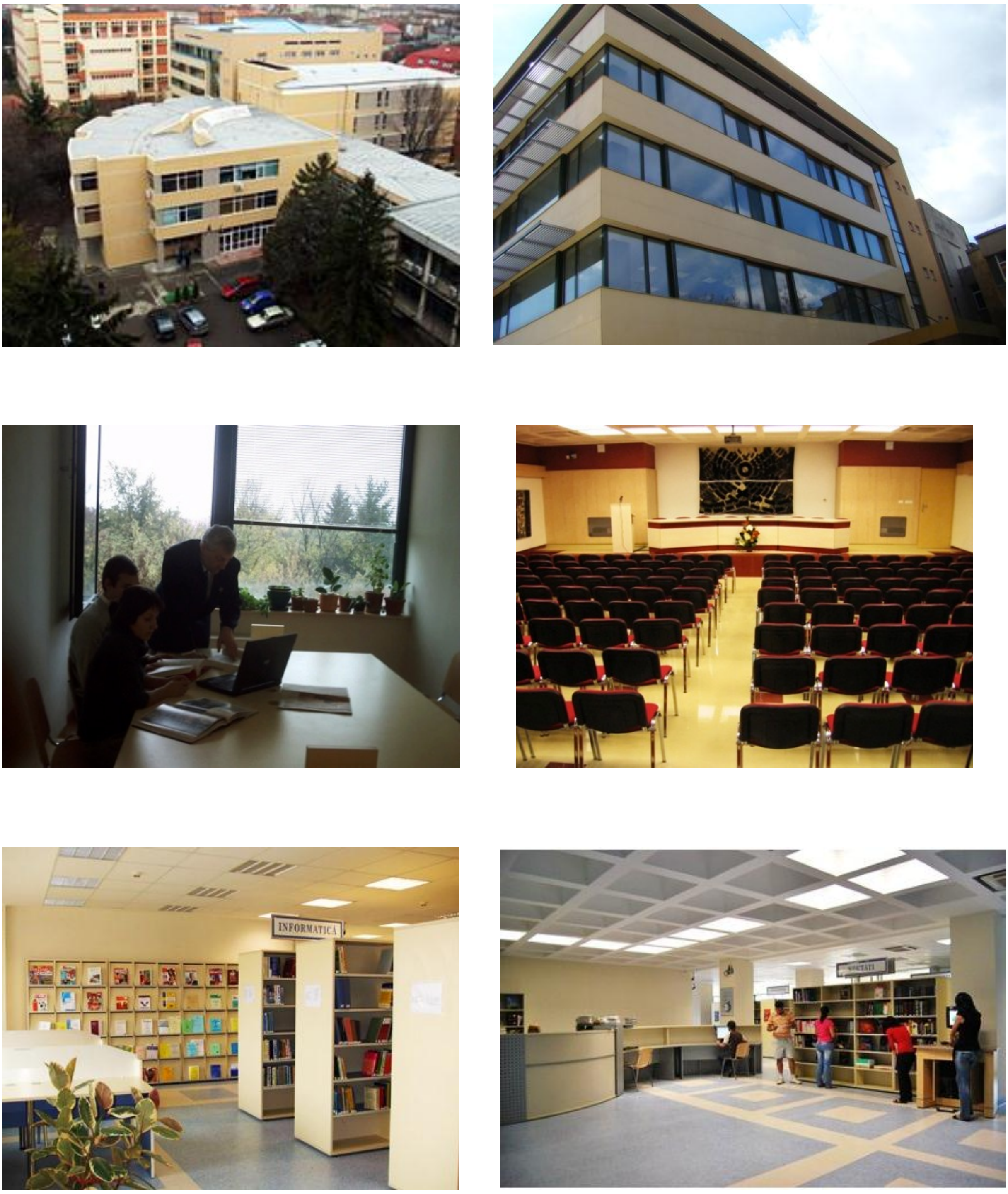


Figure 284 New city libraries

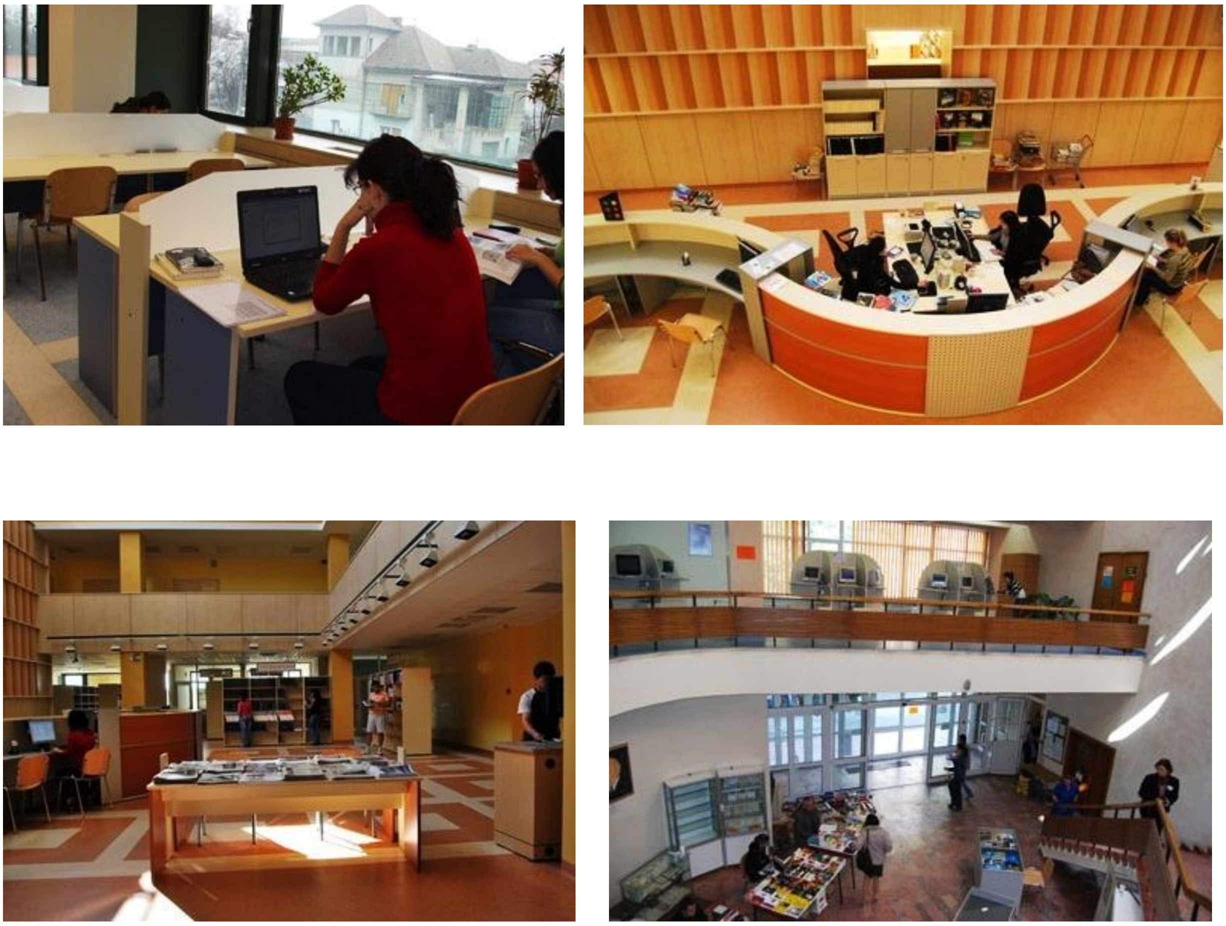


Figure 285 More new city libraries

It can be seen that still the organization and the activity is according to old patterns. The timetable is suitable only for students and pupils, the accessibility is restricted to several groups of interest and the events patronized or organized in collaboration are limited and sometimes presenting no support for a real social cohesion.

Starting with the definition of the library according to the Ministry of Culture, is the institution, compartment or specialized structure whose main purpose is to constitute, organize, process, develop and preserve collections of books, publications, other specific documents and databases in order to facilitate their use for information, research, education or recreation. It is felt from the rigid definition that even the actual way of managing libraries is rigid. The statistic website metadata correlates several terms with the notion of library proving once more that the accessibility and use of such institutions is not that flexible.

- **Types of Libraries**: *National* (e.g. Academy University, part of national information system), *Public* (e.g. County Library, of encyclopedic type at community disposal), *Specialized* (e.g. Science Library, meant for certain category of users, prioritizing their needs and access), *University* (exclusively for students and teaching stuff use, function of limiting regulations can become of public use), *School* (exclusively for pupils and teaching stuff use, function of limiting regulations can become of public use).
- **Types of users**: *Reader/User* (person consulting or borrowing books at least once per year), *Active reader/active user* (person consulting or borrowing books constantly over the year), *Subscribed user/Member* (registered person for all library services).

The future libraries are seen completely different in the contemporary architectural and social context. The new projects are set not only as places to read and study, they are more like cultural destinations and social interaction places. In order to survive in a highly commercial society they have to broaden the field of activities as well as the capacity to fulfill the requirements of a larger category of users. Easily accessible, user friendly, diverse in technical and hard copy resources, a place to meet new people, to drink a coffee, watch a black and white movie or listen to a tune of unplugged album of a rock band of the 60's; all should be simple in reaching and complex as quality.

L'IBRIdo - considering the context of the study program during which the paper was elaborated – Italy – as well as the language of the course – English – and the use and technological development of the project, one came with this suggestion. It suggested exactly what it is desired to be achieved in this building.

Libri = Books – library first of all means books, means knowledge

Ibrido = Hybrid **–** something made of mixed parts such that to obtain something stronger, more functional, resistant and performing: use, construction technology, mechanical systems etc.

Do = the verb of action, of taking initiative and change the course of the things

The final project is desired to be a place of knowledge, an example from sustainability point of view, a statement and result of taking initiative to change things.

Having defined the masterplan and more or less the function distribution within study site, one looked again at defining the final volumes via a physical model.

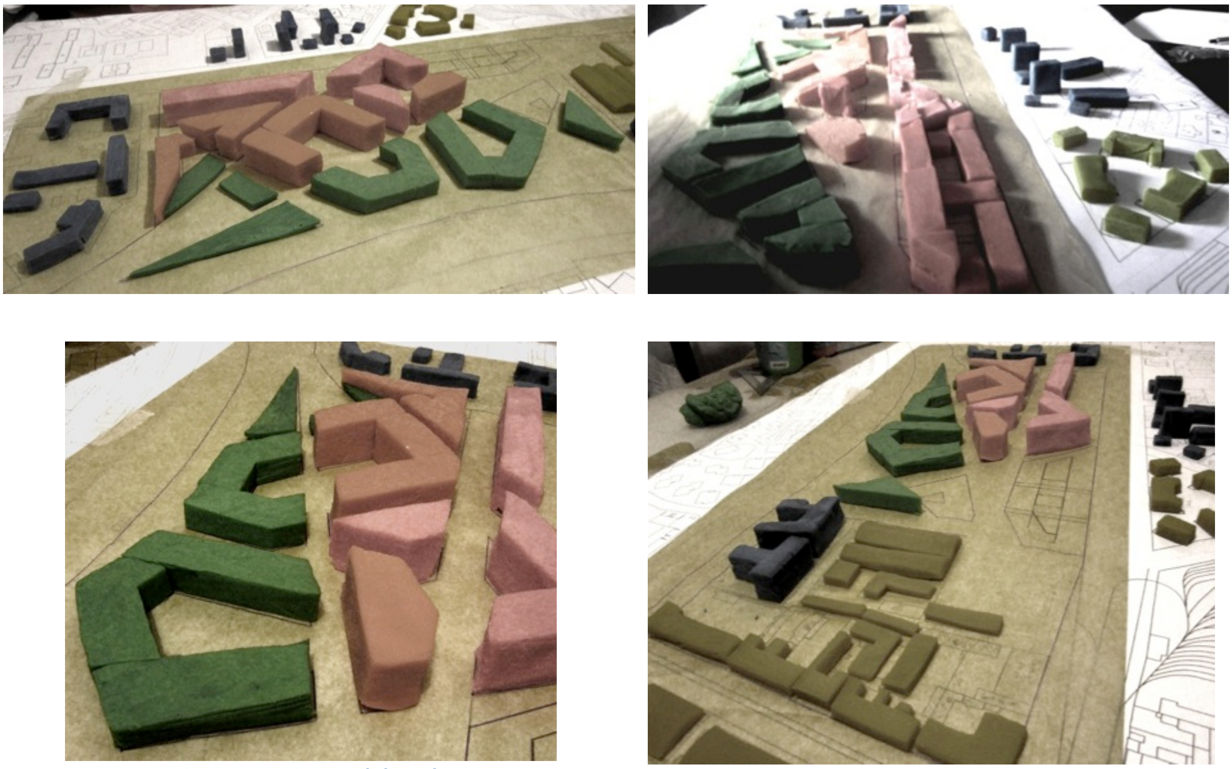


Figure 286 Site model study

Considering that the NE part of the site is reach in attraction point – agricultural market, historical buildings, church, future tram museum; one focused on the SW corner. Best exposure to the sun and green/ blue network, the spot is perfect for the location of a building that will become a landmark of the city, a hinge in connecting the new with old, green with gray, nature with buildings.

The entire concept of a sustainable, mixed use development is to be easily accessible and walkable, rich in green areas; in less word permeable and porous to human circulation and activity. Thus, the idea to make the complex as permeably as possible, allowing the access from one side to the other and within.

IV.3.2 The brief

More detailed of blocks of function distribution and circulation within the building was studied on a separate physical model: how the volumes emerge from the landscape and how they connect; best orientation of functions; best paths within the building.

Figure 287 Building model study

The final approach looked at having two building well interconnected between them. The library and a performance art centre. The library having three distinctive parts: the lower one running along NS direction, coming from the green landscape; the middle one - working as a hinge and looking to the sky via a skylight and the third one running on the WE axis comprising the "core" of the activity of the building. The performance art centre mirrors in a way the approach of a strong connection between ground and air; green and light; while in terms of function is more alive, noise and entertaining possessing exhibition area, restaurants, night clubs and a performance hall.

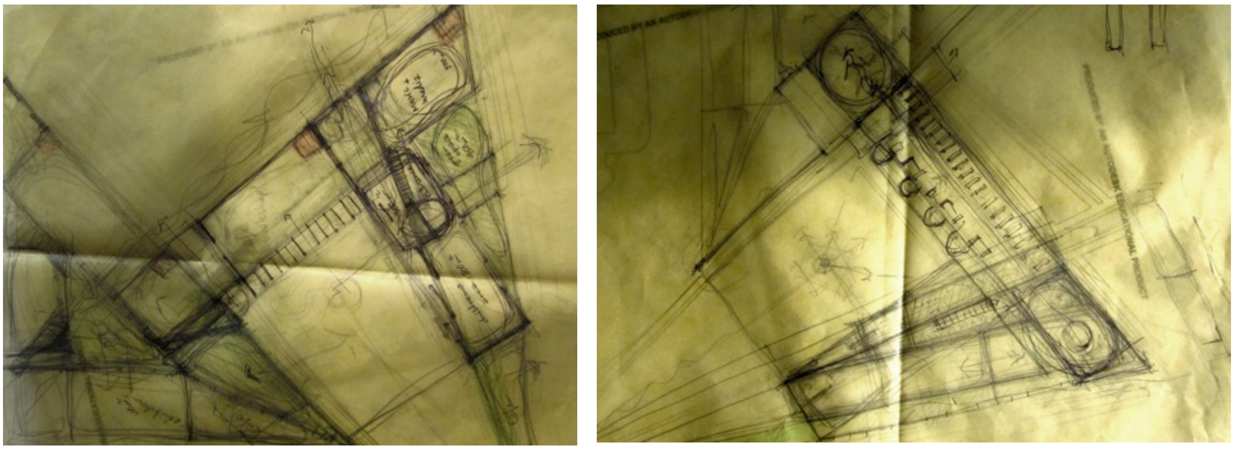


Figure 288 Library sketches

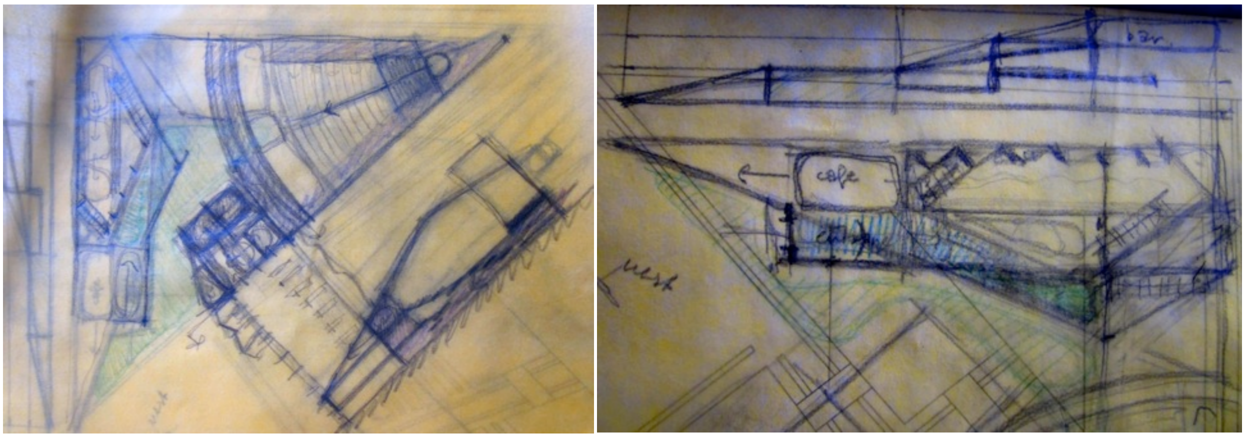


Figure 289 Performance and exhibtion space sketches

Regarding the prior use of the site – wool factory; the strong importance of Timisoara in the industrialization and technology field, and the importance of the libraries in “creating” good social specimens; one re-qualified the title of the project from a simple library to a “cultural factory”. Based on this definition the allocation of the uses inside was done. In a factory there is the main approach in the division of specialities or activities and the core of the factory which is the assembly line – where the product is manufactured – in this case the main collection area.

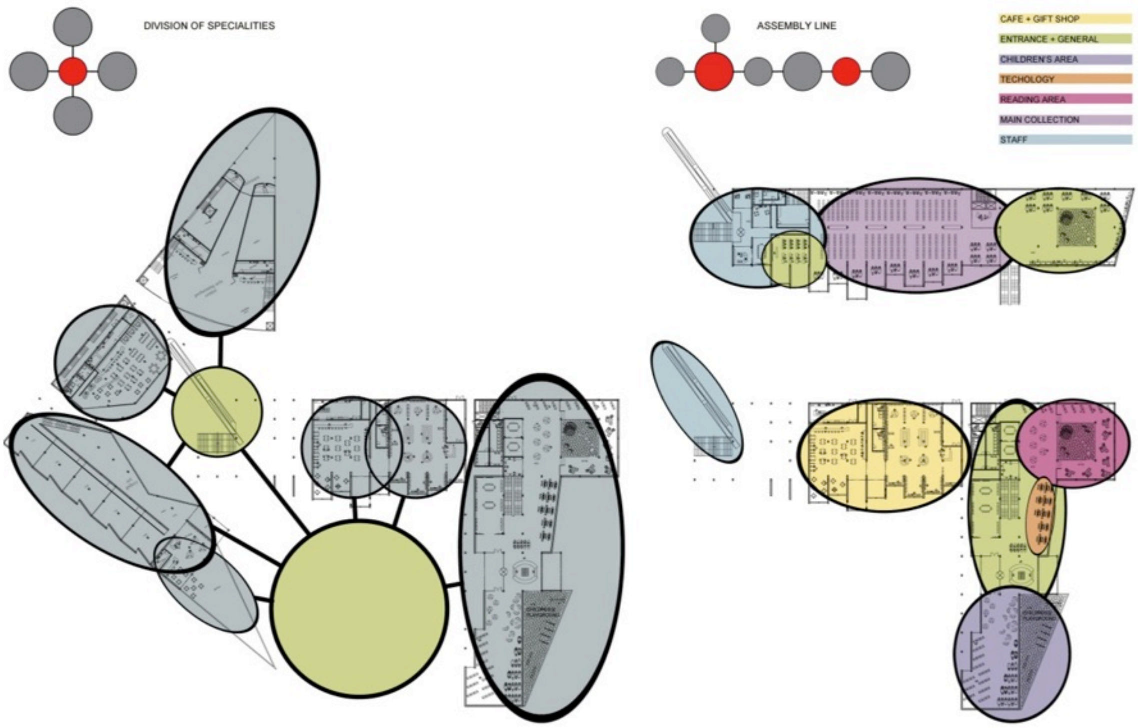


Figure 290 Conceptual approach on function distribution within a 'cultural factory'

The brief on the use and function of the building was done based on the general requirements for a structure to function as a public library. The assumption on the final number of users and the area of the development are crucial in establishing the type of library.

Table 17 Library size function of population

Site population:	590 residences 8400 traffic - offices/retail/culture
Neighbourhood:	16,357+ (site) 590 = 16,947 inhabitants
City:	314,000 inhabitants

	Branch library	Public			Central			
Inhabitants	3000	5000	10,000	20,000	30,000	50,000	70,000	100,00
Area (m2)	581	918	1350	1715	2376	3159	4185	4860
Per 10 persons	1.94	1.84	1,35	0.86	0,79	0,63	0,60	0,50

The nominated area on the site is of approximately 10,000.00 m^2, more than enough for 2,000.00 m^2 public library and additional functions. For the nominated size public library the recommended functions are:

A – Entrance section 20% of area

- information & lending
- community information area
- open shelves for new & current

- interest and themes
- consultation area
- local documentation
- journals and periodicals
- café

B – Children up to 20%
- 0-5 years
- 6 – 12 years
- 13 – 18 years

C – Reference and consultation (C+D+E+G = 30 – 45%)
- Catalogue research
- reference services and relative service spaces
- open shelves for documents in consultation
- spaces for consultation and study
- spaces for equipment for support

D – Music and entertainment
- video station on desk or information seating
- music stations on desk or information seating
- open shelves for document exhibition
- PC & multimedia section

E – Reading spaces with open shelves (non / fiction)
- spaces and able, informal seating to read
- deep storage open books
- study spaces
- trolley spaces
- group study area

F – Closed shelves stores (F+I = 10-15%)
- Storage closed

G – Special section
- conservation and consultation

I – spaces for internal services admin etc.

J – Cultural activity support 20 %

IV.3 Design

The process of designing the building considered the brief requirements. The result of the process was schematically summarized as follows:

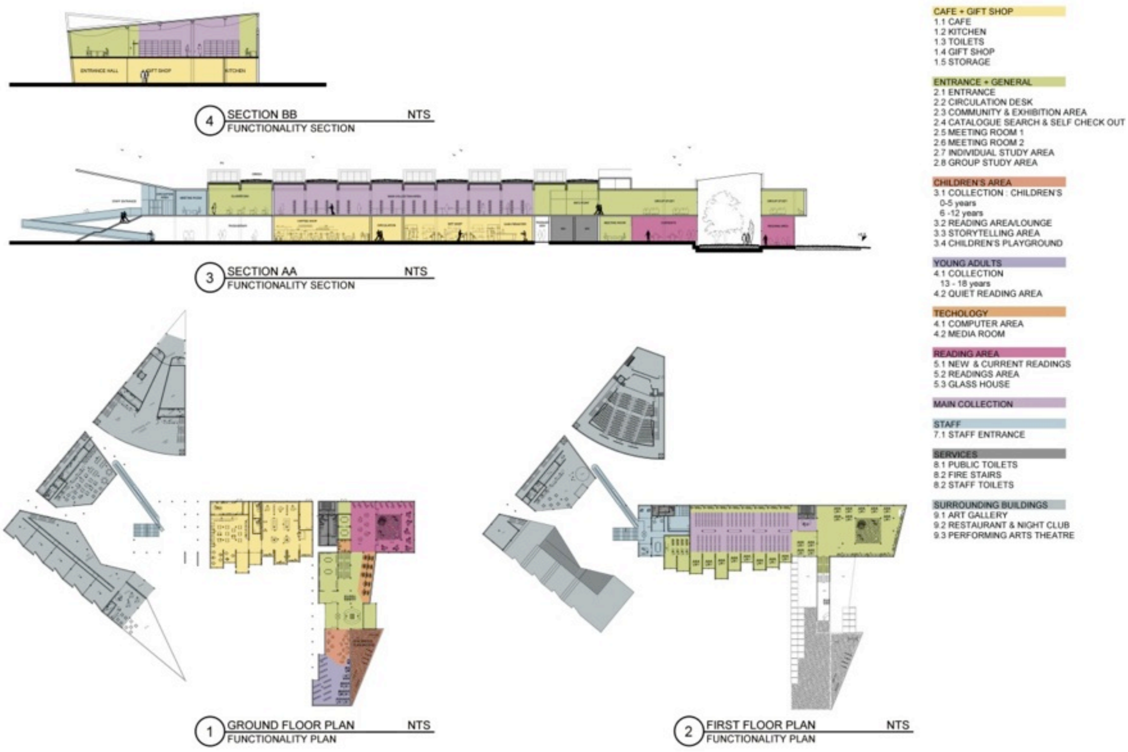


Figure 291 Library function layout

The percentage of function distribution within the building complies with the initial brief requirements. The main collection area and study places plus the children's area occupy more than 50% of the space; the additional functions like coffee shop, media and computer rooms, classrooms are within the 40% limit indicated by the guidelines.

Table 18 Library area schedule

Area schedule				
Level	**Function**	**Area (m^2)**	**Area (m^2)**	**Area (%)**
Ground Floor	café	300,00	503,00	11%
	kitchen	61,00		
	cold room	10,00		
	circulation	10,00		
	toilets	122,00		
	gift shop	386,00	439,00	10%
	storage	53,00		
	entrance	114,00	316,00	7%
	circulation desk	202,00		
	children area	362,00	362,00	8%
	self check	26,00	732,00	17%
	computer area	161,00		
	community area	110,00		
	media room	23,00		
	meeting room	46,00		
	current reading	168,00		
	reading area	140,00		
	fire escape	58,00		
First floor	individual study area	298,00	1.789,00	41%
	group study area	596,00		
	info point	152,00		
	main collection	615,00		
	classroom	128,00		
	storage	70,00	273,00	6%
	meeting room	34,00		
	office	23,00		
	entrance	85,00		
	kitchen	27,00		
	toilets	34,00		
TOTAL		**4.414,00**		100%

On the height, the distribution of functions was highly regarded based on the relation with the surrounding open spaces and the neighbour buildings' use. The ground floor is considered the active/ noisy area; permeable in terms of circulation and accessible for a longer schedule during the day and during the year. Open to the exterior it takes the activity outdoors and it brings the landscape inside: in the children area the reading outside can be performed during the warm season; facing the canal green area and interacting with the pedestrian, bicycle and green place can be easily transformed into a playground. The community area revolves around a greenhouse that brings the light in via a skylight and the ground and vegetation via the plants planted inside the greenhouse. The café and the book shop are the main stop when accessing/exciting the development site. Placed in the main way it is the place that convinces the visitor to spend time and investigate more the building. The first floor is designated for a quitter activity, more individual and scheduled ahead. It is more restrictive also from accessibility and availability point of view. It can be accessed only via tertiary space like lobbies, info point and stuff area. It has a strong visual relation with the city via the south facing glazed façade, which also creates a visual and psychological comfort for the user that studies or reads near the window. The stuff area has a separate access in order to be able to differentiate the schedules and also provide low disturbance to the users of the main collection area.

As assemble, the project functions in harmony with the landscape, surrounding buildings and most important its users.

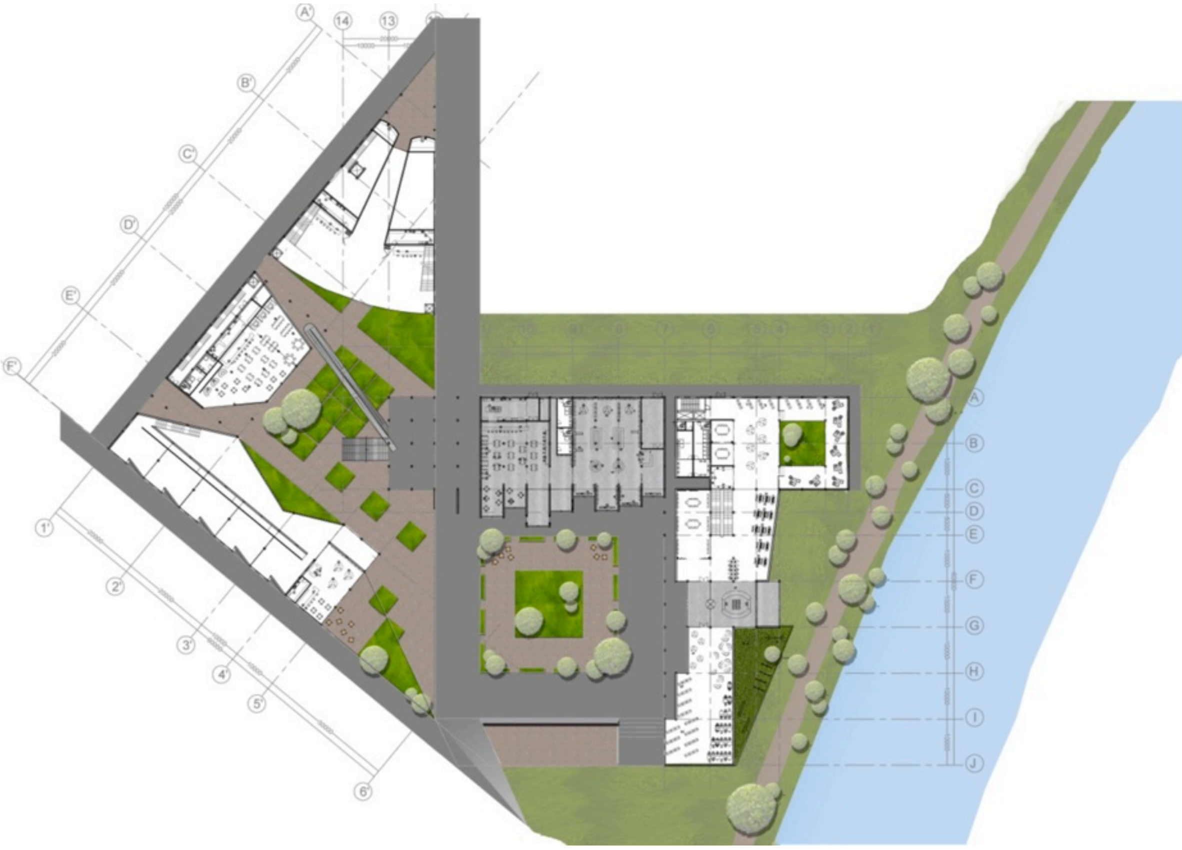


Figure 292 Landscape Plan

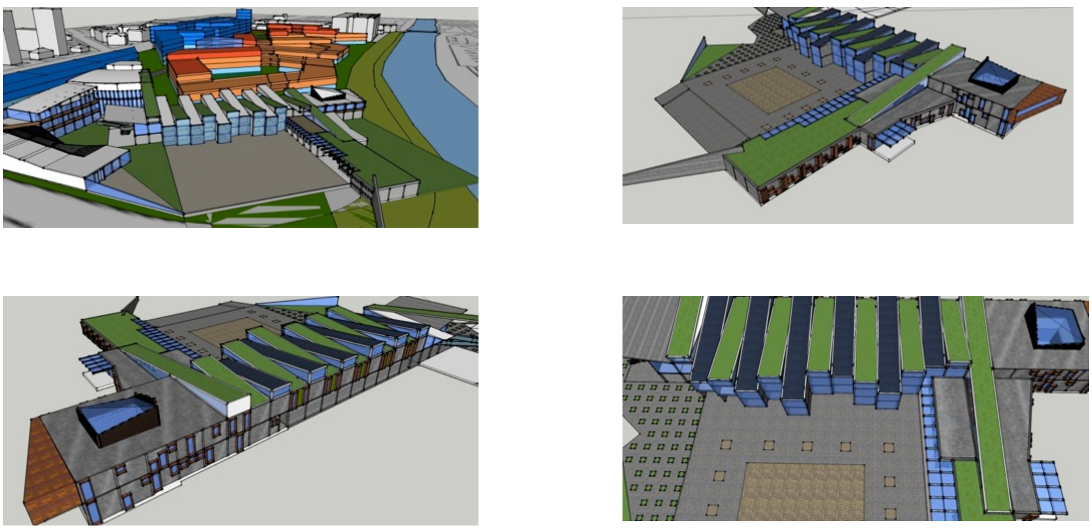


Figure 293 Building Views

Chapter V. Technology

V. 1 Climatic Data

As previously mentioned when the sustainability comes into discussion it brings along automatically the energy performance issues. The energy performance of the building is evaluated considering external and internal factors affecting the construction.

- Location function of the climatic data
- Energy sources and potential
- Solar and wind exposure in the urban/rural context
- Technical characteristics of the building: plants, structural system and envelope's materials
- Indoor ambient requirements for adequate thermal comfort of the lodgers

From climatic point of view, Timisoara is located in the moderate climate as described in the Urban Design chapter and summarized in the following schemes as per analysis in Ecotect Weather Tool based on the data provided by US Department of Energy.

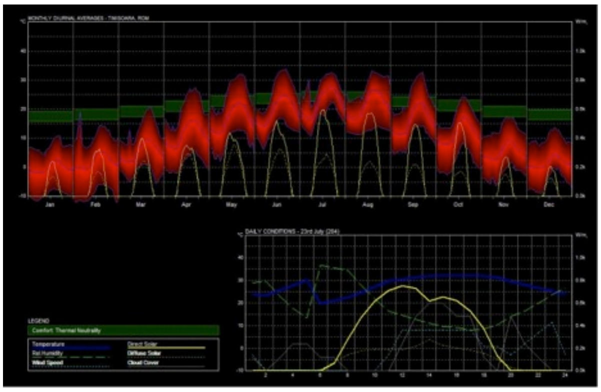


Figure 294 Monthly diurnal averages

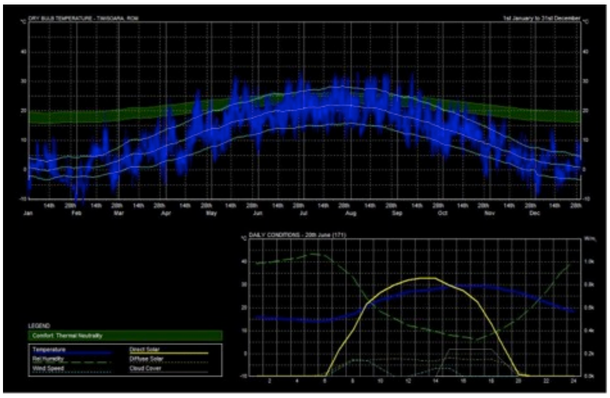


Figure 295 Monthly dry bulb temperature

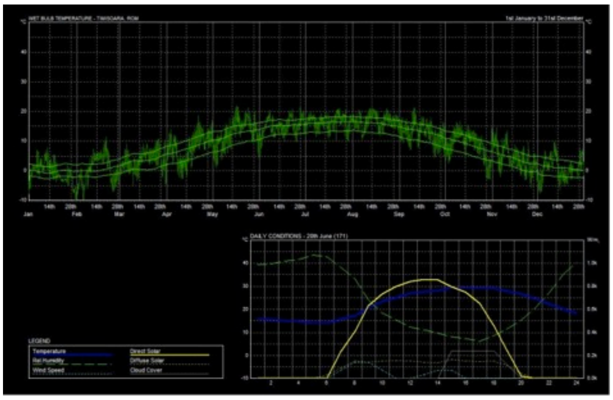


Figure 296 Monthly wet bulb temperature

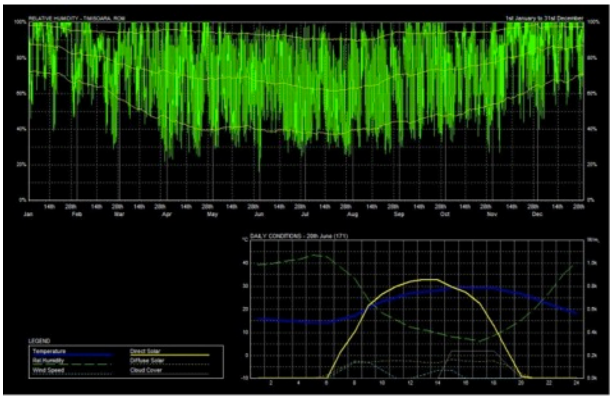


Figure 297 Monthly relative humidity

The location of the building and its orientation were considered function of the sun path and wind prevailing direction, such that to use the natural light and natural ventilation highest potential.

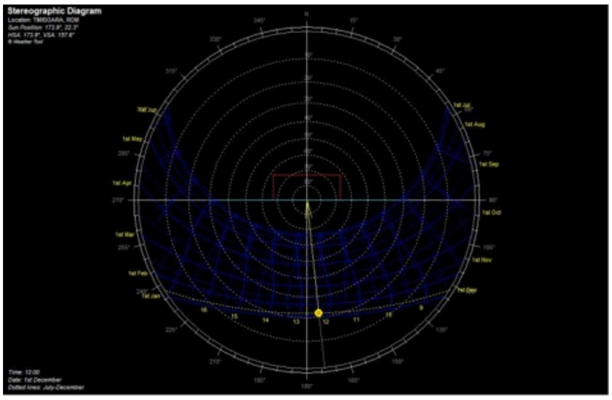


Figure 298 Solar position stereographic diagram

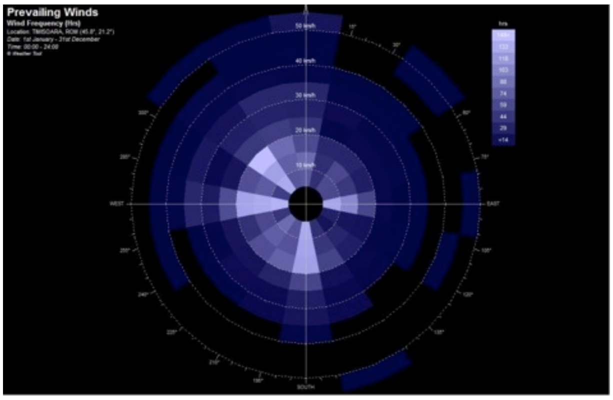


Figure 299 Prevailing winds

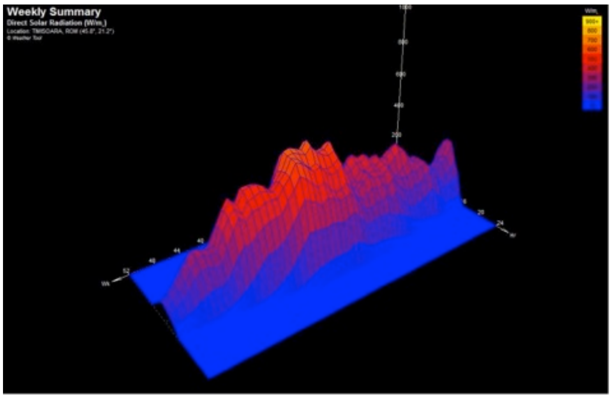


Figure 300 Direct solar radiation diagram

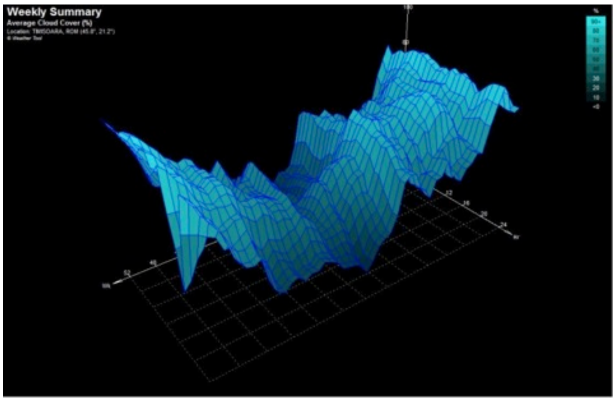


Figure 301 Average cloud cover

Table 19 Degree Days

Timisoara Weather Data								
Interval	**Measures**							
	$T_{average}$ (°C)	$Tmax_{average}$ (°C)	$Tmin_{average}$ (°C)	$Rain_{average}$ (mm)	$RH_{average}$ (%)	Dew $point_{average}$ (°C)	Heating degree days	Cooling degree days
Year	11	17	5	620	82	7	3212,2	256,9
Jan	-1	2	-5	40	91	-3	611,4	-
Feb	1	5	-3	40	87	-	502,2	-
Mar	5	11	-	40	81	1	378,9	-
Apr	11	18	5	50	80	6	191,7	-
May	16	23	10	60	77	11	43,1	-
Jun	19	26	13	80	79	15	-	41,7
Jul	21	28	15	50	74	16	-	111,9
Aug	21	28	14	50	75	15	-	103,3
Sep	18	25	11	40	76	10	8,3	-
Oct	12	18	6	50	85	7	189,4	-
Nov	6	11	2	40	92	3	341,7	-
Dec	1	4	-1	40	89	-	525,3	-

The city is characterized by an average temperature of 11°C and relative humidity of 82% throughout the year. The minimum recorded was -29°C in February and the maximum 40°C in August, but generally the days with temperature below -17°C can be summed up to two per year, while the days with temperature above 0°C are considered 103. The precipitations are not that abundant with an average of 620mm per year it can be assumed that more or less 5 day per month it rains.

In terms of energy resources one looked into the potential of the region in order to decide which alternative energy resource will be used for the building sustainable performance.
RES for Timisoara study, done by Fraunhofer in 2008, shown that more than one field can be brought into discussion: biomass, geothermal, solar, wind, hydro.

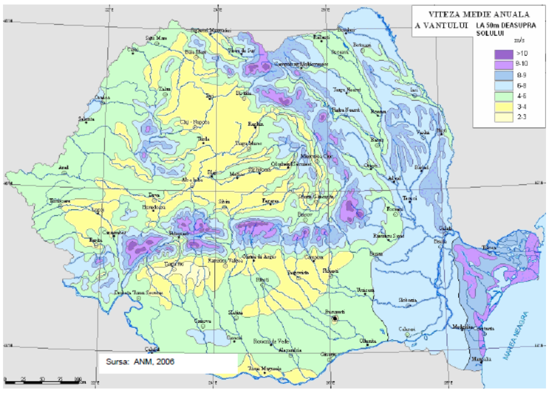


Figure 302 Wind potential

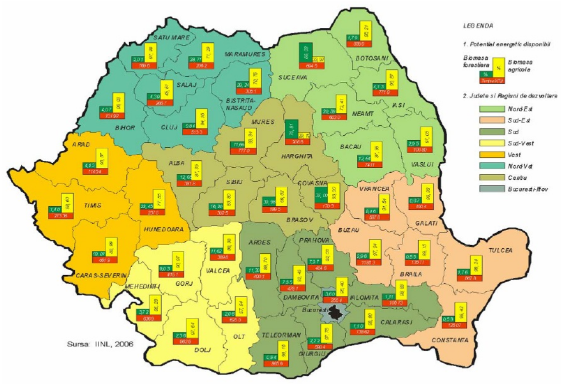


Figure 303 Biomass potential

The wind speed at 50m height is 3-5m/s, quite low to be efficiently used for energy generation. The potential for biomass in the county is high from agriculture (98%) reaching 1,930,000.00 m^3 per year (118l/inhabitant /day) resulting in energy potential of 11,580.00 MWh/year. The future investment in this field will be in a mud treatment plant from residual water.

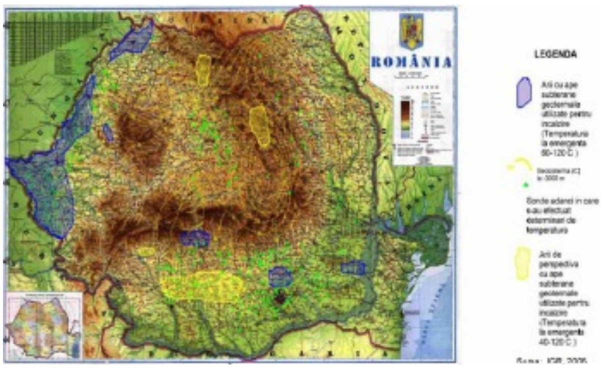


Figure 304 Geothermal potential

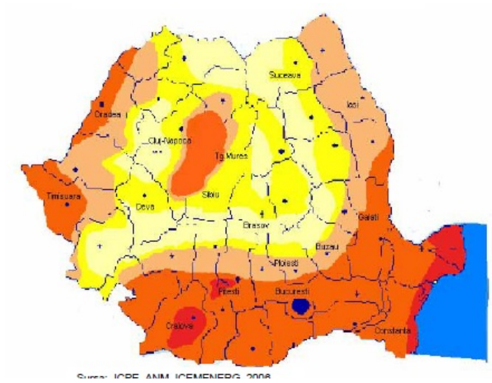


Figure 305 Solar radiation potential

The 50% of the Timis county surface has at 3000m depth temperatures located between 60-120° C and 10% of the surface with a potential of temperatures above 140°C – basically a hot spot. Under Timisoara the temperature is estimated to be around 100°C, with an average geothermal flux of 60MW/m^2 which is in general too small to be used for energy exploitation purposes.

Considering solar radiation intensity, Timisoara is located in zone II with a capacity of 1300-1350 kWh/m² per year. The optimum inclination for the panels is 35°.

PVWatts — AC Energy & Cost Savings

(Type comments here to appear on printout; maximum 1 row of 90 characters.)

Station Identification	
City:	Timisoara
Country/Province:	ROM
Latitude:	45.77° N
Longitude:	21.25° E
Elevation:	88 m
Weather Data:	IWEC
PV System Specifications	
DC Rating:	4.00 kW
DC to AC Derate Factor:	0.770
AC Rating:	3.08 kW
Array Type:	Fixed Tilt
Array Tilt:	45.8°
Array Azimuth:	180.0°
Energy Specifications	
Energy Cost:	0.2510 leu/kWh

Results			
Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)	Energy Value (leu)
1	2.03	183	45.93
2	3.07	256	64.26
3	4.21	387	97.14
4	4.71	406	101.91
5	5.46	474	118.97
6	5.87	476	119.48
7	6.27	521	130.77
8	5.99	501	125.75
9	5.04	419	105.17
10	4.40	391	98.14
11	2.47	213	53.46
12	1.74	153	38.40
Year	4.28	4379	1099.13

PV electricity generation for: Nominal power=1.0 kW, System losses=14.0%		
	Inclin.=35 deg., Orient.=-1 deg.	
Month	Production per month (kWh)	Production per day (kWh)
Jan	49	1.6
Feb	67	2.4
Mar	100	3.2
Apr	112	3.7
May	131	4.2
Jun	128	4.3
Jul	139	4.5
Aug	136	4.4
Sep	116	3.9
Oct	96	3.1
Nov	54	1.8
Dec	41	1.3
Yearly average	97	3.2
Total yearly production (kWh)		1169

Figure 306 Solar panels as per PVWatts standard house 4 kWp

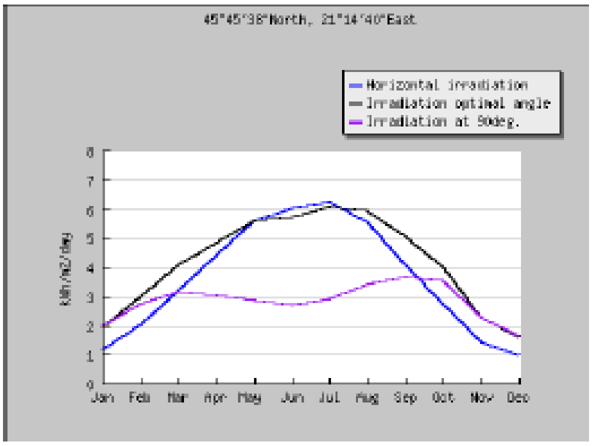


Figure 307 Monthly solar Irradiation

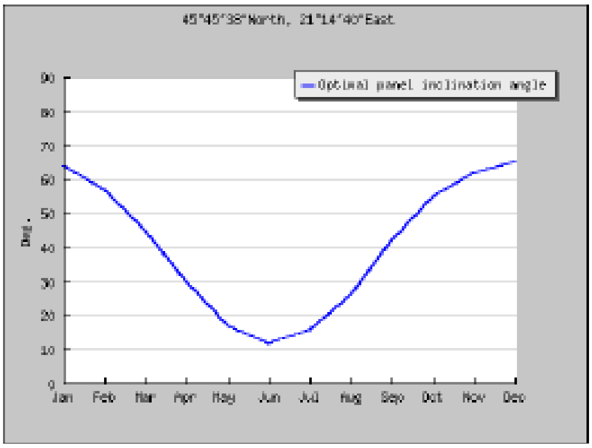


Figure 308 Optimal inclination angle

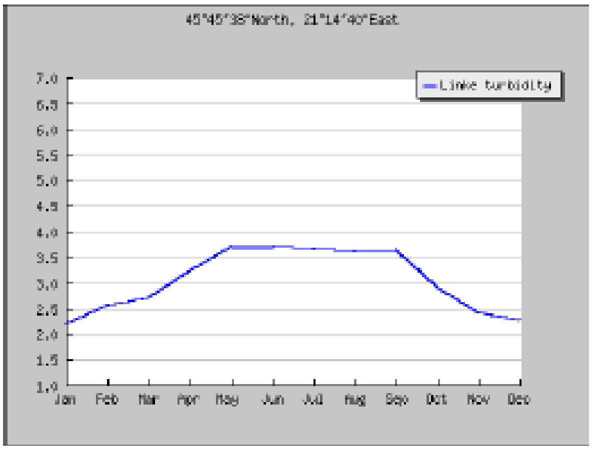


Figure 309 Linke turbidity

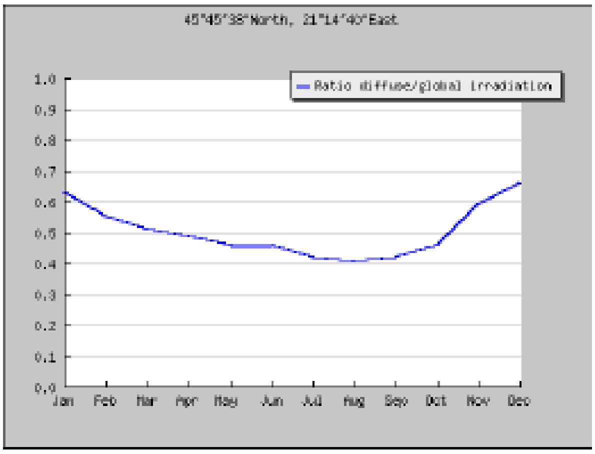


Figure 310 Ratio of diffuse to global irradiation

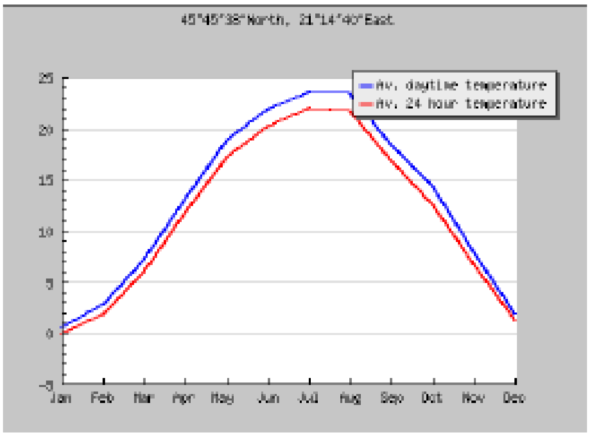


Figure 311 Average temperature

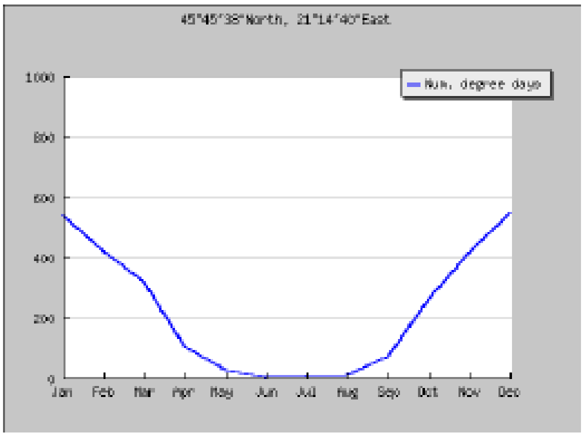


Figure 312 Number of heating degree days

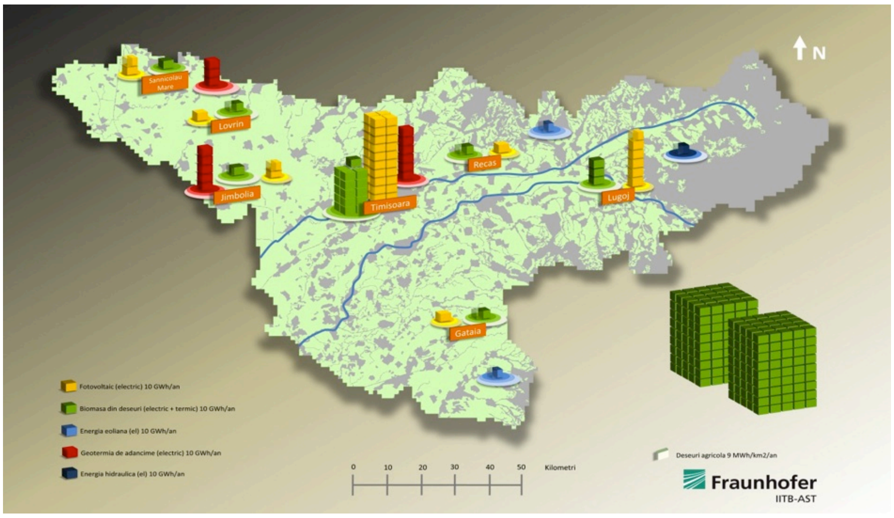


Figure 313 Summary for energy potential in Timis County

From the analysis it can be deducted that the most efficient will be the use of solar energy. Solar panels used for hot water or electricity production alternatively used with the city sources. SC Colterm SA, owned by Municipality, is the operator of the entire district heating system chain in the city and it supplies heat for about 230000inhabitants which is around 70% of total heat demand of the city.

The functionality of the building should be adequate such that to satisfy all its occupants with a degree of in-satisfaction around 5%. The comfort parameters are defined for the two seasons: winter and summer; defining on the psychrometric charts the two zones of comfort.

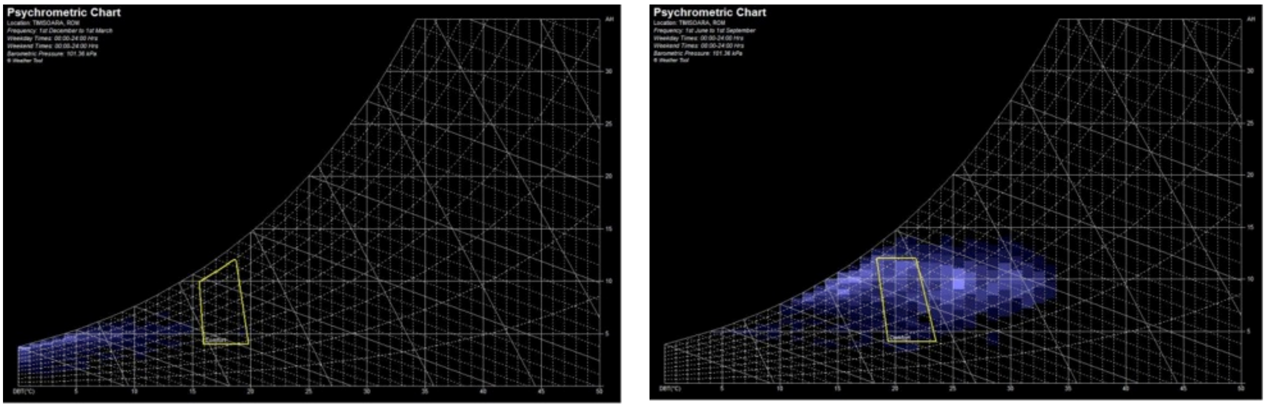


Figure 314 Comfort Zone Winter and Summer

Therefor the parameters to be analysed for determining the environmental comfort are:

- Air temperature (Dry bulb temperature, Mean radiant temperature, operating temperature)
- Humidity (Relative Humidity)
- Air movement, ventilation
- Radiation

Other variables with influence on thermal performance of building:

- Shape: surface to volume ratio, orientation
- Fabric: shading of surfaces, surface qualities (absorbance, reflection), thermal insulation, thermal inertia, relative position of resistive and capacitive layers
- Fenestration-light: size, disposition, orientation, special glasses, blinds, curtains, shading devices
- Sound-acoustics

To evaluate and use the parameters above in the proper manner one analysed the energy performance of the actual buildings in Timisoara – performing in C or D energy class – and to set the goals for the new designed building – class A energy class.

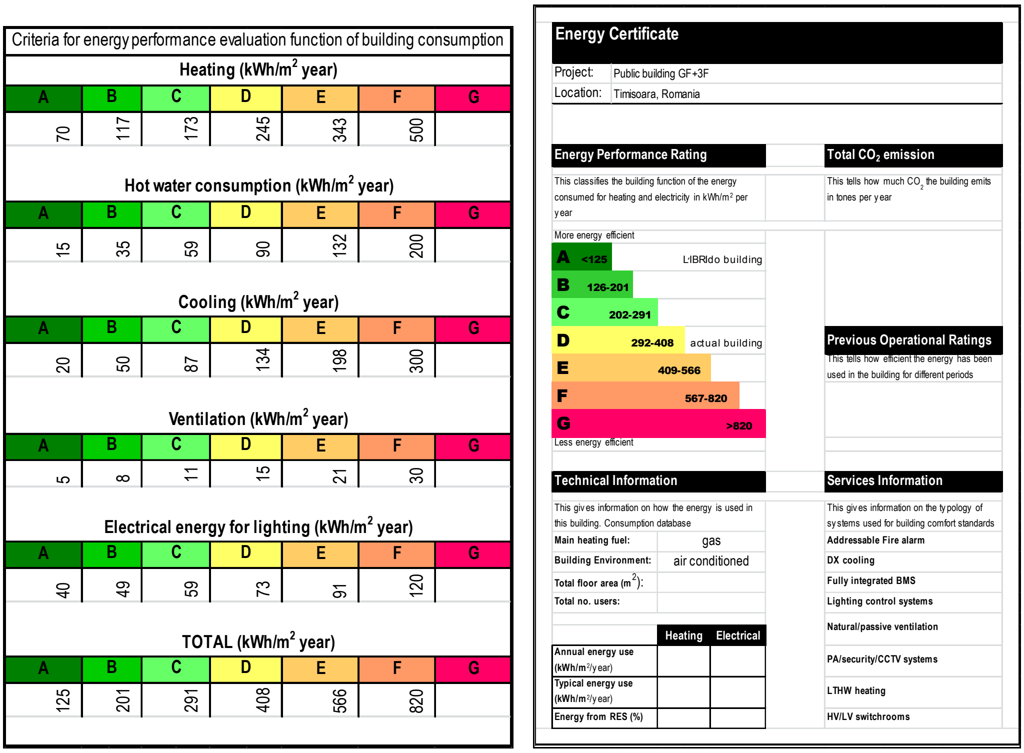


Figure 315 Energy Certificate form

Table 20 Target goals for the building energy efficiency

Site 113000m² Building 3580m²	Hot water kWh/m²/year	Heating kWh/m²/year	Illumination kWh/m²/year	water l/day/capita	Total energy kWh/m²/year	CO_2 kg/m² year
Typical lifestyle	100	230	11	340	341	78
L'IBRIdo project	59	70	40	100	125	27,5
Low energy building	15	50	20	91	120	26,4

For a project like a library or a civic center the aspects related to acoustics and illumination are crucial for environmental comfort. Consequently, light and sound projects will be treated with priority for L'IBRIdo project.

HEATING, COOLING, LIGHTING AND ACOUSTICS AS FORM-GIVERS IN ARCHITECTURE

V.2 Lighting

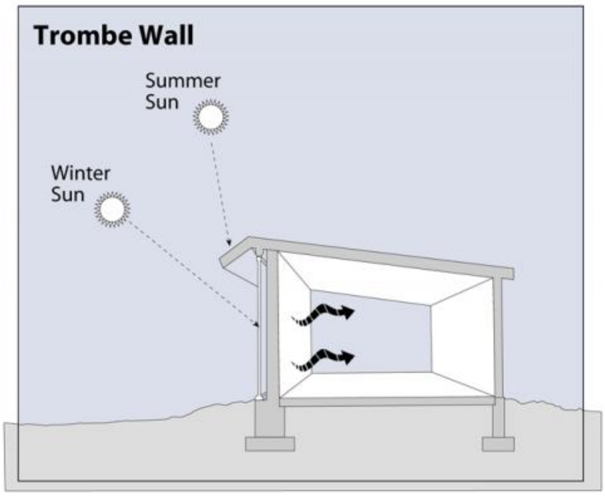
Daylight is the use of windows and skylights to bring sunlight into the building. The lighting design will look into maximizing the use of natural light and reduction in artificial lighting use during daylight hours. The location of the windows will be located function of the cardinal direction such that to incorporate daylight potential at maximum:

- South facing windows for direct sun, but properly shaded
- North facing windows for even natural light producing little glare and almost zero heat gain
- East and West facing windows good for morning and evening light, but should be properly shaded to avoid the glare and high heat gain.

L'IBRIdo south façade is placed not having an obstructed view of the sun. The idea is to use the building as a passive solar construction. The sun light coming in through the south facing windows is retained in materials that store heat, thermal mass - like concrete, brick, stone, tiles. The heating load provided by this system is called passive solar fraction and depends on the area of glazing and amount of thermal mass, which depends on the climate.

For a successful passive solar building the elements to be considered are insulation and air sealing, window location, glazing type and shading device, thermal mass location and type and auxiliary heating and cooling systems. The design techniques include direct gain, indirect gain and isolated gain.

In direct gain design the sunlight comes in the building via south facing windows, stored in the walls and floors that absorb and store heat which is released into the room during the night when the ambient temperature drops. An indirect gain passive system, the construction has the thermal storage between the south facing windows and living space – e.g Trombe wall. The isolated sun gains are captured via a sunspace that can be separated from the building with operable openings like windows or doors, which generally is called sunroom or solarium.



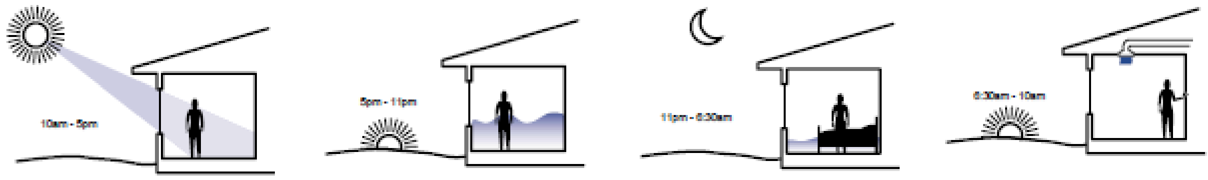


Figure 316 Passive heating and thermal mass

The high insulation and air tightness of the building envelope as well as the thermal mass are the keys in the good passive solar design. Accordingly, the skeleton of the structure should contain materials providing thermal mass, while the skin should be composed of layers of insulation with high resistance.

The solution proposed for the bearing structure is mixed concrete frame and steel structure. For the envelope the dry construction high insulated solution together with highly efficient glazing will be adopted.

In the previous steps of the urban and architectural design the sun study influenced the final decision on buildings high typology and orientation on site. The building is not affected by the shadow coming from the neighbour construction and the long axis runs east-west.
In the preliminary design the final use for the study building was established to be a library. The inner allocation of uses was mainly established due to the building orientation. Initial glazed surface was defined keeping in mind that a minimum of 5% of room floor should correspond to the vitreous surface. In order to decide the final window arrangement and exposure one should look at the basic design parameters for light for a library.
It is well known that the natural light has first of all a biological and psychological function for the humans. It offers the temporal orientation especially for the persons working for a long time in the same space; it can offer a high degree of relaxation during sedentary activities.
For the libraries, in the study and reading areas the natural light should prevail. The areas of open shelves or deposits can use either indirect light or artificial one, while the closed deposits can be provided only with artificial light. Even the natural light is important, it is worth mentioning that the direct light in the reading and video areas should be avoided due to glare effect. The south façade should be protected via the horizontal shading devices as brie-soleil or venetians, while the east and west by using vertical (even mobile) devices. The north exposure is considered adequate for the study- reading areas due to homogeneous diffused light.
In the table below the spaces and lighting levels are summarized:

Table 21 Light requirements

Space use	Lighting performance (lux)
Reading & studying room	400 – 500 (at the working level)
Multi – media room	150 – 300
Meeting room	250 – 400
Exhibition / coffee shop	100 – 300
Circulation	200 – 300
Entrance	100 – 150

Open shelves	100 – 200
Storage	150 – 200

Function of orientation and distribution of space use and siting/ reading area, the maps of required values were sketched – illuminance in the library.

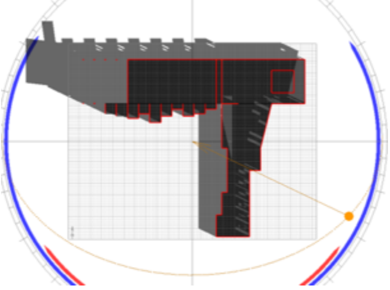
Figure 317 Required natural light GF & FF

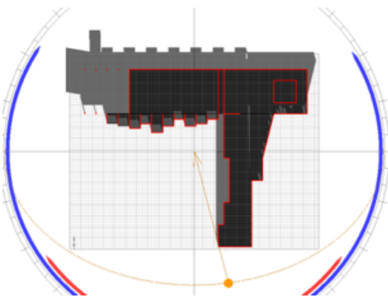
For the reading and study the maximum required amount of light is colored in red and as summarized in the previous table should be around 500 lux. At the opposite end of the scale are the entrance, circulation and coffee shop – yellow colored areas with a lighting level of 100 – 200 lux.

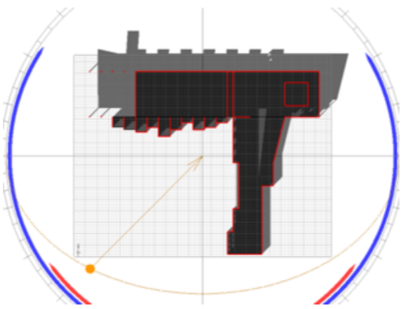
The first step of the lighting analysis considers the building with the proposed fenestration without shading dives and having double glazed low – E windows. The distribution of the windows was based on the concept that the natural light is the best light for reading and as well as the use of natural light reduces electricity consumption.

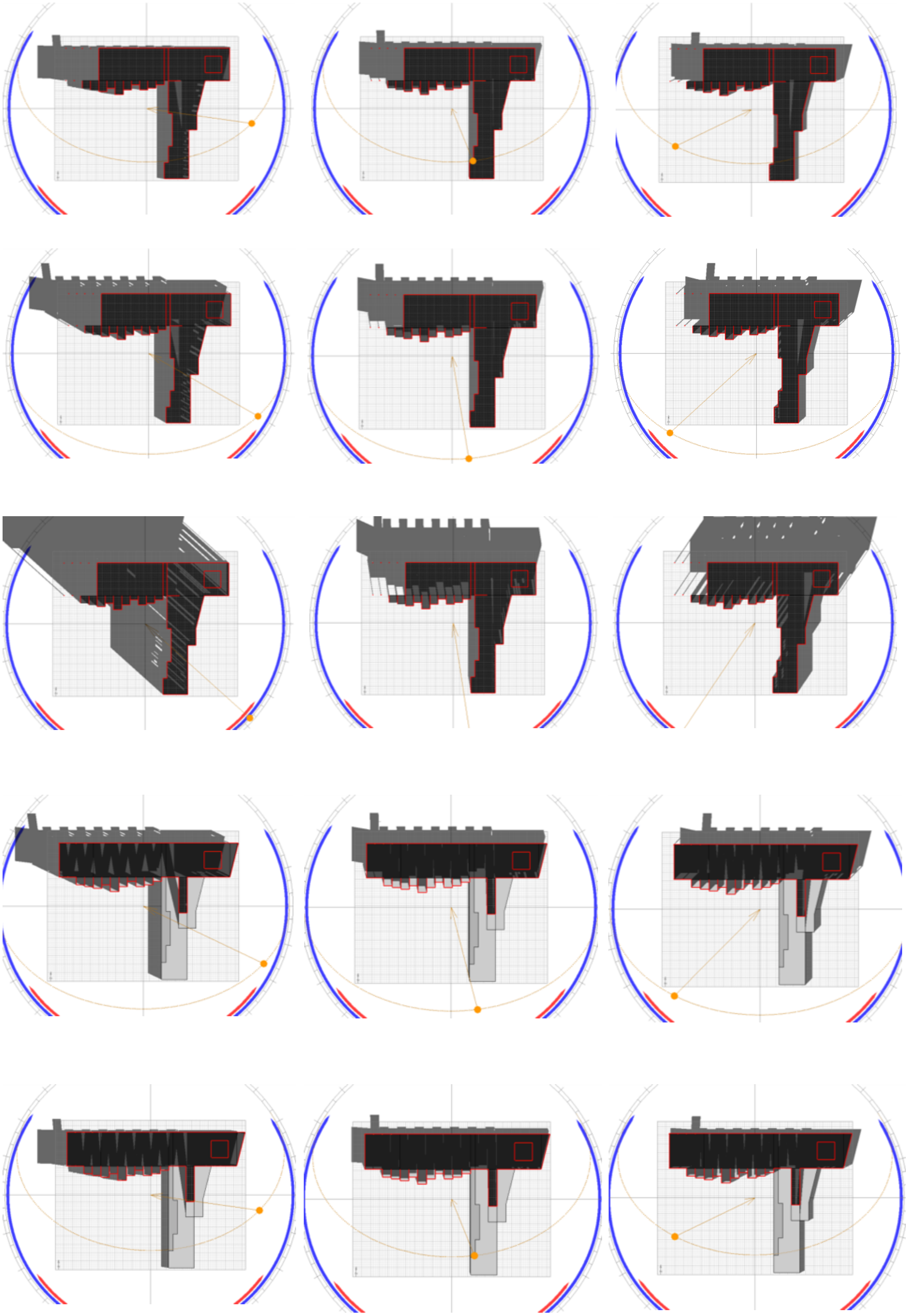
The N-S orientation of the building allows having the south façade continuously exposed to sunlight. The shades that the building generates were studied for the 2 solstices and 2 equinoxes in a year, at three important moments of the day: morning – 9:00; noon – 12:00; and afternoon – 15:00.

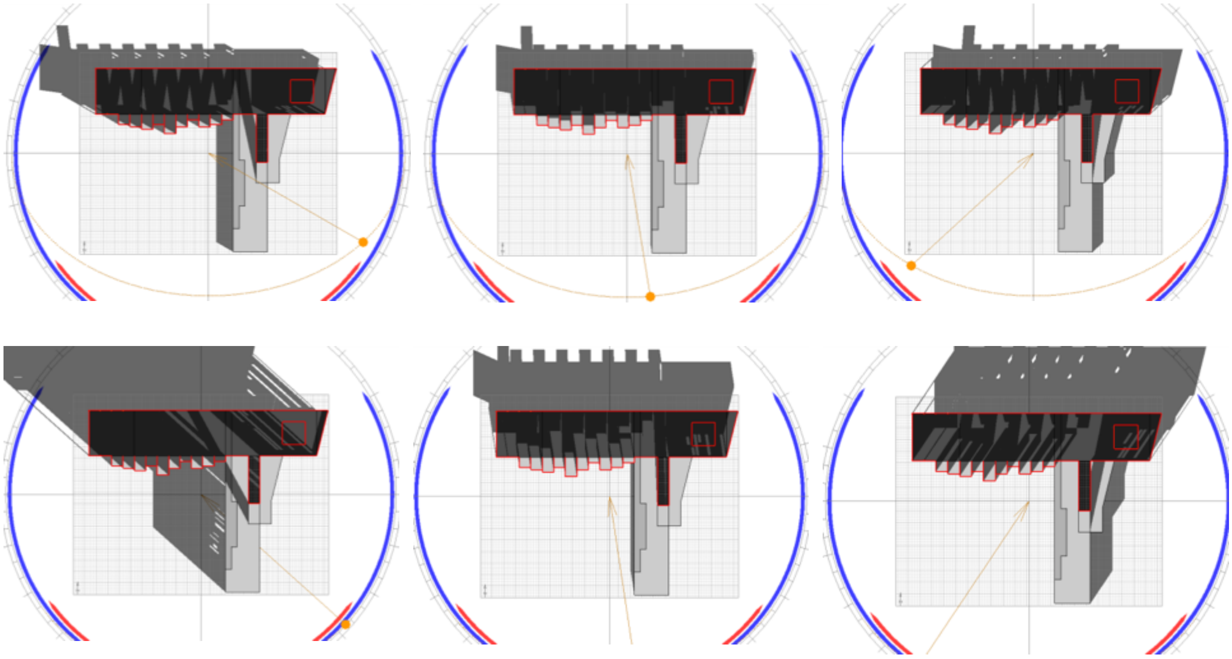
Table 22 Sun studies summer / winter/ equinox











The preliminary view of the shades and light distribution within the building emphasizes the good orientation of the building and proper fenestration distribution.
To better understand the performance of the design fenestration, the lighting analysis in term of daylight factor and illuminance level is done for the two levels of the building.

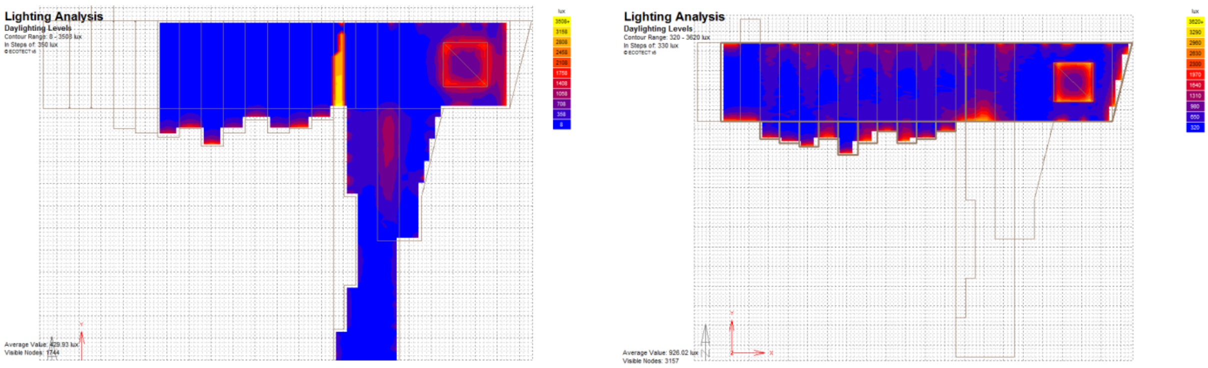


Figure 318 lighting levels GF and FF

The first analyses of the lighting level inside the building considering overcast sky (8500 lux) and no shading device gave an average value for the ground floor of 430 lux (daylight factor 5.06%) with higher values near the openings between 600 and 2000 lux and for the first floor an average value of 930 lux (daylight factor 10.89%), again with higher values close to the openings, between 1000 and 3000 lux.
The analysis proves that the designed windows need a shading system and that the artificial lighting to be used during the day will be required for some areas – core area of the children room (the actual level is around 200 lux) and the coffee shop where the levels go below 100 lux.

The south façade which benefits from the highest amount of solar radiation and daylight availability has to have the highest thermal and glare avoiding performance. The proposed solution is a double skin façade with a built in shading system.

The comparison of two windows – one with no shading double glazed and the second with the double skin (triple glazed) and shading system incorporated in terms of solar rays penetration and illuminance level were performed.

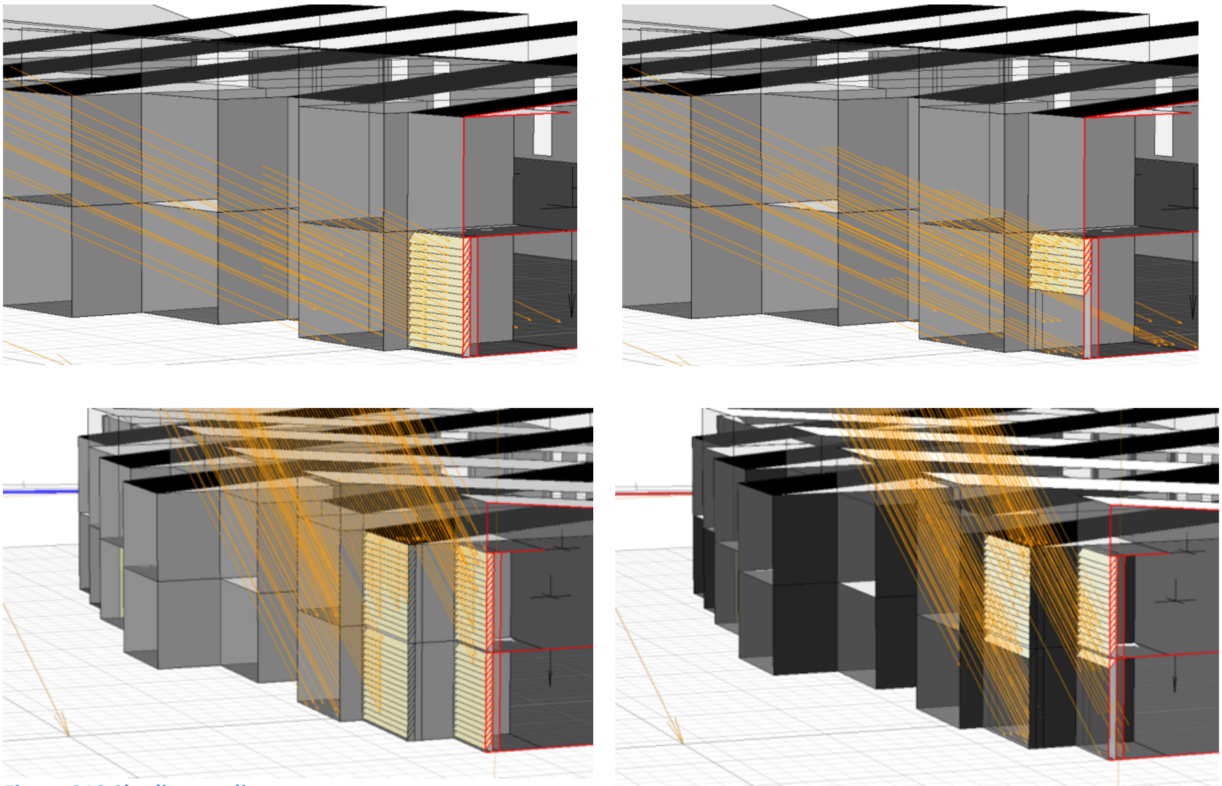


Figure 319 Shading studies

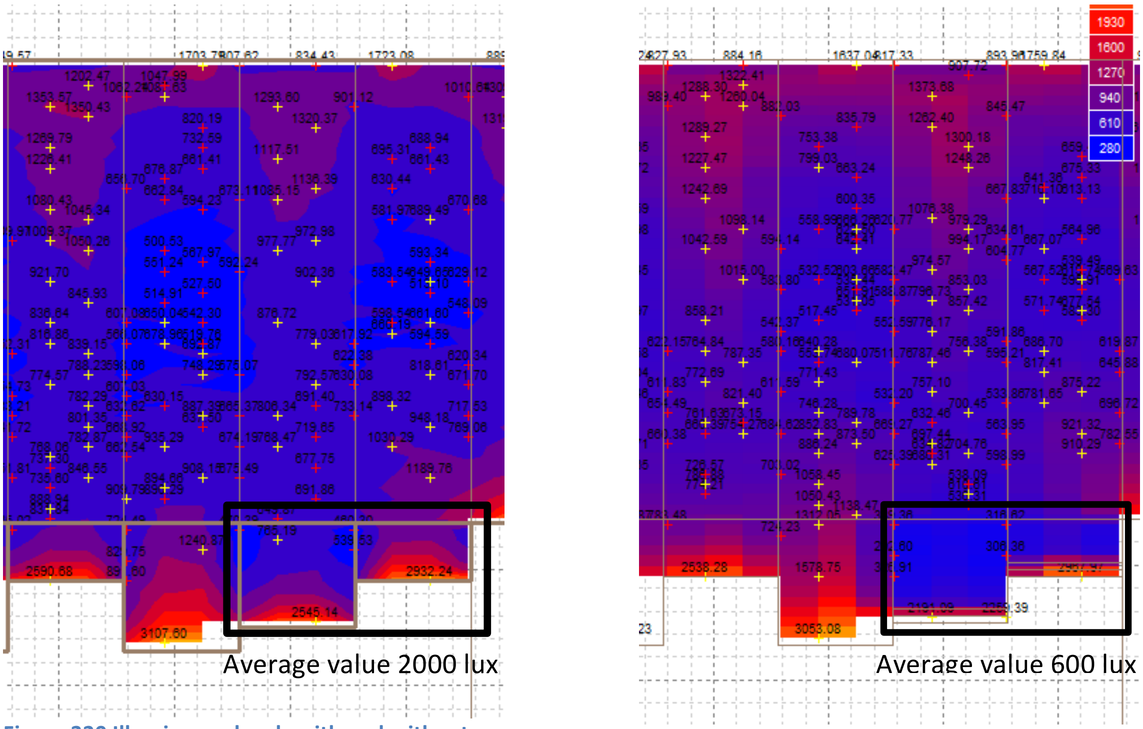


Figure 320 Illuminance levels with and without shading

The conclusion of the simulation underlines the initial assumption that the double skin system will increase the envelop performance from daylight level point of view. The study was done considering the Blinds completely closed, but there are options for level of light filtering.

To sustain the above statement the study of the performance of the façade was done for several situations: different glass properties and different shading devices. For each glass the transmittance, light filtering and sound insulation was estimated such that to be able to observe that despite better results for illuminance, the translucent glass has worse thermal and acoustic performance than the double skin.

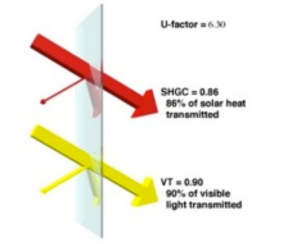
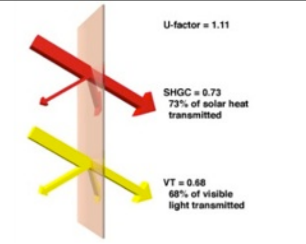
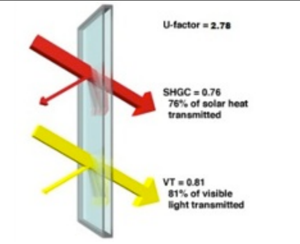
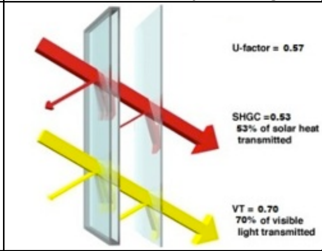
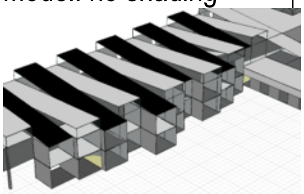
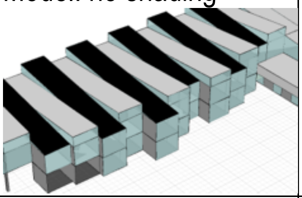
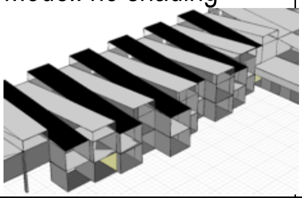
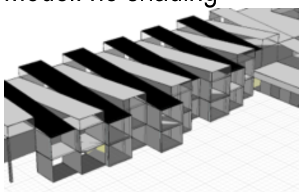
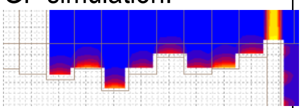
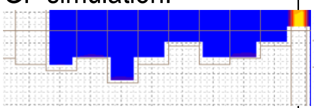
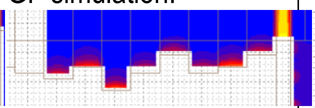
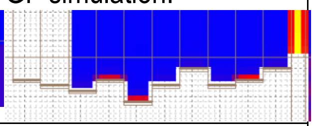
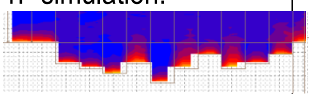
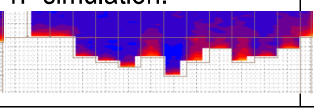
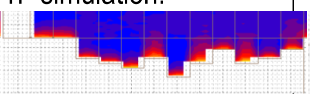
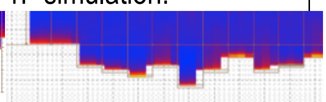
Single glazed, clear glass	Single glazed, translucent glass	Double glazed, clear glass	Double skin facade Double – cavity – single
			
Thickness: 6mm U-value: 6.30W/m^{2}K SHGC: 0.86 VT: 0.90 STC: 31 dB(A)	Thickness: 6mm U-value: 6.30W/m^{2}K SHGC: 0.73 VT: 0.68 STC: 38 dB(A)	Thickness: 24mm U-value: 2.78W/m^{2}K SHGC: 0.76 VT: 0.81 STC: 35 dB(A)	Thickness: 560mm U-value: 0.57W/m^{2}K SHGC: 0.53 VT: 0.70 STC: 46 dB(A)
Illuminance: 2211lux GF 3433lux 1F $DF_{average}$: 5.77% GF 12.70% 1F	Illuminance: 417lux GF 729lux 1F $DF_{average}$: 1.96% GF 4.62% 1F	Illuminance: 1818luxGF 2787lux 1F $DF_{average}$: 4.81% GF 10.64% 1F	Illuminance: 350lux GF 1500lux 1F $DF_{average}$: 4.34% GF 10.68% 1F
Model: no shading 	Model: no shading 	Model: no shading 	Model: no shading 
GF simulation: 	GF simulation: 	GF simulation: 	GF simulation: 
1F simulation: 	1F simulation: 	1F simulation: 	1F simulation: 

Figure 321 Facade performance study

For the clear glass and low emissivity glass the analysis was done for different combination of glass layers and shading systems.

The complete analysis of the ground floor south façade is tested for the performance of the double skin façade.

The ground floor coffee shop area was analyzed in two conditions filtering and blocking position of the blinds of the double skin façade.

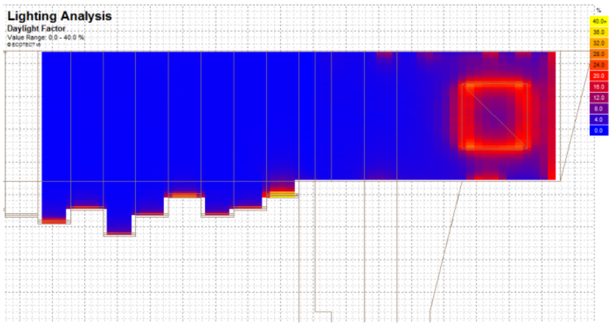


Figure 322 Closed blinds case

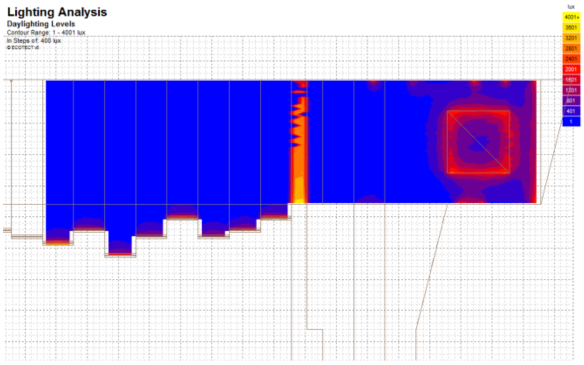


Figure 323 Filtering light blinds case

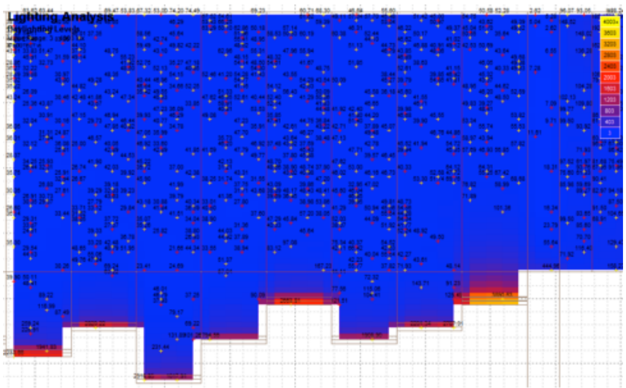


Figure 324 Closed blinds average value 200 lux

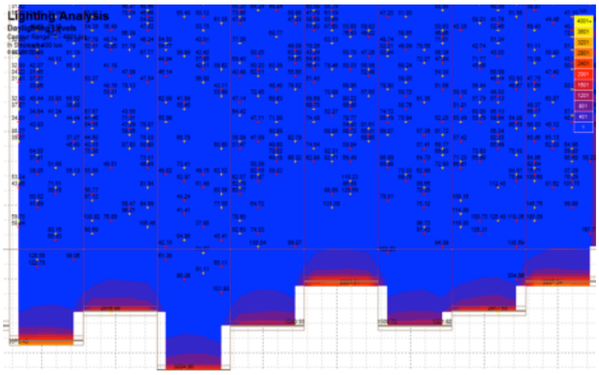


Figure 325 Filtering light blinds average value 600 lux

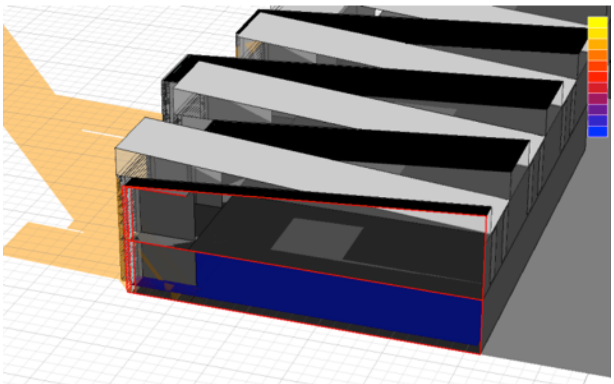


Figure 326 Shadows with blinds closed

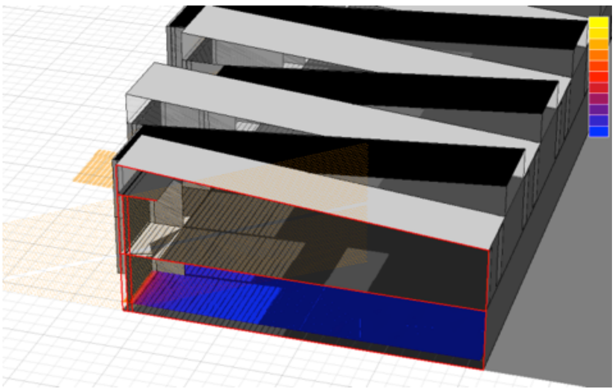


Figure 327 Shadows with blinds in the filtering position

The solution to be adopted results efficient for daylight correct use and reduction of glare in the reading area located near the south façade.

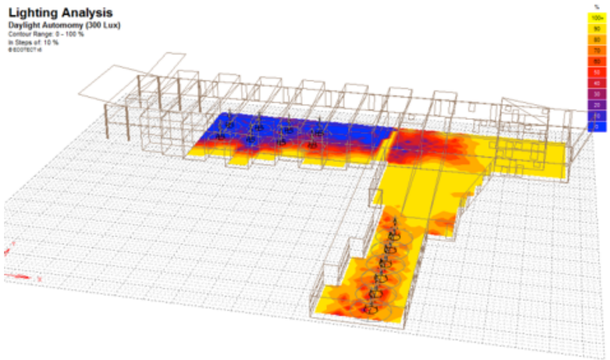


Figure 328 Daylight autonomy (300 lux) GF

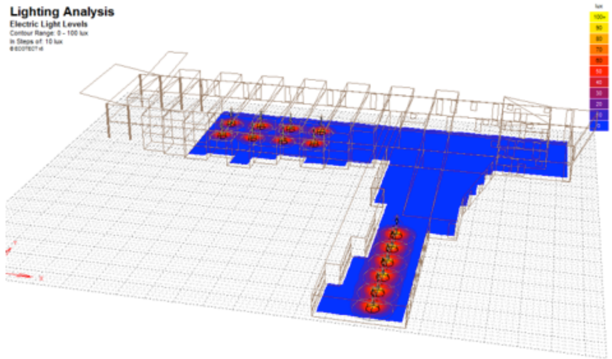


Figure 329 Random assumption on electrical light GF

For the critical areas in term of daylight availability – coffee shop and mid - section of children area – one can see the daylight autonomy is below 40% or even close to zero. The trial study assumption was providing electrical halogen lights randomly positioned. It is observed that the lights can provide a lighting level of 100 lux. The performance can be increased considering more précised, closely position ambient fixtures together with other individual lighting devices.

For the artificial lighting system the goal is energy efficiency. Generally the electrical lighting consumes up to 50% of total energy in a building. Indirectly, even more due to added cooling load. As the resent trends are to reduce energy consumption, reducing dependence on electrical light or at least reducing the use to minimum is the most adequate direction. This can be achieved via technology but as well as via a good natural light design of the building. The technology options for energy conservation features are evolving daily. Effective fluorescent lights, electronic high frequency ballasts, switches, sensors and dimming devices – allow the lights to be used only when need in right amount. The electrical light should be coordinated with the daylight:

- Electrical light to be designed to complete the daylight direction and distribution. Control strategies to be considered (e.g. fixtures oriented parallel to the window wall such that they can be dimmed or switched in response to daylight distribution)
- “Daylight harvesting” – save energy consumption by controlling the artificial light and using high performance glazing.
- Use of efficient lighting equipment to reduce connected loads. Design of acceptable quantity and quality of light so that occupants do not feel the need to “fix” the system resulting in an increase of energy consumption.
- Similar tasks groups to be grouped together to have similar light levels
- Lower levels of uniform ambient light and provide local task lighting
- Sensors for occupancy where ambient/night light is used

For the bookstacks the illuminance standard are based on the light reaching vertical plane of the books. Two approaches were developed until now: running the luminaires continuously and parallel to the stacks or orienting the fixtures perpendicular to the stacks.

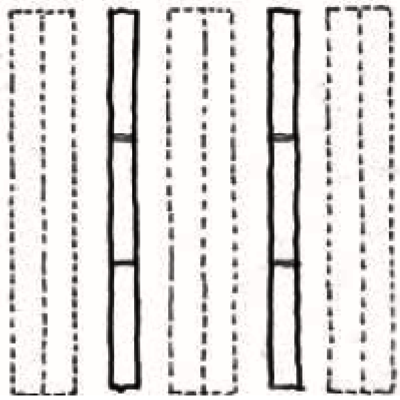
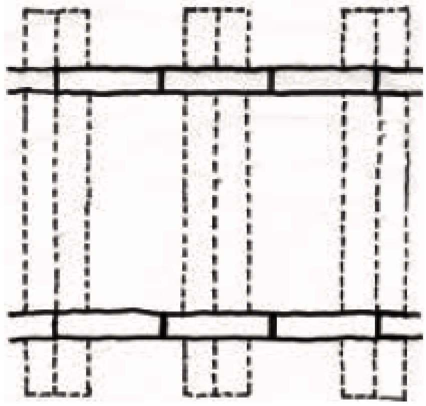
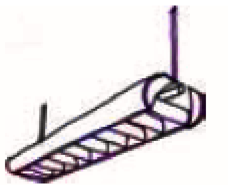
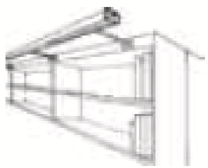



Figure 330 Orientation of luminaries and stacks

The first solution has the advantage of consuming half the watts the second consumes and that can be controlled with occupancy sensors, the disadvantage is that the system is restricted to permanent stack locations and that total directional light can be harsh. The second system advantage is that allows addition and relocation of stacks, more comfortable indirect light, but the big disadvantage is twice the energy consumption and harder to be controlled. Thus the conclusion is for a better and more energy efficient solution the lighting fixtures will be placed parallel to the stacks.
As for the type of luminaires, the high performance fluorescent lighting is a good choice for libraries. For emergency lighting separate solution must be designed – avoiding the metal halide lamps as they do not instantly re-strike after power interruption.

The task lighting control, the table lamps and carrel lights should be integrated into the furniture with local switch or dimmer for users to turn on the fixture. In addition, electrical receptacles and computer jacks at the base of the luminaires to be designed.

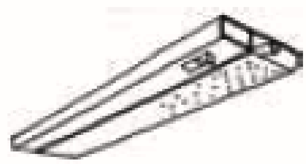


Figure 331 Lighting studies

How the illuminance is used in the building and which envelop should be provided for higher efficiency was seen in the previous analysis. The next topic related to the light, but this time artificial, is very important when the sustainability is the main goal. As renewable energy for electricity in the building will be used the solar energy, reconverted for proper final use via the photovoltaic solar system.

Grid-connected photovoltaic solar installations are particular as they work on the basis of energy exchange with the local electrical grid. In practice, in daylight hours the consumer uses the electrical energy produced by his/her own installation, while when there is no light or it is insufficient, or when the consumer requires more energy than his installation is capable of providing, the electrical grid guarantees the supply of necessary electrical energy. Grid-connected pv installations thus represent an integrative source, as they provide a contribution to the overall electric budget of the building of various amounts depending on the size of the installation. The placement of photovoltaic modules on roofs and on facades responds to the distributed nature of solar sources.

For the developed project the allocated area is the South facing tilted roof at an angle of five degrees. It is not the most efficient and optimum angle (35 degrees for Timisoara according to the PV gis simulation) but still due to the complete orientation towards south and not shading or obstruction is presented on site, the system can perform at good parameters. The total area to be covered with PV cells is of 590 m^2.

The building electrical energy demand is estimated for the lighting and other appliances to be used in the building, in two cases. Use of the system for the entire period of working hours (10 Hours – with a comfortable schedule for users from 8:00 – 20:00; operating days café and community area all year around except for bank holidays (12) and holidays (25); the library with operating capacity all year around except for holidays and 1 free day per week) and reduced use based on smart control systems – like occupancy sensors, natural light etc.

Table 23 Electrical energy demand

Electrical energy deman - Light							
Space Use	**Area (m^2)**	**Light requirement (w/m^2)**	**Opening hours**	**Operating days**	**Total Consumption (MWh)**	**Hours of light smart use**	**Total consumption**
Ground floor							
Café	860	15	10	328	42,31	8	33,85
Children's library	362	15	10	276	14,99	6	8,01
Community area	1048	15	10	328	51,56	5	23,42
Services	82	15	10	328	4,03	10	4,03
First floor							
Library	1789	15	10	276	74,06	5	33,01
Staff area	212	15	10	276	8,78	6	5,27
Services	61	15	10	276	2,53	10	2,53
TOTAL (MWh)					**198,26**	**Total (MWh)**	**110,12**
TOTAL (%)					**100,00%**	**Total (%)**	**55,54%**

For the electrical light it can be noticed that considering smart use the consumption can be reduced by more than 50%.

Table 24 Electrical energy demand

Electrical energy deman - PC, Fax, etc.							
Space Use	Area (m^2)	Appliances requirement (w/m^2)	Opening hours	Operating days	Total Consumption (MWh)	Hours of light smart use	Total consumption
Ground floor							
Café	860	12	10	328	33,85	8	27,08
Children's library	362	12	10	276	11,99	6	6,41
Community area	1048	12	10	328	41,25	5	18,74
Services	82	0	10	328	0	10	0,00
First floor							
Library	1789	12	10	276	59,25	5	26,41
Staff area	212	12	10	276	7,02	6	4,21
Services	61	0	10	276	0,00	10	0,00
TOTAL (MWh)					**153,36**	**Total (MWh)**	**82,85**
TOTAL (%)					**100,00%**	**Total (%)**	**54,02%**

The same situation for the appliances – considering closing them, unplugging, use on economy mode – can reduce the consumption by 50%.
For performing the dimensioning of the PV system based on the known data, additional information about the module to be used is required. It is assumed that the multi crystalline silicon module to be used will have a nominal power of 180 Wp and the dimensions 1581x809x50 mm.

Table 25 PV cell system

Dimensioning of PV array system							
Allocated roof area (m^2)	Tilt angle (°)	PV Panel dimensions			Panels Total Number	Nominal power (Wp)	
		Length (m)	Width (m)	Area (m^2)		1 Panel	System
590	5	1,581	0,809	1,28	461	180	**83.031,74**

The final amount of equivalent kWh/year produced by the system was established using the online available program called PV Watt. The location of the site and the requirements for the system are introduced and the final production is obtained.

PVWatts

AC Energy & Cost Savings

Cautions for Interpreting the Results

(Type comments here to appear on printout; maximum 1 row of 90 characters.)

Station Identification	
City:	Timisoara
Country/Province:	ROM
Latitude:	45.77° N
Longitude:	21.25° E
Elevation:	88 m
Weather Data:	IWEC
PV System Specifications	
DC Rating:	83.0 kW
DC to AC Derate Factor:	0.770
AC Rating:	63.9 kW
Array Type:	Fixed Tilt
Array Tilt:	5.0°
Array Azimuth:	180.0°
Energy Specifications	
Energy Cost:	0.2510 leu/kWh

Results			
Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value (leu)
1	1.33	2292	575.29
2	2.22	3755	942.50
3	3.45	6605	1657.85
4	4.56	8227	2064.98
5	5.77	10482	2630.98
6	6.51	11167	2802.92
7	6.67	11651	2924.40
8	5.82	10210	2562.71
9	4.27	7448	1869.45
10	3.15	5757	1445.01
11	1.65	2793	701.04
12	1.13	1852	464.85
Year	3.89	82238	20641.74

Figure 332 Results of PV cell study

The PV array allocated for 590 m² of roof will provide 82.2MWh per year with an average of 3.89kWh/m²/day, enough to supply 40% of the required electricity to the building.

Table 26 Energy requirements

Energy required	Condition	Total MWh	Percentage
Light	Normal	198,26	
	Smart use	110,12	
Appliances	Normal	153,36	
	Smart use	82,85	
Total	Smart use	192,97	100,00%
Energy provided		82,2	42,60%

Still depending on the national grid, the building will use the energy produced by the PV array during the morning hours and peak midday hours and will be able to compensate the high night consumption.

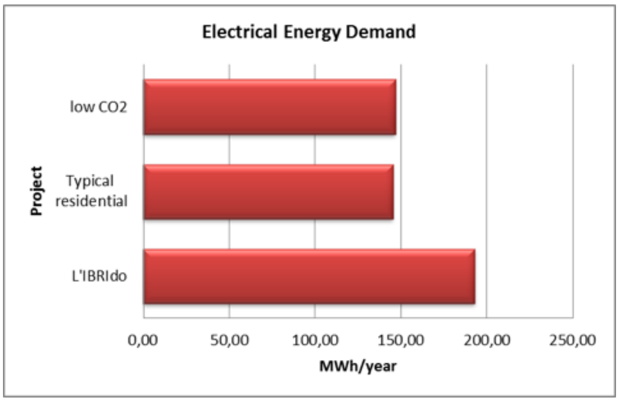
At the beginning of the chapter a comparison was set between L'IBRIdo project, typical residential house in Timisoara and a low carbon emission project. Following calculations are done to see how the project evolves in comparison to the traditional lifestyle electricity consumption and the road still to be done such that to reach the category of zero foot print. For typical residential use only for the light the consumption is almost the same as for all appliances and light in a sustainable project. L'IBRIdo project will have to improve its performance with around 30% to reach the level of low emission project. At this incipient stage it can be considered a sustainable project in continuous evolution.

Table 27 Electrical energy demand

Electrical energy deman - Light for normal residential house					
Space Use	**Area (m^2)**	**Light requirement (w/m^2)**	**Opening hours**	**Operating days**	**Total Consumption (MWh)**
Ground floor					
Café	860	11	10	328	31,03
Children's library	362	11	10	276	10,99
Community area	1048	11	10	328	37,81
Services	82	11	10	328	2,96
First floor					
Library	1789	11	10	276	54,31
Staff area	212	11	10	276	6,44
Services	61	11	10	276	1,85
TOTAL (MWh)					**145,39**
TOTAL (%)					**100,00%**

Table 28 Electrical enegy demand

Electrical energy deman - Light and appliances Low CO_2 project							
Space Use	Area (m^2)	Light requirement (w/m^2)	Opening hours	Operating days	Total Consumption (MWh)	Hours of light smart use	Total consumption
Ground floor							
Café	860	20	10	328	56,42	8	45,13
Children's library	362	20	10	276	19,98	6	10,69
Community area	1048	20	10	328	68,75	5	31,23
Services	82	20	10	328	5,38	10	5,38
First floor							
Library	1789	20	10	276	98,75	5	44,01
Staff area	212	20	10	276	11,70	6	7,02
Services	61	20	10	276	3,37	10	3,37
TOTAL (MWh)					**264,35**	**Total (MWh)**	**146,83**
TOTAL (%)					**100,00%**	**Total (%)**	**55,54%**



Considering the possibility to develop an local PV grid for the entire development area, the building has the possibility to reach complete electrical supply for artificial lighting only alternatively produced.

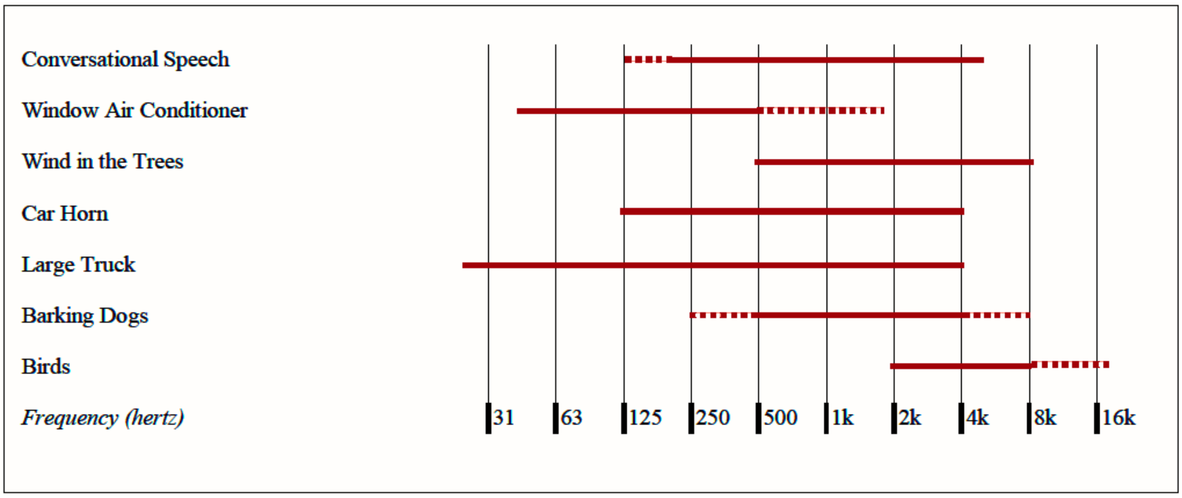
V.3 Sound

Acoustic design is another important aspect that should be considered when designing a library.

Sound waves result from physical disturbance of air molecules. The listener's inner ear contains organs that vibrate in response to the molecular disturbance, converting the vibrations into changing electrical potentials that are sensed by the brain, allowing hearing to occur.

Acoustical analysis should involve both the sources and the receivers together with the path in between.

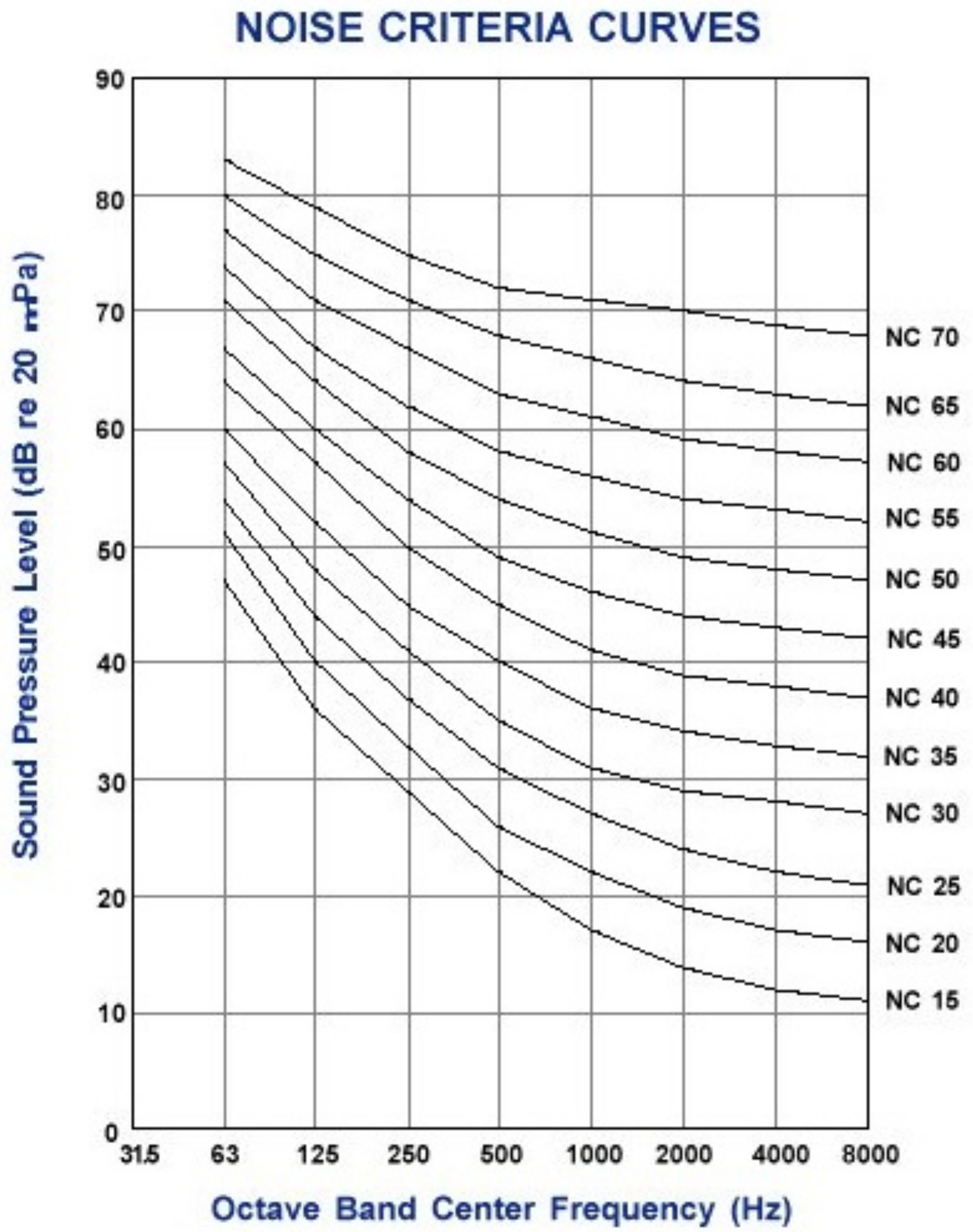
Unless it is a pure tone, the sound wave is typically made up of vibrations at different frequencies (number of waves passing a single point in one second, moving at the speed of sound in the air).



Sound and noise are described using decibel scale (logarithmic scale that expresses the sound pressure levels that affect human ear).

	Sound pressure (Pa)	Sound pressure level (dB)	Example sound source
	200.0	140	Threshold of pain
	20.0	120	Near a jet aircraft engine
	2.0	100	Near a jackhammer
	0.2	80	Typical factory
	0.02	60	Normal speech level
	0.002	40	Quiet living room
	0.0002	20	Quiet recording studio
	0.00002	0	Threshold of hearing

Designing new libraries means also to choose construction materials that will allow sound control from exterior and good space performance in terms of acoustics. The Noise Criteria (NC) rating is a design criterion for the target level of background noise in the room and it is based on the fact that human hearing is less sensitive to low frequencies than to high ones, such that the SPL criterion of background noise varies with the frequency of noise spectrum.



Thus, for the design of L'IBRIdo the acoustic criteria for each space are listed.

Table 29 Background noise levels in the library spaces

Space Type	NC Rating
Open Public Areas (Circulation, Reference)	35-40
Computer Work Areas	40
Private Offices	30-35
Open Staff Work Areas	35-40
Copy Rooms	40
Teleconference Rooms	max 25
Reading Rooms	25-30
Classrooms, Training Rooms	25-30

Another important acoustic parameter is the reverberation time (RT (60)) – how quickly in time the sound decays in the room (in seconds). It depends on the physical volume and surface materials (their capacity of sound absorption) and can be calculated using Sabine's formula$T_{60} = \frac{0.163*V}{A}$, where V represents the total volume of the room (in m^3) and A is the total absorption area (in m^2 Sabine), meaning the sum of the all materials areas times their absorption coefficient.

Typically a library will poses short reverberation time; highly absorbent materials being used in a large extent. Longer reverberation time will be required for auditoriums, cafeterias to allow for the sound to persist.

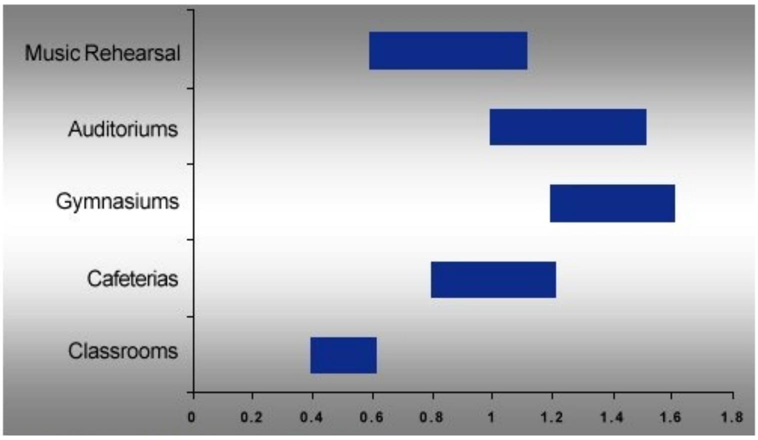


Figure 333 Reverberation time (in sec)

Referring to the absorption capacity of the materials used in the construction process one has to mention the Noise Reduction Coefficient (NRC). Average of sound absorption coefficients from 250Hz to 2 kHz, the primary speech frequency range, and is ranging from perfectly absorptive (NRC = 1) to perfectly reflective (NRC = 0).

Generally, in the library, the addition of the sound – absorbing materials to the space is not only a technical aspect of high performance but as well an issue of interior harmony and design. Creative shapes and texture are used to rend the space silent and pleasant.

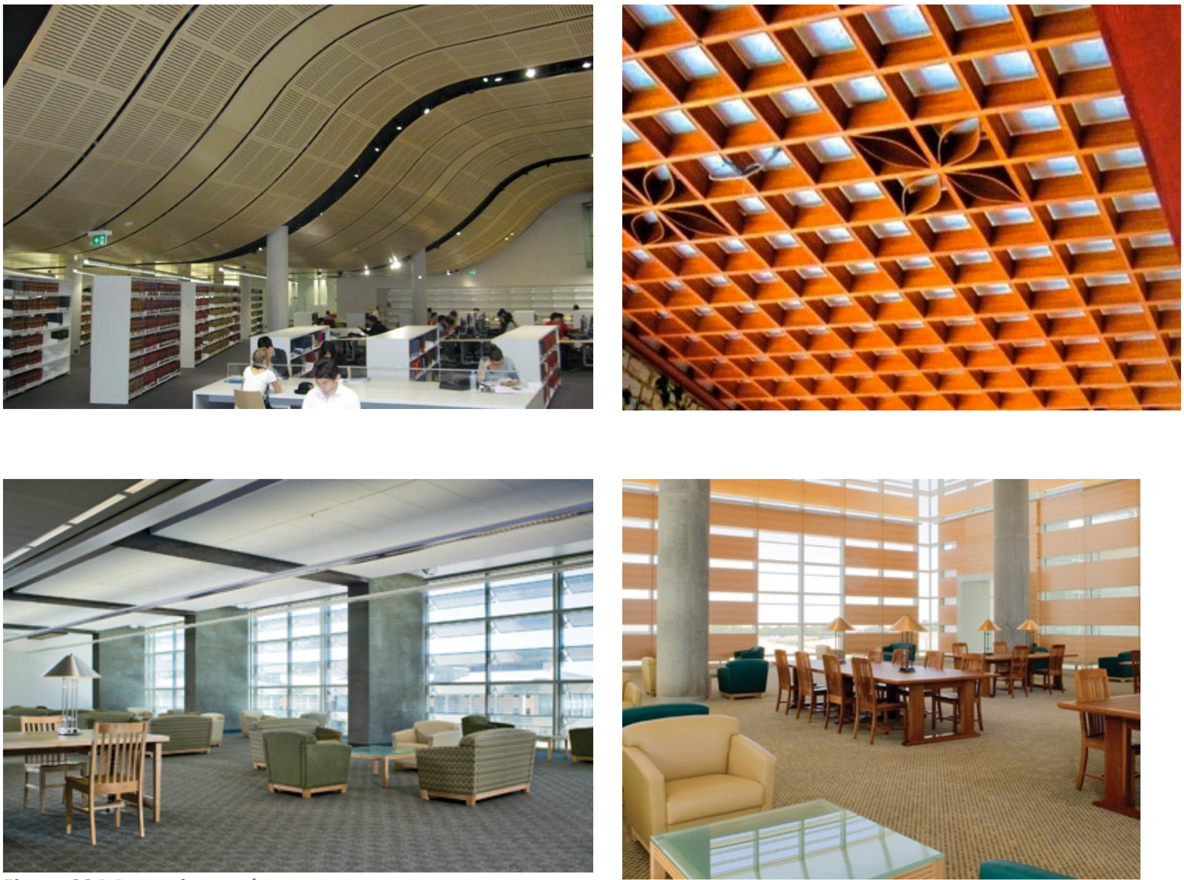


Figure 334 Acoustic panels

But before proceeding in evaluating the acoustics in the designed building, one studied the environment conditions and sound pollution.

The actual position of the future project is at the intersection of two roads, which according to the urban design policy will be reorganized in one slow traffic street and one pedestrian/ bicycle and green network street.

The sound level maps during the day and during the night are available and it can be observed that the area under study is quite. The noise levels are mainly due to traffic and can reach levels higher than 70 dB (A) during the day and levels higher than 55 dB (A) during the night. The surroundings of the building are comprised in the low part of the noise evaluation scale, thus the building functionality and the location are suitable one for the other.

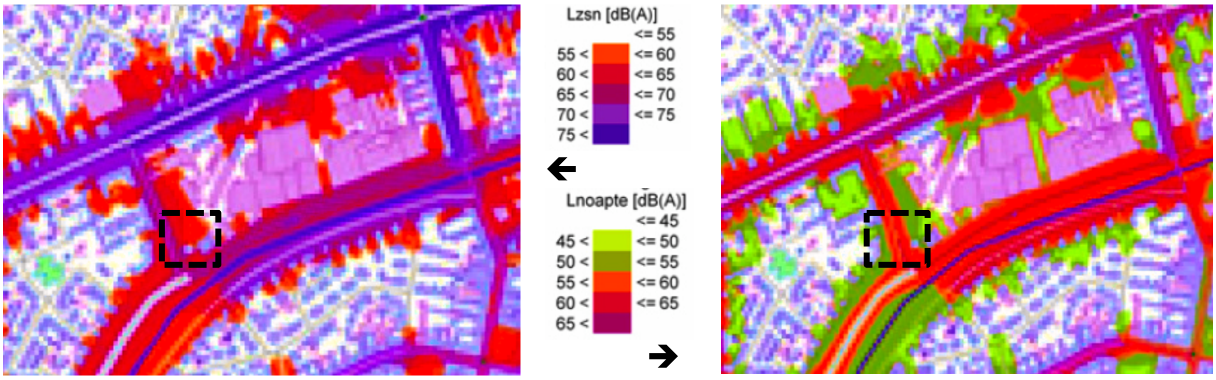


Figure 335 Noise levels day and night

Still, should not be forgiven the future reorganization of the traffic, with again a diminution of car born noise and the mixed used development in the Northern part of the building which might produce an increase in people born noise. Attention should be paid to the external envelope sound proofing capacity. From this point of view the sound transmission class – decibel attenuation - of materials forming the enclosure would be crucial in determining the final solution.

Considering the remark above and the acoustic requirements for the library the finishing materials for all the spaces were established.

In terms of acoustic parameters, the maps were done based on the reverberation time requirements. For the reading and study area as well as for the main collection the value of 1 second is recommended (dark green on the map). For the circulation and leisure area a value of maximum 1.5 seconds can be achieved. As per design standards and guidelines, the optimum reverberation time value for an area used mainly for speech and not music, should be placed between 0.8 – 1.0 seconds. For a classroom the optimum value is 0.6 seconds. Attention will be paid when assigning the materials to the noise sources (marked with red level lines on the map) and to the glazed facades which will have to provide a good STC level.

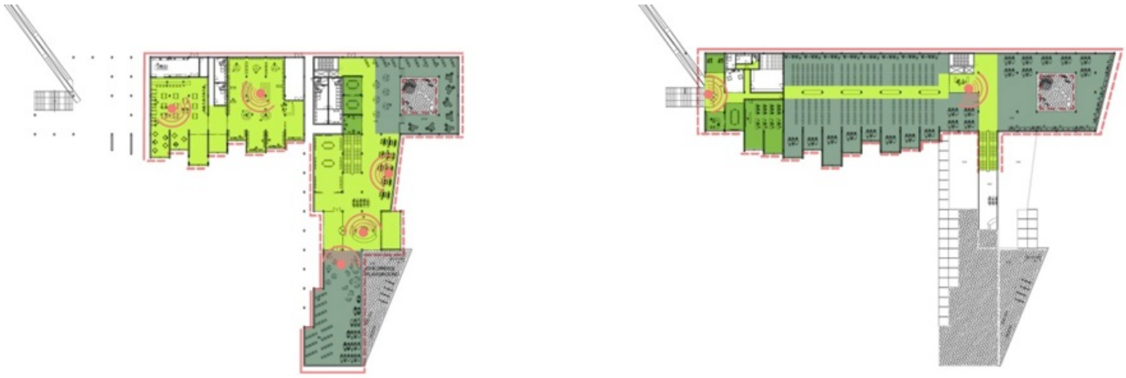


Figure 336 Acoustic requriements GF & FF

The finishing materials in the library should have a high absorbance capacity such that to reduce the reverberation time and high reflection of sound.

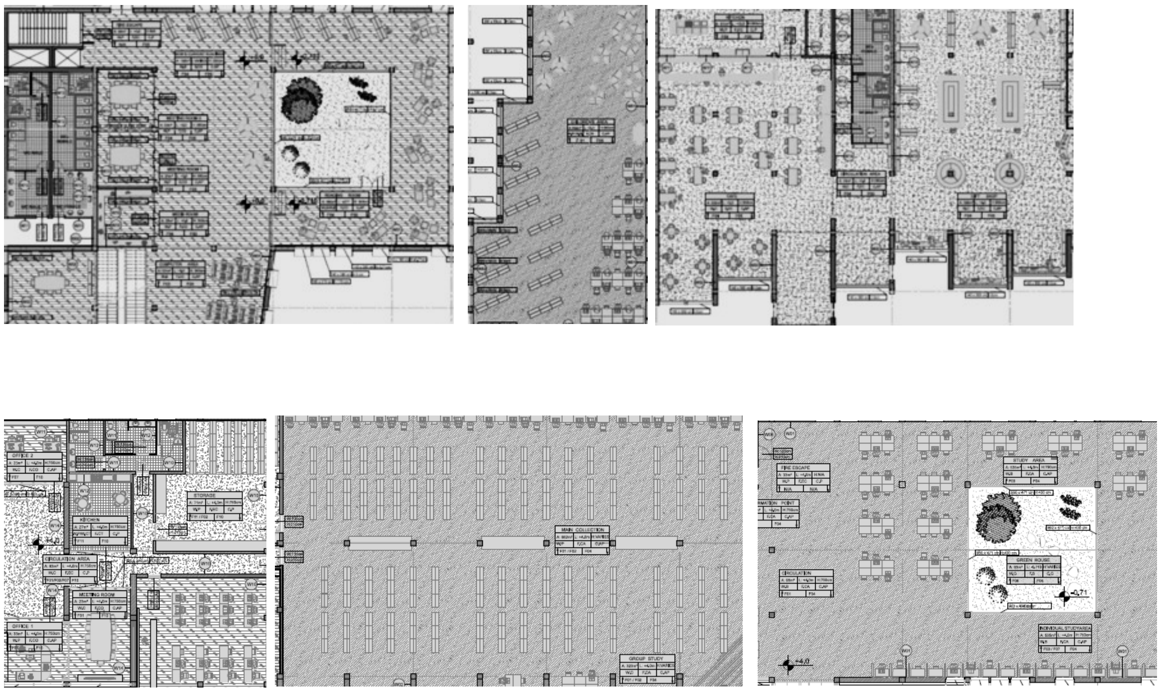


Figure 337 Floor finishes

For the floor in the rooms used for reading and study, the carpet was the option; while for the more active areas cork finishing was allocated. In the main entrance and coffee shop the exposed concrete painted with epoxy paint was the final choice, considering as well the thermal mass requirements for passive buildings design concept. For the rest room the selection went to the traditional anti-slip tiles system.

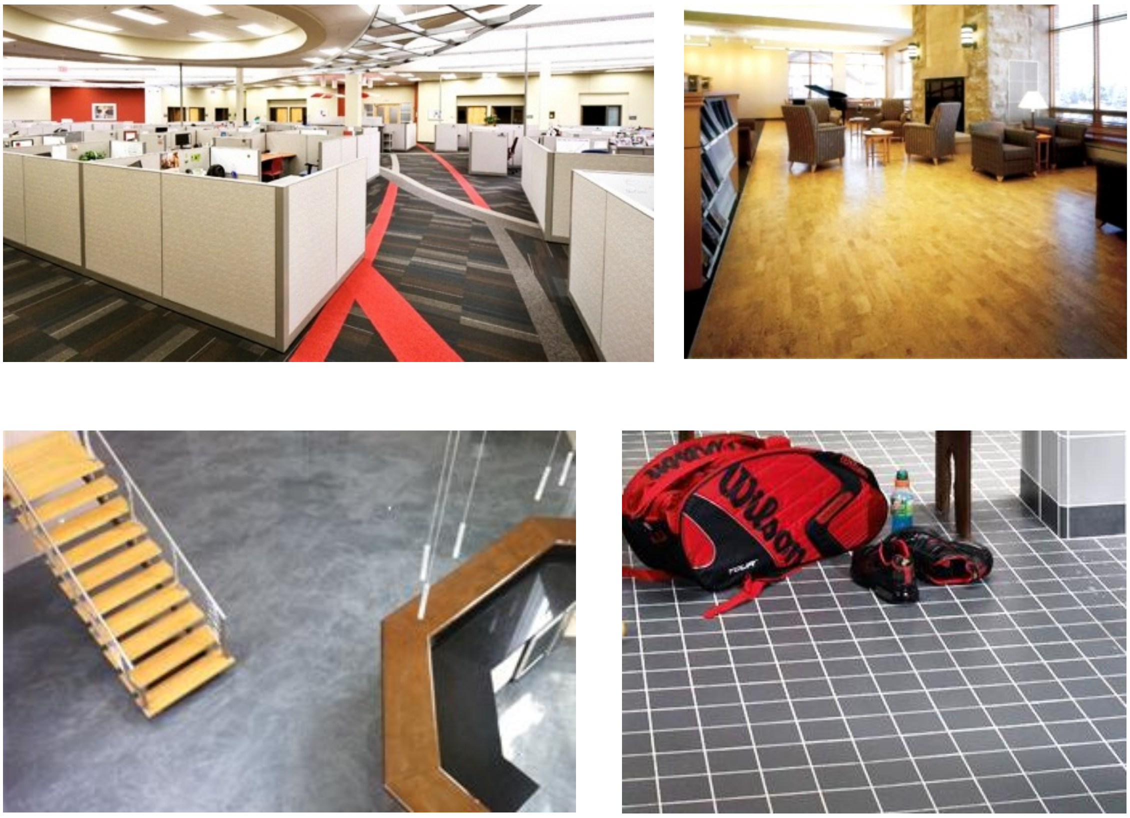


Figure 338 Floor solutions

As for the ceiling, for all space the option was acoustic ceilings, transforming this aspect in one of the main interior design characteristics combining both practical and the pleasant aspects.


Figure 339 Ceiling Solutions

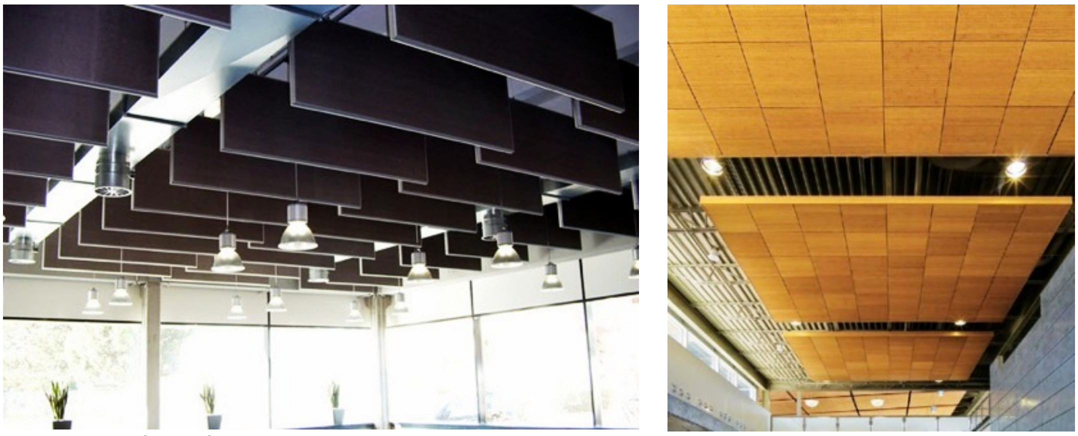


Figure 340 Ceiling solutions

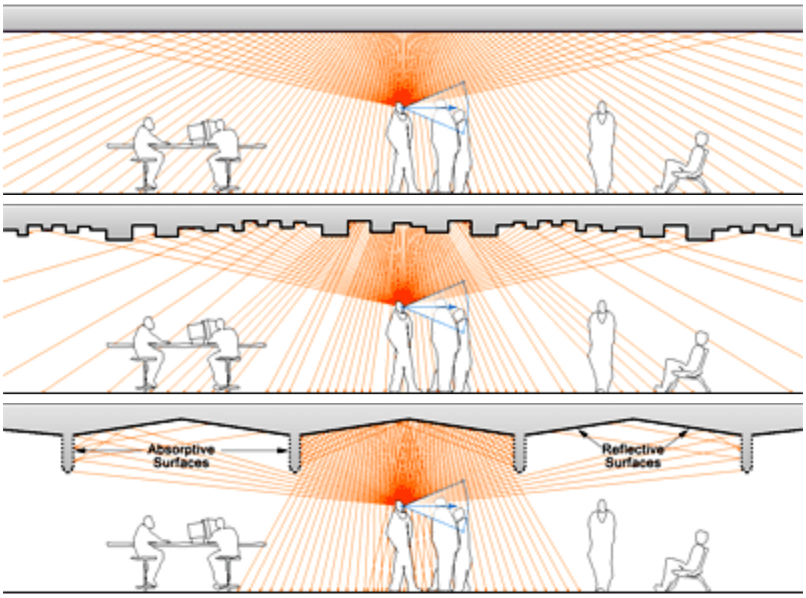


Figure 341 Sound reflection studies

For the walls the option of exposed material was much preferred than to plaster and painted one. Despite this, the second option was used where furniture is placed on the walls, e.g. children area.

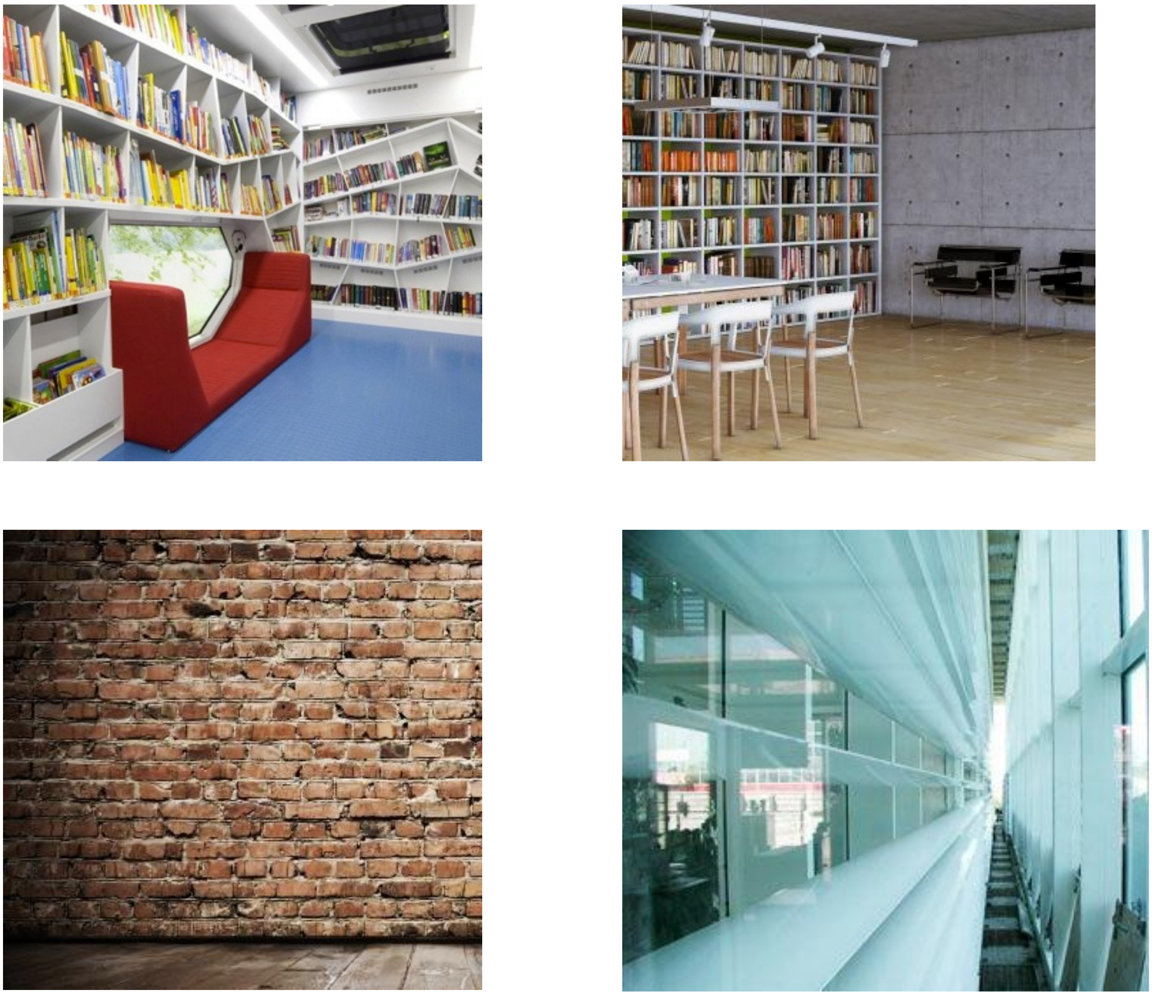


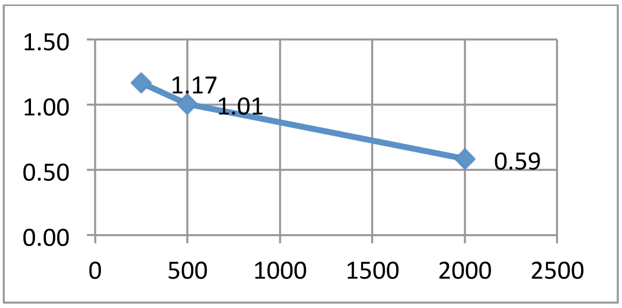
Figure 342 Wall solutions

For the large vitreous surfaces located in the south the double skin façade system was the most appropriate solution while for the other windows double glaze low - E glass is to be used.

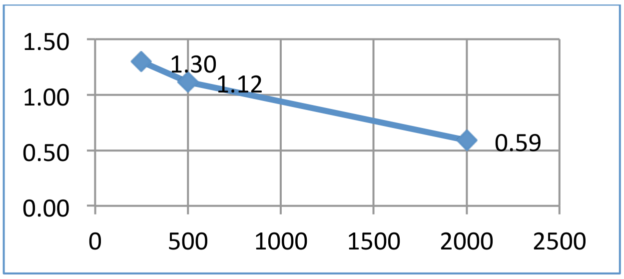
Based on the solutions for surfaces finishing the reverberation time for each room was evaluated. The assumptions for the calculation were: empty space, three levels of frequency (250Hz, 500Hz and 2000Hz). The summary of the calculation is presented in the table and graphs below.

Summary for RT calculation			
Frequency (Hz)	250	500	2000
Reverberation Time (sec)	1,30	1,12	0,59
	0,35	0,70	0,67
	0,69	0,63	0,52
	0,84	0,70	0,55
	0,76	0,66	0,55
	0,69	0,62	0,53
	0,55	0,55	0,50
	0,55	0,55	0,50
	0,55	0,55	0,50
	0,83	0,79	0,67
	0,82	0,79	0,67
	0,74	0,66	0,42
	1,17	1,01	0,59
	0,93	0,81	0,65
	0,54	0,55	0,39
	0,51	0,51	0,38
$Rt_{average}$	0,74	0,70	0,54

Figure 343 Results for RT study



Main collection area



Children area

The distribution of the results function of the assign materials can be better understood from the schematically representation.

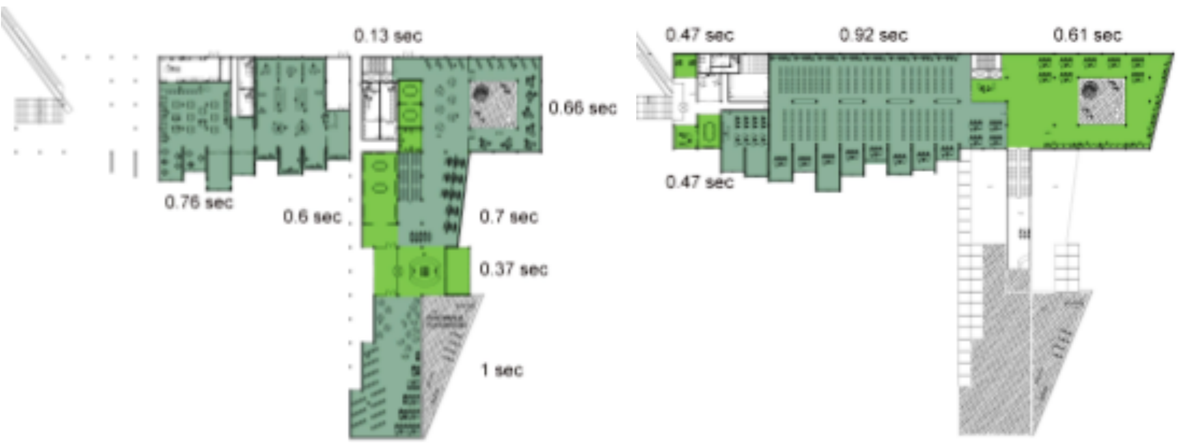


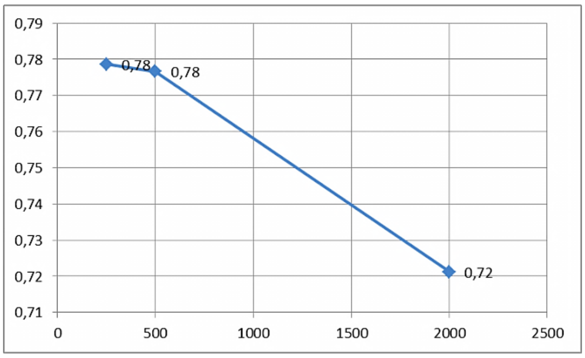
Figure 344 RT results

For the main collection area and the children's area the reverberation time is close to recommended values. The rooms are appropriate for speech and the furniture to be added will reduce the amount of parallel surfaces by reducing risk of resonances. As well as the occupation of the room with people will further decrease the reverberation time. Still, it is recommended that the lowest levels of RT should not be under 0.3 sec – the "dead" sound threshold – the levels characterized by loss of bass in back.

The verification of the reverberation time was done for more three cases: exposed concrete floor and plasterboard ceiling in all spaces; exposed concrete floor and acoustic ceiling in all spaces and carpet and acoustic ceiling in all spaces.

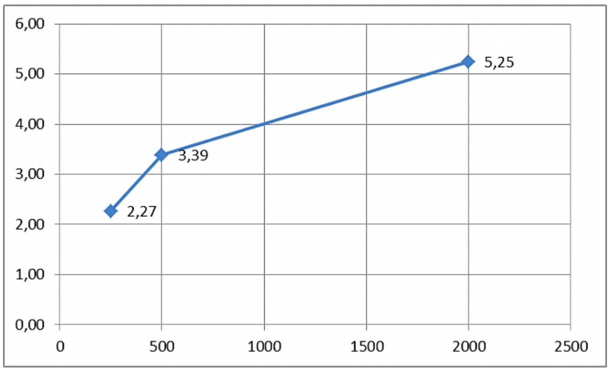
Table 30 RT studies

Frequency (Hz)	250	500	2000
Reverberation Time (sec)	1,45	1,12	1,29
	0,35	0,70	0,67
	0,72	0,73	0,65
	0,89	0,83	0,69
	0,80	0,78	0,69
	0,73	0,72	0,66
	0,57	0,62	0,61
	0,57	0,62	0,61
	0,57	0,62	0,61
	0,83	0,79	0,67
	0,82	0,79	0,67
	0,79	0,77	0,68
	1,26	1,20	1,03
	0,97	0,95	0,81
	0,57	0,62	0,62
	0,57	0,57	0,58
$Rt_{average}$	0,78	0,78	0,72



Reverberation time for concrete floor and acoustic ceiling

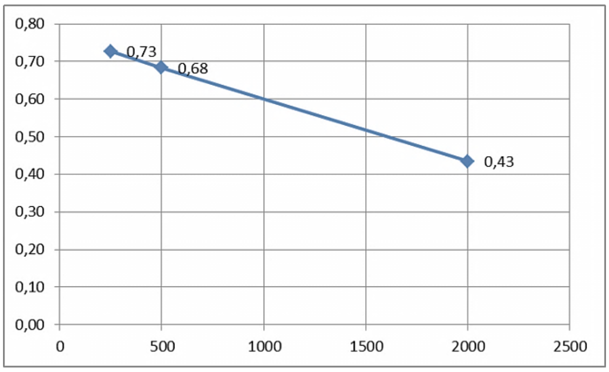
Frequency (Hz)	250	500	2000
Reverberation Time (sec)	3,92	5,67	8,47
	0,50	2,52	5,27
	1,92	2,92	4,48
	3,97	5,80	7,91
	2,67	3,94	7,34
	1,99	2,86	5,15
	1,13	1,74	3,09
	1,13	1,74	3,09
	1,13	1,74	3,09
	3,01	4,20	5,38
	2,92	4,21	5,74
	2,52	3,64	6,09
	4,29	5,87	7,64
	3,03	4,32	5,63
	1,13	1,70	3,24
	0,99	1,38	2,34
$Rt_{average}$	2,27	3,39	5,25



Reverberation time for concrete floor and acoustic ceiling

Table 31 RT studies

Frequency (Hz)	250	500	2000
Reverberation Time (sec)	1,30	1,12	0,59
	0,34	0,61	0,41
	0,68	0,63	0,41
	0,83	0,71	0,42
	0,75	0,67	0,42
	0,69	0,63	0,41
	0,54	0,55	0,39
	0,54	0,55	0,39
	0,54	0,55	0,39
	0,78	0,68	0,41
	0,77	0,68	0,42
	0,74	0,66	0,42
	1,17	1,01	0,59
	0,92	0,82	0,51
	0,54	0,55	0,39
	0,51	0,51	0,38
$Rt_{average}$	0,73	0,68	0,43



Fig…Reverberation time for carpet floor and acoustic ceiling

From the study it can be seen that an almost empty building in terms of finishing and occupancy can have high reverberation time even at high frequency reaching even resonance. The buildings, fit out with proper sound absorbing materials, can display a reverberation time situated at the lower part of the scale, going sometimes really close to the lower limit of loss of bass in the back. Therefore, for the developed project the proper combination of sound absorbing materials placed in more silent areas and the sound reflecting materials in the places used as transitional ones is expected to provide the best performance from acoustical point of view.

Responsible design checklist of the project can tick: maximum functionality (privacy of speech, quiet and contemplative space); optimal efficiency and productivity (acoustic will not be the inhibitor of the productivity, non-noise induced stress); protection of the health of end user (no noise exposure – no hear loss); consider aesthetics (wood, metal, stone in different shapes and colors); consider sustainability (acoustic is part of sustainable design – people as a resource are valuable, thus their comfort and productivity are affected by the acoustic environment; designing to meet acoustic needs all increase the sustainability of the place and people using it).

In terms of noise sources, parameters checked and remedies studied and controlled; one can summarize:

				
Outside noise		within space noise		between space noise
Distance from noise source Doubling the distance reducing level by 6 dB	→	Reverberation time limited to 1 second Absorptivity of materials	→	STC rating of materials between spaces: walls, doors, Weak points in the structure: ducts, outlets etc.
Sound barrier in terms of tightness and massiveness of external envelope > 5kg/m2 Reduction of traffic Requalification of one street for slow traffic – pedestrian and bicycles	→	Carpet on the floors – 20% absorptive To be completed by the acoustic material in the ceiling – 80% absorptive	→	Partitions slab to slab Insulation – improve STC by 6 dB Metals studs as they perform better than wood ones Increased air space for the window cavity (60 cm)

V.4 Air

In terms of the thermal performance using thermal mass was the first step in reducing the energy consumption for heating. The concrete and masonry combination in enclosing the building will provide this capacity. The basic approach is to use hollow core slabs for the main storage of heat. As the south exposure is mainly enclosed by glazed façade, the solution proposed is with double skin with high air gap and internal blinds as well as sloped surface towards ground.

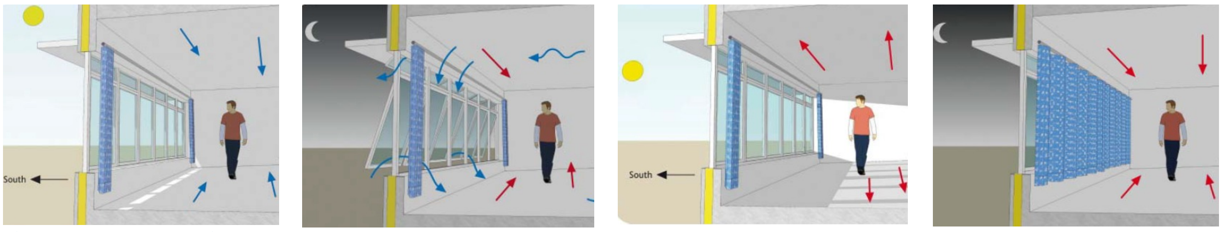


Figure 345 Summer time and winter time thermal mass action

The system functions in the advantage of the building performance. During hot weather the concrete and bricks absorb internal heat gains helping stabilizing the temperature. At night the heat absorbed can be removed by using night ventilation. During the cool season the thermal mass is used to reduce fuel consumption. The low angle sun enters the building via the south façade and the solar gains are absorbed by the ground floor and released at night.

The basic rules that were followed: the internal masonry/concrete leaf was left exposed; the insulation was placed between the external and internal leaf – to increase the time lag; the south façade has generous glazed surfaces, while the north one minimize them as much as possible.

The solution adopted was evaluated in terms of performance by defining the thermal and hygrothermal properties of the external enclosure of the edifice.

For the vertical enclosure the two types of walls are composed by an external layer of prefabricated concrete panels a significant layer of insulation and an internal layer of either prefabricated elements or brick leaf. The option for the brick was once because of aesthetical issues and second due to psychological comfort that can be influenced by the warm color of the finishing material. As well the masonry has good performance in terms of thermal mass. The analysis proves that the enclosure functions properly and that the temperature gradient evolution is respecting the layers properties.

For both solution the U-value is about 0.20 W/m^2K and the condensation within the inner leaves is avoided due to the correctly placed vapor barrier.

In the city evolution study there are several construction systems used for enclosing the buildings that are worthy to be compared with the adopted solution for the project in order to see the advantages of the system.

The brick walls of approximately 900 mm, the frame reinforced structures filled in with autoclaved aerated concrete blocks of 250mm or the precast concrete panels of 250 mm thickness.

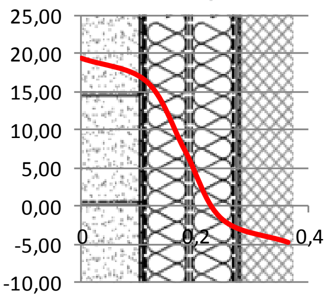
Transmittance and temperature distribution calculation

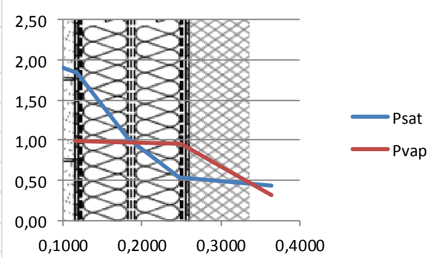
Material (interior → exterior)	Thickness (m)	Thermal Conductivity (W/(m.K))	Thermal resistance (m^2K/W)
Brickwork	0,1150	-	0,6000
Vapor barrier	0,0020	-	-
Mineral Wool	0,0650	0,037	1,7568
Mineral Wool	0,0650	0,037	1,7568
Water barrier	0,0020	-	-
Precast concrete block	0,1150	0,190	0,6053

	Temperature (ºC)	Relative humidity (%)	Saturated Vapor Pressure (Kpa)	Surface resistance (m^2K/W)
Outside conditions	-5,00	80	0,401	0,04
Inside conditions	20	50	2,337	0,13

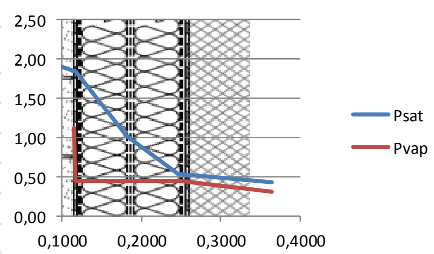
Wall specific total thermal resistance	$R^*_{tot}=(R^*_{Si}+R^*_{cd}+R^*_{Se})=$	4,8888
Wall thermal transmittance	$U=1/R^*_{tot}=$	0,2046
Specific heat flux through the wall	$\varphi=U*\Delta\vartheta=$	5,1138

Temperature distribution		System thickness (m)
$\vartheta_1=\vartheta_I-\varphi*R^*_{Si}=$	19,34	0
$\vartheta_2=\vartheta_1-\varphi*R^*_{cd1}=$	16,27	0,1150
$\vartheta_3=\vartheta_2-\varphi*R^*_{cd2}=$	7,28	0,1820
$\vartheta_4=\vartheta_3-\varphi*R^*_{cd3}=$	-1,70	0,2470
$\vartheta_5=\vartheta_O+\varphi*R^*_{Se}=$	-4,80	0,3640



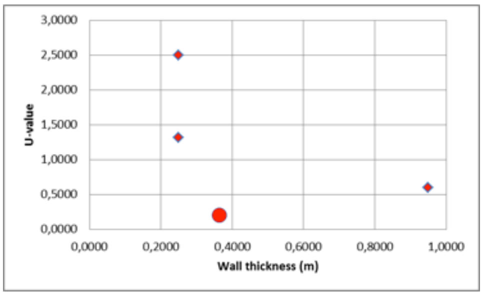


Case 1: without barrier



Case 2: with barrier

Material (interior → exterior)	Thickness (m)	Thermal Conductivity (W/(m.K))	Thermal resistance (m^2K/W)
Brickwork	0,9500	-	0,6000
BCA	0,2500	0,100	2,5000
Prefabricated panels	0,2500	0,190	1,3158
Sandwich panel	0,3640	-	0,2046



It can be easily seen that the system has a very good performance from heat transmittance point of view. Providing the lowest U-value with the optimum thickness and using materials with higher conductance. And if compared with the minimum required by the norms of northern countries the value is better – minimum required U = 0.25 W/m^2K.

For the ceiling the detail in the main collection area consists of a prefabricated roof element of 200mm thickness in general with layers on top, either green for diminishing the heat transfer and the one with photovoltaic cells that filters part of the solar energy that is reaching the roof surface. For the other areas a hollowcore roofing insulated was adopted for thermal, acoustic and sustainability issues. The typical value for the transmittance is around 0.29 W/m^2K.

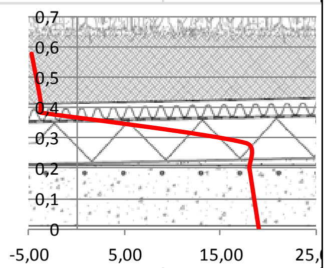
Transmittance and temperature distribution calculation

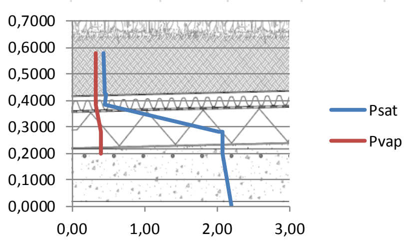
Material (interior → exterior)	Thickness (m)	Thermal Conductivity (W/(m.K))	Thermal resistance (m^2K/W)
Concrete slab	0,2000	1,480	0,1351
Screed	0,0800	1,480	0,0541
Acoustic insulation	0,0030	-	-
EPS	0,1000	0,034	2,9412
Waterproofing membrane	0,0020	-	-
Zinc sheet	0,0400	110,000	0,0004
Antiroot filter	0,0020	-	-
Peat layer	0,1500	1,200	0,1250

	Temperature (ºC)	Relative humidity (%)	Saturated Vapor Pressure (Kpa)	Surface resistance (m^2K/W)
Outside conditions	-5,00	80	0,401	0,04
Inside conditions	20	50	2,337	0,13

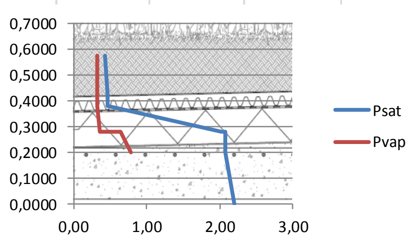
Wall specific total thermal resistance	$R^*_{tot}=(R^*_{Si}+R^*_{cd}+R^*_{Se})=$	3,4257
Wall thermal transmittance	$U=1/R^*_{tot}=$	0,2919
Specific heat flux through the wall	$\varphi=U*\Delta\vartheta=$	7,2977

Temperature distribution		System thickness (m)
$\vartheta_1=\vartheta_I-\varphi*R^*_{Si}=$	19,05	0
$\vartheta_2=\vartheta_1-\varphi*R^*_{cd1}=$	18,07	0,2000
$\vartheta_3=\vartheta_2-\varphi*R^*_{cd2}=$	17,67	0,2830
$\vartheta_4=\vartheta_3-\varphi*R^*_{cd3}=$	-3,79	0,3830
$\vartheta_5=\vartheta_4-\varphi*R^*_{cd4}=$	-3,80	0,3850
$\vartheta_6=\vartheta_5-\varphi*R^*_{cd5}=$	-3,80	0,4270
$\vartheta_7=\vartheta_O+\varphi*R^*_{Se}=$	-4,71	0,5770





Case 1: without barrier



Case 2: with barrier

Despite the intensive use of the concrete, the design horizontal enclosure towards the sky performs at very good parameters.

For the flooring system the solution adopted was considering the thermal mass aspects. The hollowcore slab placed on the ground can easily store large amount of heat in the exposed area of the south ground floor café zone and combined with the mechanical ventilation supply via the cores provides good heat transfer between air and concrete, enabling a cooling capacity of up to 40W/m2.

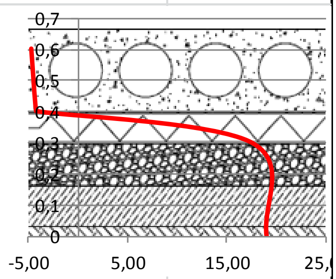
Transmittance and temperature distribution calculation

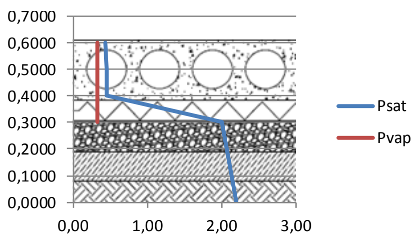
Material (interior → exterior)	Thickness (m)	Thermal Conductivity (W/(m.K))	Thermal resistance (m^2K/W)	
Concrete slab	0,3000	1,480	0,2027	
EPS	0,1000	0,034	2,9412	
Waterproofing membrane	0,0020	-	-	
Drainage gravel	0,1000	2,000	0,0500	
Compacted soil	0,1000	1,500	0,0667	

	Temperature (ºC)	Relative humidity (%)	Saturated Vapor Pressure (Kpa)	Surface resistance (m^2K/W)
Outside conditions	-5,00	80	0,401	0,04
Inside conditions	20	50	2,337	0,13

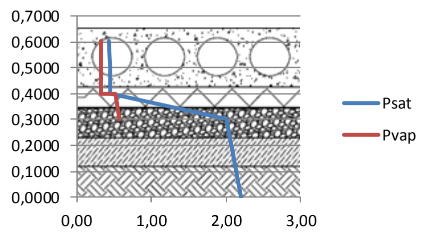
Wall specific total thermal resistance	$R^*_{tot}=(R^*_{Si}+R^*_{cd}+R^*_{Se})=$	3,4305
Wall thermal transmittance	$U=1/R^*_{tot}=$	0,2915
Specific heat flux through the wall	$\varphi=U*\Delta\vartheta=$	7,2875

Temperature distribution		System thickness (m)
$\vartheta_1=\vartheta_I-\varphi*R^*_{Si}=$	19,05	0
$\vartheta_2=\vartheta_1-\varphi*R^*_{cd1}=$	17,58	0,3000
$\vartheta_3=\vartheta_2-\varphi*R^*_{cd2}=$	-3,86	0,4000
$\vartheta_4=\vartheta_3-\varphi*R^*_{cd3}=$	-4,22	0,4020
$\vartheta_7=\vartheta_O+\varphi*R^*_{Se}=$	-4,71	0,6020





Case 1: without barrier



Case 2: with barrier

The thermal performance is good, the U- value being in the range of recommended value of maximum 0.3 W/m2K. Attention though should be paid to the condensation by either increasing the layer of insulation or even considering using alternative solution of the cupolex system that provides protection against water and radiation infiltration.

For the glazed surface, one looked at the southern façade as it is the most important from functionality point of view. The rest of the windows are low –E double glazed with shading system according to the orientation.

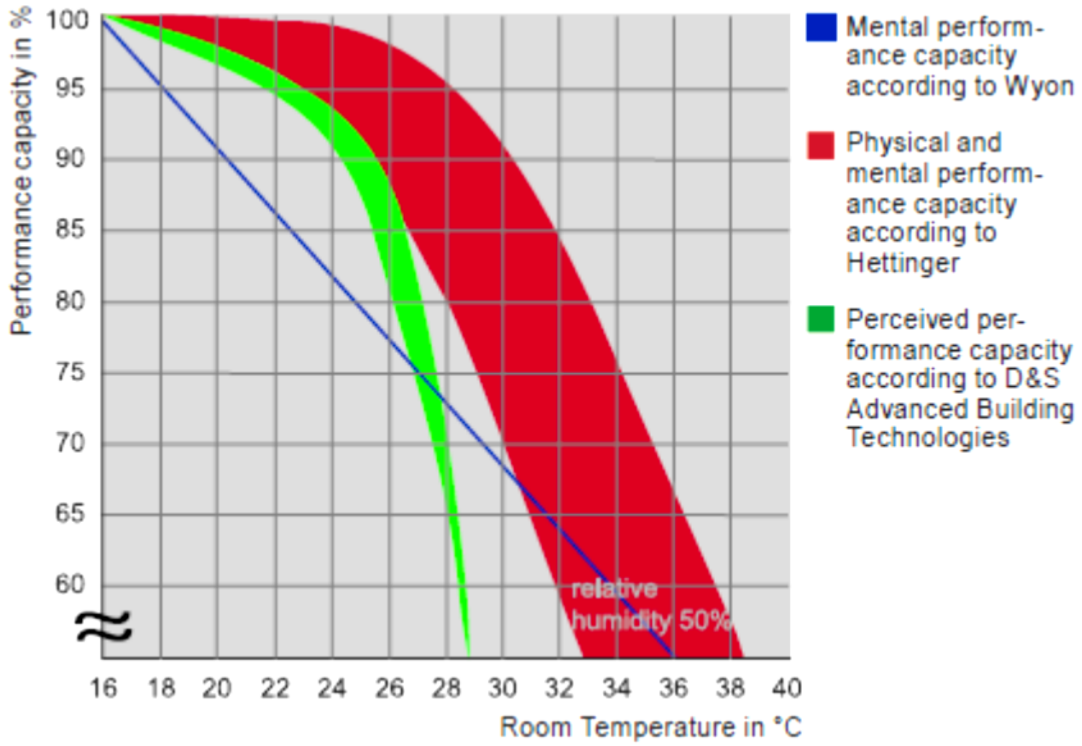
Material (interior → exterior)	**Thickness (m)**	**Thermal Conductivity (W/(m.K))**	**Thermal resistance (m^2K/W)**	
glass play	0,0080	1,700	0,0047	
gas cavity	0,0220	0,016	1,3750	
glass play	0,0060	1,700	0,0035	
air cavity	0,5000	-	0,1800	
glass play	0,0060	1,7	0,0035	
	Temperature (°C)	**Relative humidity (%)**	**Saturated Vapor Pressure (Kpa)**	**Surface resistance (m^2K/W)**
Outside conditions	-5,00	80	0,401	0,04
Inside conditions	20	50	2,337	0,13
Wall specific total thermal resistance			$R^*_{tot}=(R^*_{Si}+R^*_{cd}+R^*_{Se})=$	1,7368
Wall thermal transmittance			$U=1/R^*_{tot}=$	0,5758
Specific heat flux through the wall			$\varphi=U*\Delta\vartheta=$	14,3946

The system is performing well from thermal point of view allowing as well high percentage of natural light penetration.

Knowing the performance of the envelope one can step into next design approach which regards the air movement within the building, its speed and quality. The performance of the users is highly related with the air temperature and freshness. Clean air and adequate temperature not only provide a comfortable environment but can increase the performance of the individuals using the space.

Table 32 Building performance function of user requirements

Application	Usage Means & Merit	Requirements	Need	Building & Facility Function
Library	Many people studying intensely, leisure/ break, library operation	Very good air quality, high thermal comfort level covering all areas, short - term turn – off during less crowded periods	High volume of outdoor air flow, short turn-off times, high level of performance reserves for heating –up process	Efficient ventilation concept, optimal heat supply covering all areas, adequate lighting, energy-saving outflow of heat sources



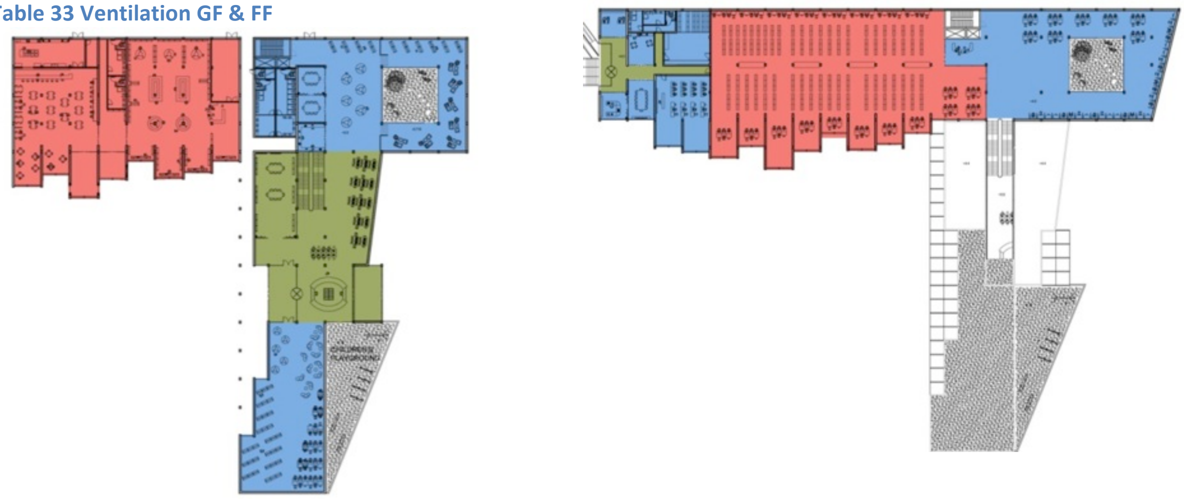
Performance capacity of humans as related to room temperature

Buildings with airtight envelope systems are typically conditioned with mechanical heating, ventilating, and air-conditioning (HVAC) systems. Mechanical HVAC systems maintain fairly constant thermal conditions and can be applied in any geographical location. Since mechanical cooling and fan energy use account for approximately 20% of commercial building electrical consumption, the concept of integrating passive natural ventilation in conventional air-conditioned buildings has received attention from building industry. In addition, users are increasingly interested in measures that can improve indoor air quality via fresh air or free ventilation through windows, in part as a reaction to the problems that result from poorly maintained conventional HVAC systems (e.g., sick building syndrome, Legionnaire's disease, etc.). Mixed-mode ventilation refers to a space conditioning approach that combines natural (passive) ventilation with mechanical (active) ventilation and cooling. Mixed-mode or hybrid ventilation is appropriate for the design of new buildings and the retrofit of older, naturally ventilated buildings, where internal loads have increased due to increased occupancy or equipment loads.

Considering the three main operation modes of mixed ventilation: contingency (mechanical designed

building to convert to natural), zoned (different conditioning strategies simultaneously used in different zones) and complementary (AC and natural ventilation in the same zone – operating on seasonal and daily basis); one divided them within the building as follows:

Table 33 Ventilation GF & FF



The mechanical ventilation of the main collection area and of the café area will be done via the floor such that to account for the advantages of displaced ventilation schemes and also to avoid excessive noise – the ducts for the library will run in the café area at the intrados of the slab over café, while the ducts for the café will run at the ground level in a specially isolated gutter. The main entrance and the lobby will be ventilated naturally. The area is already exposed to more intense air change and thus running a mechanical system in the area is not economical. For the reading/ community area and the children's library the option was natural cross ventilation due to operable windows placed parallel to each other and perpendicular to the prevalent wind direction and additional mechanical ventilation during peak hours of use or very hot summer days via low energy consumption fan coil units.

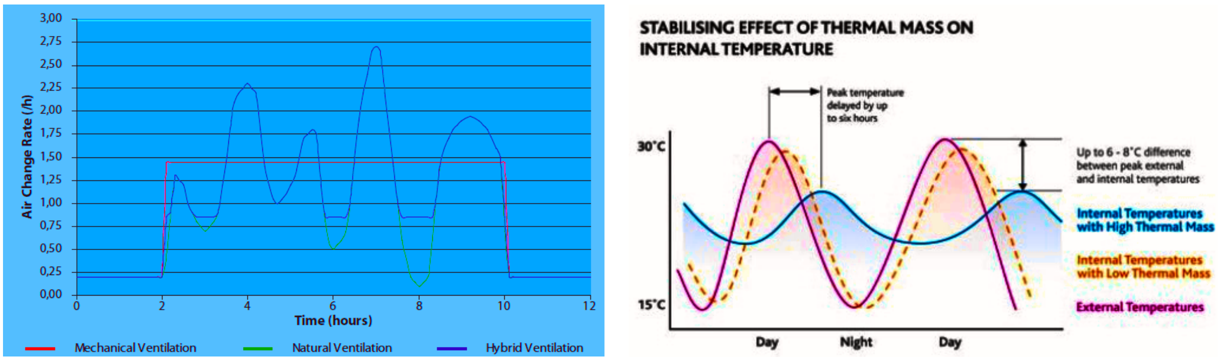


Figure 346 Hybrid ventilation and thermal mass

The use of thermal mass for compensating the conditioning of the air provided within the space reduces the heating energy consumption by 15%. The mechanical ventilation passes low velocity air through the cores of the slab in serpentine pattern, which increases the contact period between the air and concrete for better heat transfer. Additional heat gain can be used from the double skin façade airtight cavity that is connected to the air supply system.

The efficiency of the supply system for the mixed mode area is firstly stated via the system chosen. The VAV system instead of traditional CAV.

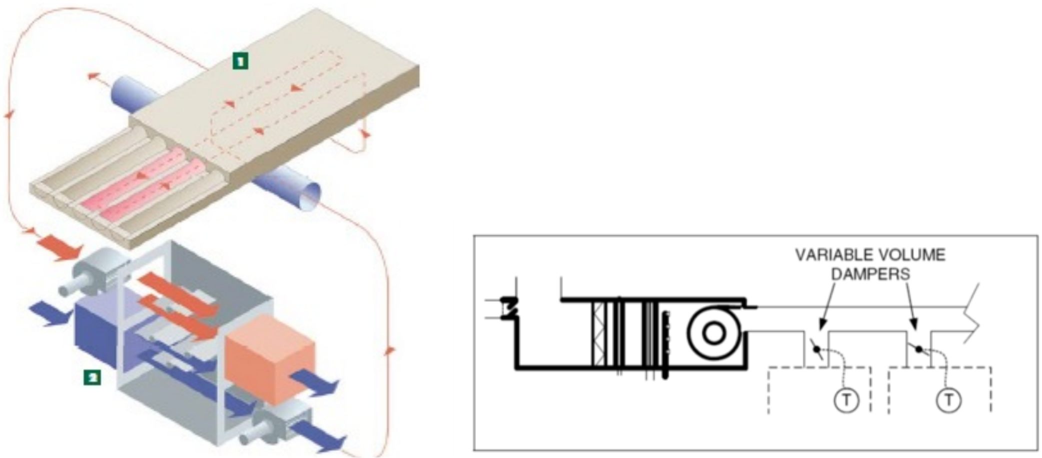


Figure 347 Ventilation systems

The sizing of the supply ducts was done based on the requirements of fresh air within the building and the full capacity of each space.

Figure 348 Air Quality GF & FF

Table 34 Thermal load evaluation

HVAC system design											
Location	area (m^2)	volume (m^3)	density (m^2/person)	total occupancy (persons)	fresh air demands (l/s/pers)	Air flow (l/s)	N (ach) ≥ 4..6	N (ach)	Final flow (l/s)	Duct area (m2)	Duct no and size
Main library	2001,00	7003,50	6	334	8	2668,00	1,37	4,00	7781,67	1,56	3 by 125x45
Café area	860,00	3010,00	1,5	573	10	5733,33	6,86	6,86	5733,33	1,15	2by 125x45
Children's library	362,00	1267,00	2	181	8	1448,00	4,11	4,11	1448,00	0,29	65x45
Reading/community	1048,00	3668,00	2	524	8	4192,00	4,11	4,11	4192,00	0,84	2 by 90x45

Air heating and cooling demand					
Location	Final flow (l/s)	∆Twinter (°C)	Heating q (kW)	∆Tsummer (°C)	Cooling q (kW)
Main library	7781,6667	5	46690	11	102718
Café area	5733,3333	5	34400	11	75680
Children's library	1448	5	8688	11	19113,6
Reading/community	4192	5	25152	11	55334,4

Other loads					
Location	Occupancy	Area	Heat gain person (W)	Lighting (W)	Appliances (W)
Main library	334	2001,00	26680,00	30015,00	24012,00
Café area	573	860,00	45866,67	12900,00	10320,00
Children's library	181	362,00	14480,00	5430,00	4344,00
Reading/community	524	1048,00	41920,00	15720,00	12576,00

Table 35 Thermal load evaluation

Heat gain			
Element	Area (m^2)	Heat gain (W/m^2 of galss)	Total (W)
E,W and N glazed façade	1375	150	206250
South glazed façade	570	250	142500

Theoretical storage capacity of 300mm hollow core concrete slab is around 100Wh/m² per °C. With an average increase in slab temperature by 3 °C, this would mean 300Wh/m² divided by 10 hours operating period, around 30 W/m². The ground floor café area will have an exposed area and equivalent ceiling of 345m², which means that the reduction of the heating load for the area can be of 10350W, which is more or less the thermal load due to lighting or it can be considered that the solar heat gains are absorbed by the thermal mass in this way reducing the impact of solar energy on the internal gains.

The cooling and heating loads can be determined considering the heat losses via the envelope, due to infiltrations and ventilation and the heating and cooling degree days specific for the Timisoara climate.

Table 36 Thermal load evaluation

Zone	Area (m^2)	U value (W/m^2K)	ΔT winter (°)	Heat loss conduction (W)	$ACH_{infiltration}$	Room volume (m^3)	Infiltrated air volume	Heat loss infiltrations (W)
Main library								
walls	80,00	0,20	25,00	400,00	0,15	7003,50	17,51	31673,33
roof	2001,00	0,29		14507,25				
floor	2001,00	0,20		10005,00				
glass	422,50	0,57		6020,63				
Café area								
walls	195	0,20	25,00	975	0,15	3010,00	7,525	13612,725
roof	860	0,20		4300				
floor	860	0,29		6235				
glass	285	0,57		4061,25				
Children's library								
walls	172,5	0,20	25,00	862,5	0,15	1267	3,1675	5730,0075
roof	362	0,29		2624,5				
floor	362	0,29		2624,5				
glass	137,5	1,01		3471,875				
Reading/community								
walls	242,5	0,20	25,00	1212,5	0,15	3668,00	9,17	16588,53
roof	1048	0,29		7598				
floor	1048	0,29		7598				
glass	137,5	1,01		3471,875				

Table 37 Thermal load evaluation

Zone	Area (m^2)	U value (W/m^2K)	ΔT summer (°)	Heat loss conduction (W)	$ACH_{infiltration}$	Room volume (m^3)	Infiltrated air volume	Heat loss infiltrations (W)
Main library								
walls	354,96	0,20	11,00	780,91	0,15	7003,50	17,51	13936,26
roof	2001,00	0,29		6383,19				
floor	2001,00	0,20		4402,20				
glass	285,02	0,57		1787,08				
Café area								
walls	479,855	0,20	11,00	1055,681	0,15	3010,00	7,525	5989,599
roof	860	0,20		1892				
floor	860	0,29		2743,4				
glass	0,145	0,57		0,90915				
Children's library								
walls	309,98	0,20	11,00	681,956	0,15	1267	3,1675	2521,2033
roof	362	0,29		1154,78				
floor	362	0,29		1154,78				
glass	0,02	1,01		0,2222				
Reading/community								
walls	379,98	0,20	11,00	835,956	0,15	111,90	0,27975	222,66981
roof	1048	0,29		3343,12				
floor	1048	0,29		3343,12				
glass	0,02	1,01		0,2222				

Total cooling load	Ventilation	Infiltration	Conduction
Main library	102718,00	13936,26	13353,38
Café area	75680,00	5989,60	5691,99
Children's library	19113,60	2521,20	2991,74
Reading/community	55334,40	222,67	7522,42
TOTAL sector	252846,00	22669,74	29559,52
Total (W) with 10 safety factor%	335582,79		
Total (KWh)	335,58		
Total season loss considering degree day			
Cooling degree days for Timisoara			257,00
Annual heat load (kW)			82794,99

Total heating load	Ventilation	Infiltration	Conduction
Main library	46690,00	31673,33	30932,88
Café area	34400,00	13612,73	15571,25
Children's library	8688,00	5730,01	9583,38
Reading/community	25152,00	16588,53	19880,38
TOTAL sector	114930,00	67604,59	75967,88
Total (W) with 10 safety factor%	284352,71		
Total (KWh)	284,35		
Total season loss considering degree day			
Heating degree days for Timisoara			3212,20
Annual heat load(kW)			876861,87

Finally, based on the cooling and heating loads the system can be designed. The chiller's cooling capacity $q(kW) = \frac{cooling\ load}{running\ period} = \frac{335.58}{10} = 33.5kW$ and the tank capacity $C(m^3) = \frac{cooling\ load}{water\ heat\ capacity} = \frac{335.58}{8} = 42m^3$

The heating capacity $q(kW) = \frac{heating\ load}{running\ period} = \frac{284.35}{10} = 28.5kW$

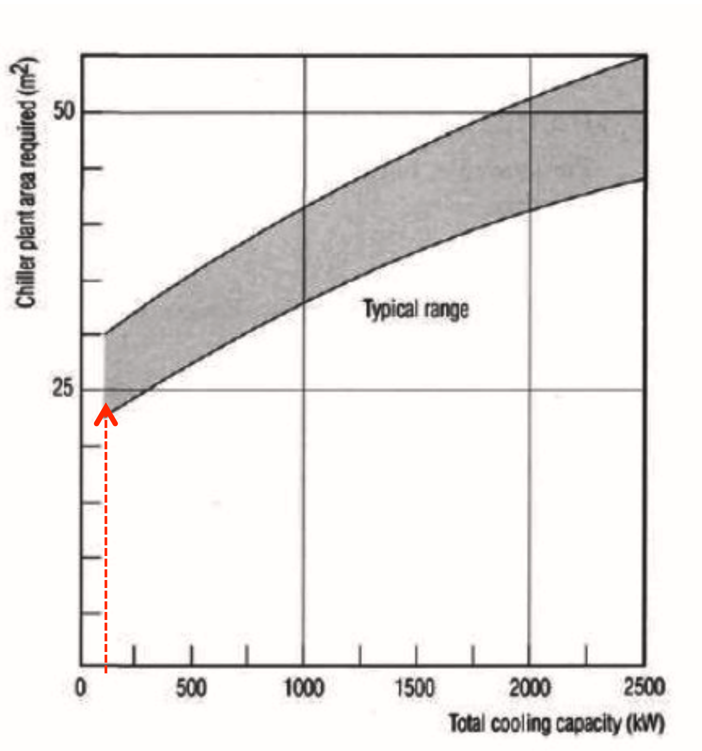


Figure 349 Space requirements for chiller

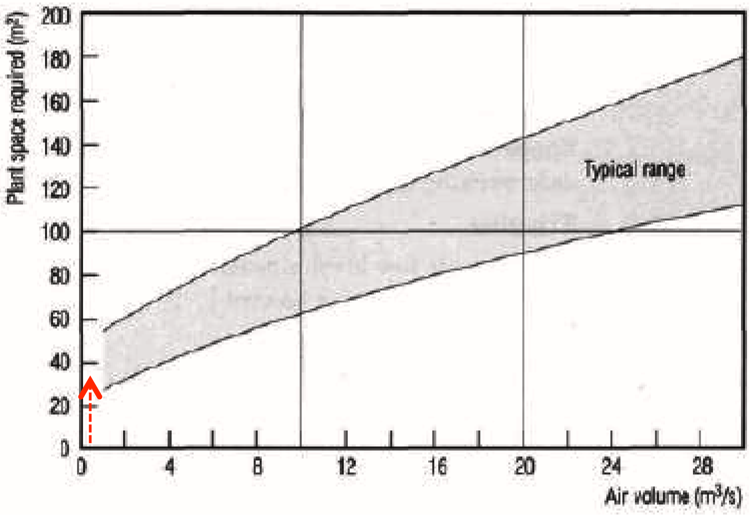


Figure 350 Space requirements AHU

Chapter VI : Structural Analysis

The direction of the structural design was dictated by the architectural concept of “cultural factory”. Together with the fact that the area on which the project will develop is an ex-industrial area and the new trend of sustainable construction also from execution point of view, tradition of using concrete as structural material led to the decision of using prefabricated concrete elements in order to “anchor” our concept to the ground.

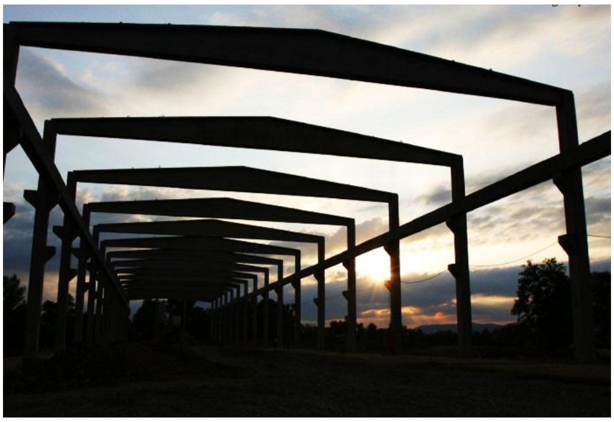



Figure 351 Background and Aim

There are at least 10 reasons for choosing precast concrete as construction material:

- Comfortable: intrinsic thermal inertia and acoustic insulation properties
- Safe: structurally stable, higher life cycle, prevents fire spread, strong to resist blasts and earthquakes
- Versatile: factory production allows wide variety of surface finishing, colour and shape
- Healthy: stable material that does not need chemical treatment, no emissions in the internal environment
- Optimised: improved quality products i.e. reduced tolerances, thinner sections, engineered solutions
- Durable: lasts for years
- Ecological: made of natural raw material, locally available; can be re-used and recycled almost 100% despite the reinforcement amount
- Fast: elements can be cast in the factory when foundations have not started yet
- Affordable: it combines the excellent quality of factory production with relatively inexpensive material
- Sustainable: for people and planet in profit – a three win situation for the three pillars of society

The design building has approximately an L- shape, measuring 100 on 80 meters. The irregular structure will be dimensioned according to necessary strength and stability rules and regulations and the structural modelling is achieved using finite element structural modelling programs – Etabs.

Geometric configuration in plan presents 13 bays of variable length (5 m or 10 m). On the transversal side the building has 9 spans, again of variable length (5 m or 10 m). The two plans in superstructure are not similar in surface - ground floor 2775m^2; first floor 2348m^2. The basement is just a technical room of 135m^2. In elevation the structure is a frame structure with the peculiarity that the envelope walls are triple layer walls formed by two heavy components – concrete and bricks; and a lightweight one – insulation. In height, the building has the following configuration: basement 3 m, ground floor 4m and the first floor with a varying clear height : shorter side 4m and tallest 6m.

The building has an importance class C3 as per design norms due to the main destination for people congregation.

Materials and elements assessment is done considering the three main components: foundation, infrastructure and superstructure. The foundations are prefabricated isolated ones under the columns made of concrete class C30/37.

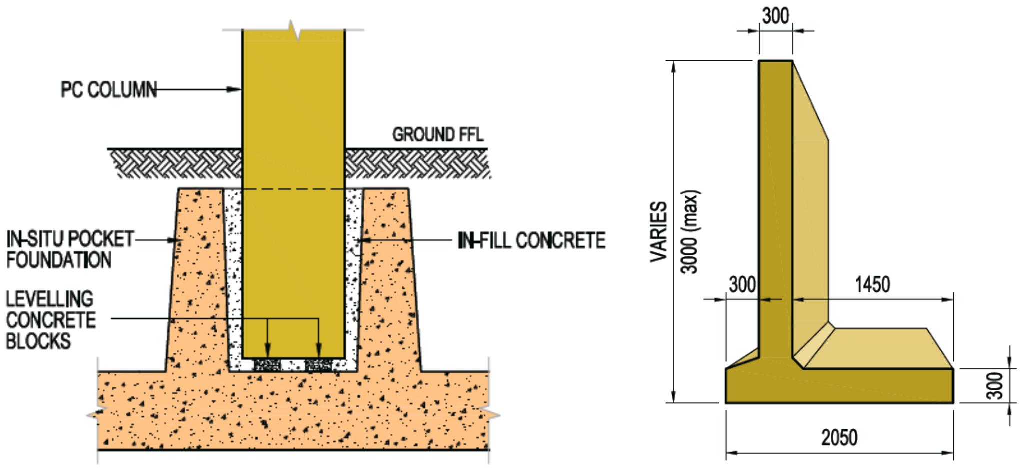


Figure 352 Typical solutions of precast elements

The infrastructure consist of structural precast retaining concrete wall of 30 cm thickness in both directions, enclosed by the ground floor slab composed of hollow core slab.

The superstructure consists of concrete walls for the staircase core and frame structure composed of prefabricated columns and beams of concrete class C40/50 and reinforcement B500.

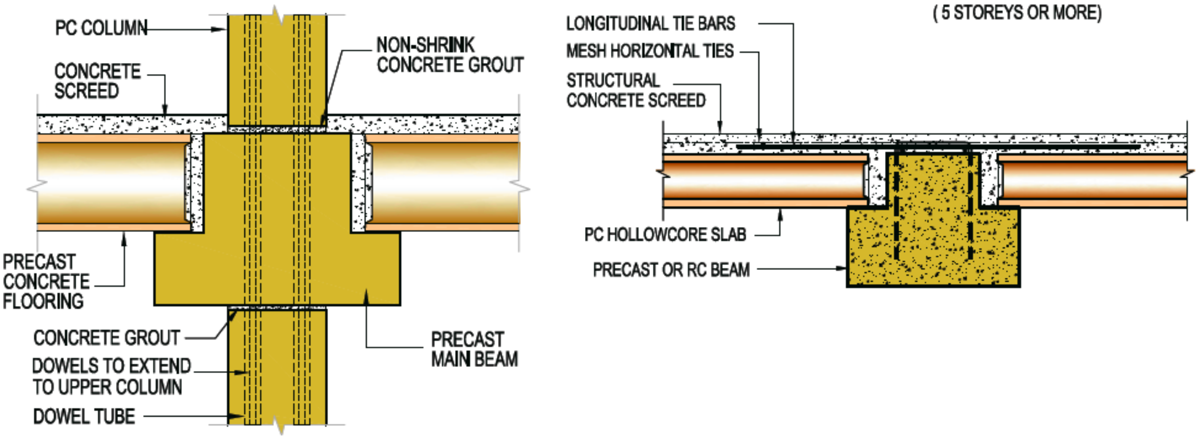
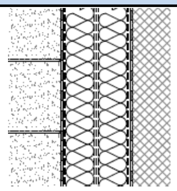


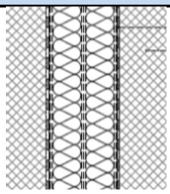
Figure 353 Typical solution for upper structure

Soil condition of the area of interest is available via a geotechnical report. According to the study following stratification is disposed by the foundation soil: -2.00 m clay; -12.00 m fine sand with medium compactness; - 18.00 m plastic clay. The freezing depth of the soil is at 60 – 70 cm as per national norm (STAS 6054-77), while ground water table is encountered at -2.00 m. The final conclusion is that the minimum foundation depth is at -0.90 m.

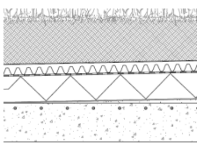
To perform the structural analysis one needs to define the actions on the building. The self – weight of the building components is the first to be evaluated in order to be able to define the dead load.

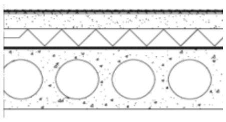
Zone	Material	Thickness	Specific weight	Total weight	Load
Outer shell - Vertical enclosure		(m)	(kg/m3)	(kg/m2)	(kN/m2)
	Brickwork	0,1150	1700	195,5	1,92
	Vapor barrier	0,0020	30	0,06	0,00
	Mineral Wool	0,0650	30	1,95	0,02
	Mineral Wool	0,0650	30	1,95	0,02
	Water barrier	0,0020	15	0,03	0,00
	Precast concrete block	0,1150	1400	161	1,58
				Total	3,54

For the floor height of 3.50 m (slab thickness reduced from clear height), the linear weight is 12.39 kN/m. Considering 30% openings, the total linear weight of the wall is 8.7 kN/m, applied on the perimeter beams and not distributed on the slab.

Zone	Material	Thickness	Specific weight	Total weight	Load
Outer shell - Vertical enclosure		(m)	(kg/m3)	(kg/m2)	(kN/m2)
	Precast concrete block	0,1150	1700	195,5	1,92
	Vapor barrier	0,0020	30	0,06	0,00
	Mineral Wool	0,0650	30	1,95	0,02
	Mineral Wool	0,0650	30	1,95	0,02
	Water barrier	0,0020	15	0,03	0,00
	Precast concrete block	0,1150	1700	195,5	1,92
				Total	3,87

The final linear load is evaluated in the same way as previously. The value of 9.5 kN/m will be finally applied on the beam.
For the internal partitions the lightweight solution adopted is composed by insulation and plasterboard (or glass). According to EN 1991 – 1- 1 (6.3.1.2(8)) an equivalent uniformly distributed load over the floor, instead of the free action of movable partitions, can be considered. The nominal value of the uniformly distributed partitions load in this case will be considered 0.5kN/m2.
For the slabs the loads to be considered in the evaluation are summarized in the tables below.

Zone	Material	Thickness	Specific weight	Total weight	Load
Outer shell - horizontal enclosure		(m)	(kg/m3)	(kg/m2)	(kN/m2)
	Ceiling	varies	-	9,765	0,10
	Concrete slab	0,2000	2500	500	4,90
	Screed	0,0200	1200	24	0,24
	Acoustic insulation	0,0030	30	0,09	0,00
	EPS	0,1000	25	2,5	0,02
	Waterproofing membrane	0,0020	15	0,03	0,00
	Zinc sheet	0,0400	3900	156	1,53
	Antiroot filter	0,0020	15	0,03	0,00
	Peat layer	0,1500	800	120	1,18
				Total	7,97

Zone	Material	Thickness	Specific weight	Total weight	Load
Inner shell - Horizontal enclosure		(m)	(kg/m3)	(kg/m2)	(kN/m2)
	Precast concrete block	0,3000	2500	750	7,35
	Acoustic insulation	0,0080	30	0,24	0,00
	EPS	0,0600	30	1,8	0,02
	Screed	0,0500	1200	60	0,59
	Carpet	0,0050	26	0,13	0,00
				Total	7,96

As the building is a C type category – the imposed load on the floor is considered 3kN/m^2. In the main collection area due to the destination of books storage (E1 category), the imposed load should be considered 7.5 kN/m^2.
The snow load is defined according to EN 1991-1-3 and national code CR-1-3-2005 “Cod de proiectare. Evaluarea actiunii zapezii asupra constructiilor” and is expressed under the form: $s = \mu \cdot C_e \cdot C_t \cdot s_k$

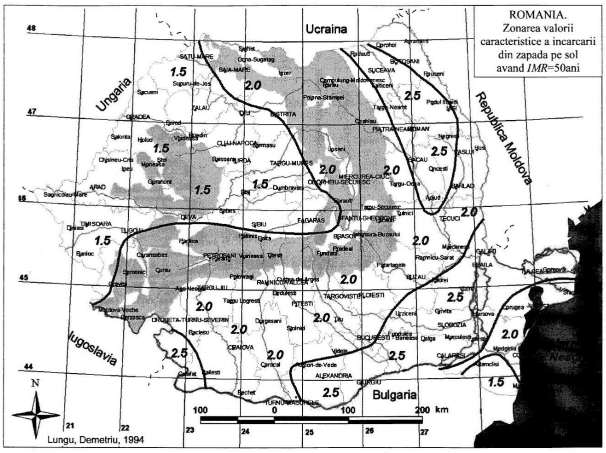
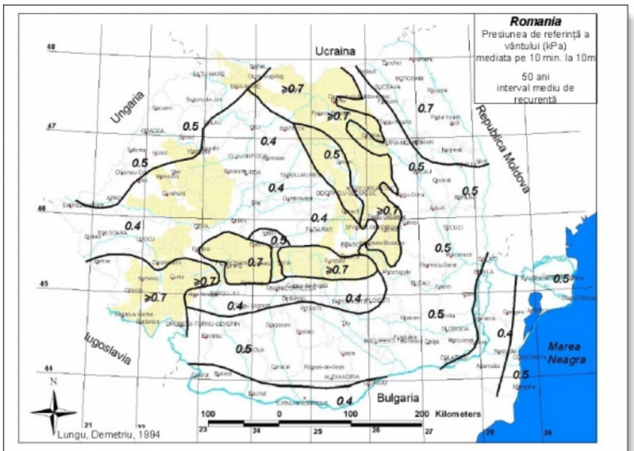


Figura 2.1 Romania - zonarea valorii caracteristice a incarcarii din zapada pe sol $s_{0,k}$, kN/m^2

m – snow load shape coefficient which for the studied building is considered 0.8 due to the roof inclination of 5°
Ce – exposure coefficient which for the study area is considered to be 1.0, moderate exposure to snow
Ct – thermal coefficient, accounts for reduction of load due to roofs with high transmittance; for the building the U-value of the roof is 0.2W/m2K and the coefficient is considered 1.0
Sk – characteristic value of snow load on the ground, for Timisoara the value is 1.5 kN/m2

The final snow load to be considered is: $s = 0.8 \cdot 1.0 \cdot 1.0 \cdot 1.5 = 1.2\ kN/m^2$

The wind load is determined according to EN 1991-1-4 and the national code NP-082-04 "Cod de proiectare. Bazele proiectarii si actiuni asupra constructiilor. Actiunea vantului". The reference wind pressure, measured at a mean of 10 min, at 10 m above the ground level for a mean recurrence interval of 50 years is 0.4 kPa.



gura A.2 Valori caracteristice ale presiunii de referință a vântului, mediată pe 10 min., având 50 ani interval mediu de recurență (2% probabilitate anuală de depășire)

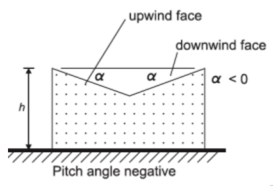
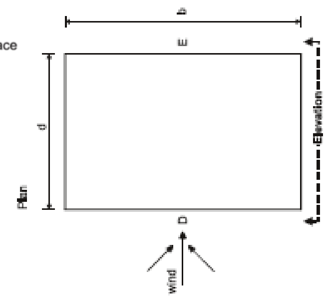
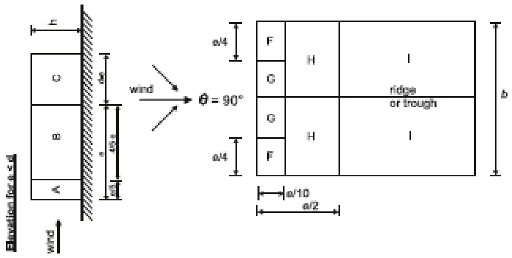
The basic wind velocity is considered vb = 33 m/s as per table A.1 in the national norm
The mean wind velocity at a certain height z above the terrain can be calculated: $v_m(z) = = c_r(z) \cdot c_o(z) \cdot v_b$.
co – the orography coefficient equal to 1.0
cr –roughness coefficient defined for Timisoara function of terrain category (IV) zo =1.0 m and zmin = 10 m, kr =0.234 ➔ cr (zmin) =0.234lnz(z/z0) = 0.539 and cr (z)=0.234ln(z)
The gust (peak) velocity vp(z)=vm(z).G, G which is square root of the exposure coefficient $c_e(z)$
Basic velocity pressure: $q_b = \frac{1}{2}\rho v_b^2$

The peak velocity pressure $q_p(z) = c_e(z) \cdot q_b$. The wind pressure on the external wall can be determined from the expression $w_e = c_{pe} q_p(z_e)$, while the wind force has the expression function of the wind pressure and the area on which it acts: $F_w = \sum_i w_{ei} \cdot A_i$.

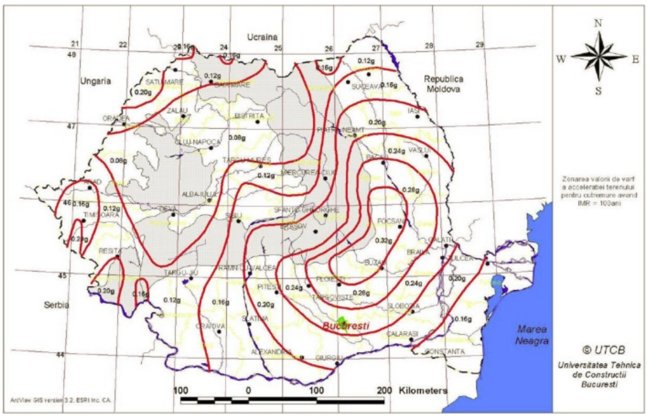
Whether the wind direction is parallel to the principal frames or orthogonal to them, the area of the walls directly affected by the wind action (100m first case or 80 m second case)is greater than the height of the building (10 m). As per EN 1991 1-4, the reference height z_e, is assumed to coincide with the height of the building and a constant uniform distribution is taken for the pressure and depressions on the vertical walls.

z (m)	$c_r(z)$	$I_v(z)$	$c_e(z)$	q_b [N/m^2]	$q_p(z)$ [N/m^2]
10,00	0,54	0,43	1,17	680,63	798,29

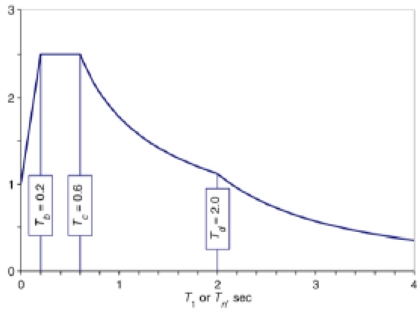
The external shape coefficient c_{pe}, depends on the wind direction to the planes of the principal frames. For the building under study the wind is parallel to the planes of the principal frames. The elevations and plans of the building are divided in zones function of the quantity e = min {b, 2h} = min {100, 20} = 20 m and the ratio h/d = 10/100 = 0.1.

zone	A	B	C	D	E	F	G	H	I
h/d	c_{pe} for vertical walls					c_{pe} for duopitch roof			
<0,25	-1,2	-0,8	-0,5	0,7	-0,3	-1,8	-1,2	-0,7	-0,6
  									
wind pressure: $q_{pe}(z_e) \cdot c_{pe}$	-957,94	-638,63	-399,14	558,80	-239,49	-1436,92	-957,94	-558,80	-478,97

The seismic load is evaluated according to the EN 1998 an the national norm "Cod de proiectare seismica P100-1/2006"



For Timisoara the characteristics are: the ground acceleration is a_g = 0,16g and the corner period T_C = 0,7s.



The standard procedure in the norms is forced based design on the basis of the results of linear analysis (static lateral force s or modal response spectrum) reduced by the behaviour factor q.

Lateral Force Method of analysis to derive the base shear by assigning total mass to 1st translational mode in the horizontal direction of interest is used as the building height is lower than 30m (H = 10m) and the natural oscillation period is smaller than 2.00 seconds or $4 \cdot T_C$. As per Eurocode 8, the fundamental period for concrete structures is estimated using an empirical expression $T_1 = 0.075 \cdot H^{\frac{3}{4}}$ = 0.4217sec. The importance class of the building is III (buildings whose seismic resistance is of importance in view of the consequences associated with a collapse; e.g. schools, cultural institutions) with an importance factor of $\gamma_1 = 1.2$. ➔ peak ground acceleration will be normalized by the importance factor $a_g = 1.2 \cdot 0.16g = 1.88m/s^2$. For the type C soil (deposit of sand and clay) the horizontal design spectra can be defined function of periods. Using the values of k = 1.15; $T_B = 0.2sec$; $T_C = 0{,}6\,\sec\, and\ T_D = 2.0\ sec$ and comparing to T_1, it can be seen that the spectrum will be calculated for the condition $T_B \leq T_1 \leq T_C$: $S_e(T) = a_g \cdot S \cdot \eta \cdot 2.5 = 5.415m/s^2$; η = 1 the damping correction factor for 5% viscous damping.

The final design spectrum is obtained by reducing the elastic spectrum by the behaviour factor $q = q_0 \cdot k_w \geq 1.5$. The base value of the behaviour factor for the frame systems of medium ductility class (DCM) is $q_0 = 3.0 \cdot \frac{\propto_u}{\propto_1} = 3.0 \cdot 1.1 = 3.3$, the α coefficients are multipliers of the horizontal seismic force accounting for the plastic hinges formation and limit of flexural strength of elements. The k_w factor accounts for prevailing failure mode in structural systems with walls; for the actual case – frame structure k_w = 1.0. The final behaviour coefficient to be used will be q = 3.3 ➔ $S_d = \frac{S_e}{q} = 1.64m/s^2$.

The seismic base shear force for the two horizontal directions is determined by formula $F_b = S_d(T_1) \cdot m \cdot \lambda$, where λ =0.85 correction factor (for $T_1 \leq 2 \cdot T_c$) ➔ distribution of the horizontal seismic force will be estimated by the expression $F_i = F_b \cdot \frac{s_i \cdot m_i}{\sum s_i \cdot m_i}$, where s_i is the clear height of the floor and m_i is the storey mass.

Due to regularity criteria – avoidance of eccentricities by having a symmetrical building with an aspect ratio for a rectangle including the building to be around 4 and setbacks or overhangs not more than 25% of the building total dimension in the direction of variation; stiffness variation; accumulation of stress – the total construction will be subdivided in three components connected via seismic joints: the compound running around NS axis with dimensions 60x25m having only one level; and the two compounds running along WE direction, one of 70x20m with two levels and one of 45x20m having again two levels.

Part 1 Children's area & Main entrance									
Level	Function	Area (m^2)	Load (kN/m^2)	Total slab (kg)	Walls length (m)	Wall height (m)	Load (kN/m^2)	Total walls (kg)	Final (kg)
± 0.00	slab over the ground	975	8,66	844350	118	2	4,78	112808	112808
+4.00	roof slab	975	7,85	765375	118	2	4,78	112808	878183
									990.991,00

Part 2 Main social interaction area									
Level	Function	Area (m^2)	Load (kN/m^2)	Total slab (kg)	Walls length (m)	Wall height (m)	Load (kN/m^2)	Total walls (kg)	Final (kg)
± 0.00	slab over the ground	677	8,66	586282	74	2	4,78	70744	70744
+4.00	slab over ground floor	777	8,66	672882	74	4	4,78	141488	814370
+8.00	roof slab	777	7,85	609945	74	2	4,78	70744	680689
									1.565.803,00

Part 3 Main library/coffee shop									
Level	Function	Area (m^2)	Load (kN/m^2)	Total (kg)	Walls length (m)	Wall height (m)	Load (kN/m^2)	Total walls (kg)	Final (kg)
± 0.00	slab over the ground	995	8,66	861670	90	2	5,68	102240	102240
+4.00	slab over ground floor	1486	9,56	1420616	90	4	5,23	188280	1608896
+10.00	roof slab	1486	7,85	1166510	90	3	4,78	129060	1295570
									3.006.706,00

The final calculation of the seismic load distribution is summarized as follows:

Part 1 Children's area & Main entrance							
Level	Function	hi (m)	wi (kg)	hiwi	∑hiwi	Fb (kN)	Fi (kN)
+4.00	roof slab	4	878183	3512732	3512732	1381,4415	1381,441

Part 2 Main social interaction area							
Level	Function	hi (m)	wi (kg)	hiwi	∑hiwi	Fb (kN)	Fi (kN)
+4.00	slab over ground floor	4	814370	3257480	8702992	2182,7294	816,9831
+8.00	roof slab	8	680689	5445512			1365,746

Part 3 Main library/coffee shop							
Level	Function	hi (m)	wi (kg)	hiwi	∑hiwi	Fb (kN)	Fi (kN)
+4.00	slab over ground floor	4	1608896	6435584	19391284	4191,3482	1391,026
+10.00	roof slab	10	1295570	12955700			2800,323

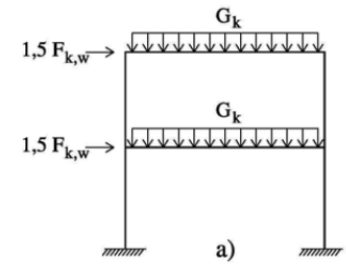
The combination of loads will be considered such that to have the most unfavourable stress state for the components of the structure. The norms mention the safety factors to be used in loads combination such that to consider a possible instantaneity in occurrence. Two main states for the loads combinations are defined as per linear analysis based on theory of elasticity: ultimate limit state and serviceability limit state:

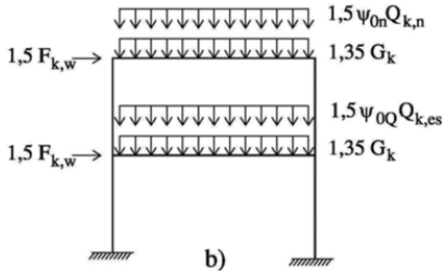
ULS = $\sum_{j=1}^{n} \gamma_{G,j} \cdot G_{k,j} + \gamma_{Q,1} \cdot Q_{k,1} + \sum_{i=1}^{n} \gamma_{Q,i} \cdot \Psi_{0,i} \cdot Q_{k,i}$

Where the values of the partial safety factors are considered for elements design in unfavourable case (as per tables available in the European norm): $\gamma_G = 1.35,\ \gamma_Q = 1.50.$ For the variable loads partial coefficients are taken the values: 1.00 for occupancy (books storage designation), 0.70 for the movable partitions, 0.50 for snow and 0.50 for wind.

SLS = $\sum_{j=1}^{n} G_{k,j} + Q_{k,1} + \sum_{i=1}^{n} \Psi_{0,i} \cdot Q_{k,i}$

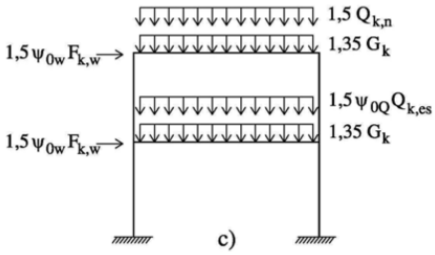
Basic combinations for the verification of the superstructure:





Predominant load wind – favourable

Predominant load wind – unfavourable



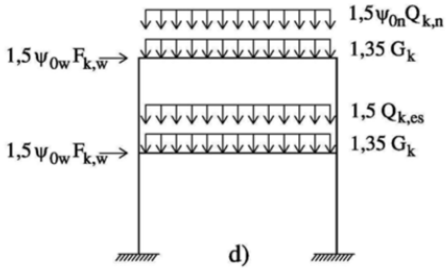


Figure 354 load combinations

Predominant snow load

Predominant service load

Preliminary selection of the structural elements

In designing the slabs and beams, the preliminary choice of the type of element is based on the span length and loads to be carried and the manufacturer guides. Considering that the designed building will be a library and will have to store books the load to be considered is 7.5 kN/m^2. The span's maximum dimension was assumed 10.00m. Using the following table the preliminary sizing of the slab is done. One can observe that for spans having the maximum dimension equal to 5 m the 200mm hollow core slab can be an option, while in case larger spans are desired the best option is 300mm hollow core slab. The beams will have to carry a load of less than 100 kN/m and can be placed having the span of 5 m, thus from the tables the edge and internal beams can be selected. For the columns the dimension ranges between 400mm and 900mm. The initial selection was nominated as 400x400 square columns.

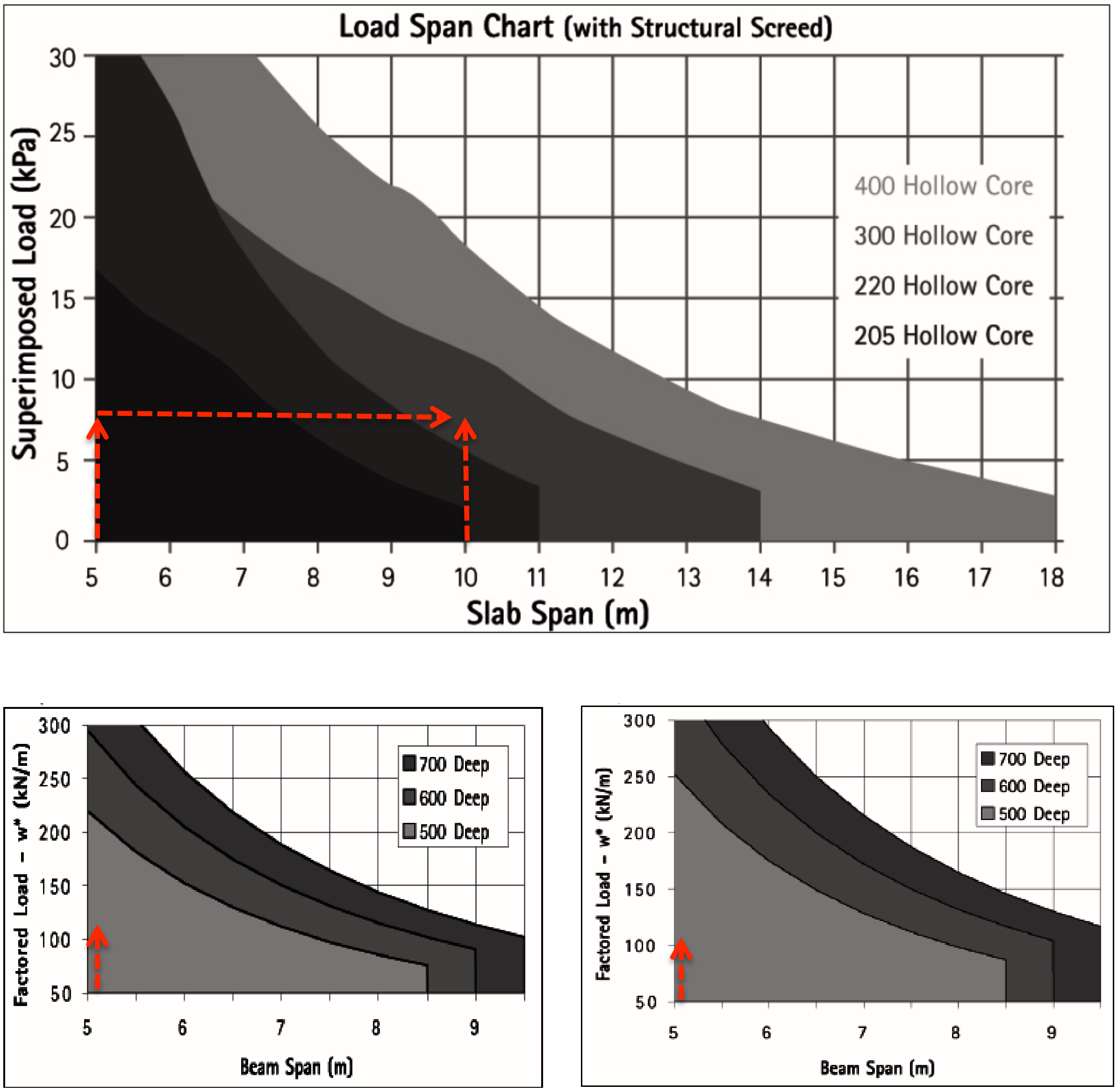
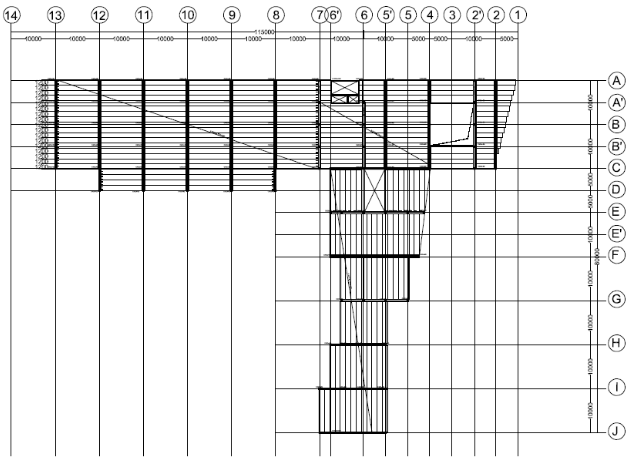
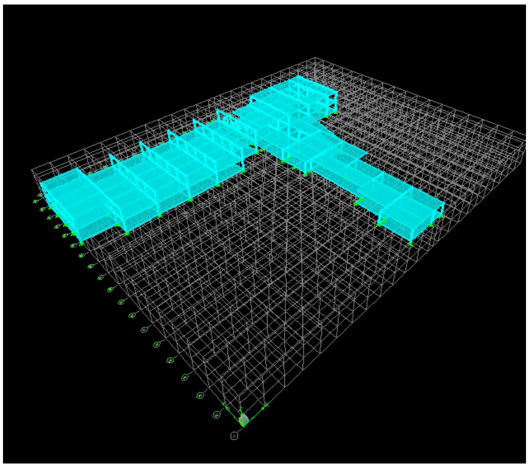


Figure 355 Selection of elements

For the preliminary design of the structural elements, additionally to the European norms were used the B. Mosley "Reinforced Concrete Design to Eurocode 2",sixth edition and technical manuals for precast elements design and manufacture elaborated by the National Precast Concrete Association Australia, based on local norms (AS 3600 – 2001 Concrete structures, AS 1170 – 2002 Structural design actions).





General layout building model

The hollowcore plank floor will span 10 m between centreline of bearings carrying a live load of 7.5kN/m^2 (storage destination and movable partitions). It will have an in-situ screed of minimum 60mm. The bearing length is considered 150mm on each side. Concrete class recommended for prestressed members pre design C40/50 (f_{ck} = 40N/mm^2) and prestressing steel of class Y1860 (f_{pk} = 1860N/mm^2) are to be used as component parts of the structural slab. The beams will span 5 m and will have same materials as the slab. The ground floor columns will develop on a 4m height.

The prestressing is taken as variable load for serviceability limit state and as restrain for ultimate limit state. Therefor in the final load combination the prestressing is considered normalised by a safety factor.

ULS = $1.35 \cdot G_k + 1.5 \cdot Q_{k1} + \sum 1.05 \cdot Q_{ki} + \gamma_P \cdot P$, where □ is taking the value 0.9 for the favourable case and 1.1 for the unfavourable one.

Initial design for prestress is carried at SLS using the combinations:

Case 1: $1 \cdot G_k + 1 \cdot Q_k$

Case 2: $1 \cdot G_k + 1 \cdot W_k$

Case 3: $1 \cdot G_k + 1 \cdot S_k$

Case 4: $1 \cdot G_k + 1 \cdot Q_k + 0.7 \cdot W_k + 0.7 \cdot S_k$

Case 5: $1 \cdot G_k + 1 \cdot S_k + 0.7 \cdot W_k + 0.7 \cdot Q_k$

Case 6: $1 \cdot G_k + 1 \cdot W_k + 0.7 \cdot Q_k + 0.7 \cdot S_k$

The preliminary design starts with considering the effective length of the element. For continuous beams and slabs the distance between the centres of bearing supports is taken as effective length: In this case the 10m length minus the half of the column size and the half of the bearing support: 9.725 m.

For the initial sizing the prestress forces after losses are used. For a standard strand type of minimum 12.9 mm in diameter the strand load is 88kN. Basic ratios of span/effective depth for continuous one – way slabs end span is 26 and mid span is 30; for the continuous beams the end span is 18 for the mid span is 20. For the column the condition to be checked is effective height to the least lateral dimension not exceeding 15, in such way it is avoided the necessity to design for effects of slenderness. In the initial design the effective height of the column will be 0.85 times the storey height.

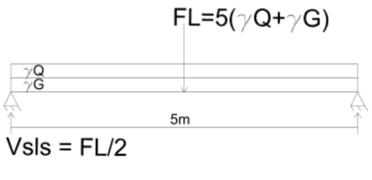
In choosing the slab thickness two primary functional requirements are to be fulfilled: structural strength and deflection. Typical span to depth ratio for one way, multi span slab on narrow beam is determined function of the imposed load of 7.5 kN/m and the condition 6m ≤ L ≤ 13m and it is 36. From this one can estimate the depth of the future slab around 277 mm. As the next dimension that is prefabricated is 300 mm, the final cross section will have a depth of 300mm. Additional requirement for the pre-sizing for this type of slab is to have a minimum of 4 panels per floor and a minimum thickness of 250mm. For the beams the span /effective depth ratio should have the values of 8 for cantilever, 18 for simply supported and 22 for the continuous ones. Having a span of 5m, the actual depth of the beams should be minimum 230mm under the slab. Total depth should account also for the thickness of the slab.

After the depths of the slab and beams were established it is mandatory to check the width of the beam, column sizing and practicality of the prestressed reinforcement and its distribution plus the nodes between elements.

For the XC1 class exposure against corrosion the nominal cover required is 20 mm. Taking into account also the fire exposure a minimum value of 25 is taken.

The initial design is performed for serviceability limit state and the checks to be done are maximum shear force and both maximum and minimum bending moment in critical sections. The loading arrangement is considered for all spans carrying the design permanent and variable load, alternate spans carrying the design permanent and variable load and other spans carrying the design permanent load or any two adjacent spans carrying the design permanent and variable load and the other spans the variable load.

For determining the width of the beam the element is considered simply supported loaded with both permanent and variable design loads. Width of the beam = $\frac{1000 \cdot V_{sls}}{2 \cdot d}$



Fig…Loads schematics

For the beam we have the self-weight of 25kN/m^3 times the depth of 530mm, the linear load from the exterior wall of 9.5kN/m and the influence load coming from the slab supporting on the beam which is the permanent load of the beam 25kN/m^3 times the depth of 300mm, the finishing load of more or less

1kN/m² and the superimposed live load (including storage and partitions) of 7.5kN/m²; all collected from half of the slab – equivalent slab area. The final value of the beam width will be around 370 mm and can be rounded up to 400 mm, considering the reinforcement cover and the fire resistance requirements.

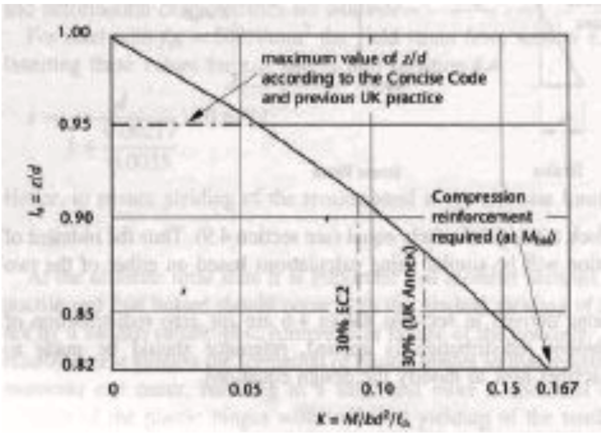
Considering the elastic analysis and the simplified approach for the envelope diagram if bending moment and shear force estimation for different loading patterns (most unfavourable arrangements); the bending moments and shear force of the for a continuous slab can be determined.

Bending moments and shear force for one way continuous slab					
Type	end support	end span	penultimate support	interior span	interior support
Moment	-0.04Fl	0.075Fl	-0.086Fl	0.063Fl	-0.063Fl
Shear	0.046F	-	0.6F	-	0.5F

	Bending moments and shear force for one way 6 spans - 10m slab; F = 213.75kN/m						
	1	2	3	4	5	6	7
Bending support	-85,5	-183,8	-134,7	-134,7	-134,7	-183,8	-85,5
Bending span	160,3	134,7	134,7	134,7	134,7	160,3	
Shear support	9,8	128,3	106,9	106,9	106,9	128,3	9,8

The section design for the solid slab is done by estimating first the bending reinforcement $A_s = \frac{M}{0.87 \cdot f_y \cdot z}$

The lever arm z is function of the ratio $k = \frac{M}{b \cdot d^2 \cdot f_{ck}} = \frac{134.7 \cdot 10^6}{1000 \cdot 270^2 \cdot 40} = 0.045$ ➔ the lever arm z/d = 0.95; z = 256.5mm.



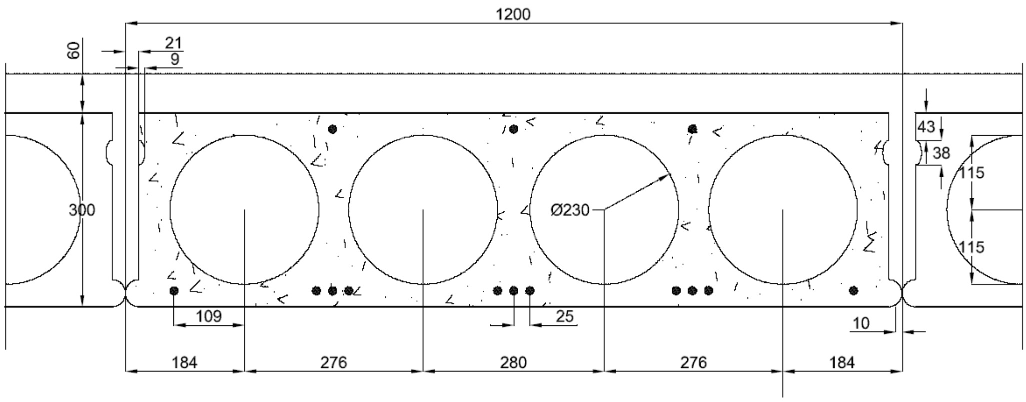
Lever arm determination

The required area of bending reinforcement will be 1207mm², thus if one considers the 7 wire strands of diameter 12.7mm and of 126mm² area each, it can be seen that the cross section will require 10 strands. For the reinforcement the difference with the manufacturer suggestion is in the assumption of the prestressing strength: 500N/mm² vs. 1500N/mm²

The condition of Mrd = 134kNm < Mu = $k_{lim} \cdot f_{ck} \cdot b \cdot d^2 = 140kNm$ is verified and the second check is for $A_{sreq} \geq 1.5\% \cdot b \cdot d = 1215mm^2$

For M > $0.167 \cdot f_{ck} \cdot b \cdot d^2 = 140\ kNm$ also the compression reinforcement is provided. In this case it is considered the edge support $A_{s2} = \frac{M - 0.167 \cdot f_{ck} \cdot b \cdot d^2}{0.87 \cdot f_{yk} \cdot (d - d_{2)}}$, where d_2 is the centroid depth. Which after performing the calculations is 266 mm^2 consisting in 2 strands of diameter 12.7mm.

For the serviceability limit state the check for the slab is for deflection to be under the required value span/500, which in this case is 0.002m.



Final slab solution

For the beam the same simplified approach of the bending moment and shear force coefficients was adopted. In this case the pre-dimensioning is done for ULS. The loads considered for the calculation are the self-weight of the assumed 530x700mm beam, the self- weight and loads of the beam considering the equivalent influence area being half and half of the slabs supporting on the beams.

	Bending moments and shear force for continuous beams					
	Type	end support	end span	penultimate support	interior span	interior support
	Moment	0	0.09Fl	-0.11Fl	0.07Fl	-0.10Fl
	Shear	0.45F	-	0.6F	-	0.55F
	Bending moments and shear force for one way 5 spans - 5m mid beam; F = 213.75kN/m					
	1	2	3	4	5	6
Bending support	0,0	-437,8	-398,2	-398,2	-437,8	0,0
Bending span	358,4	278,7	278,7	278,7	358,4	
Shear support	36,6	477,8	438,0	438,0	477,8	36,6

Moments evaluation for beams

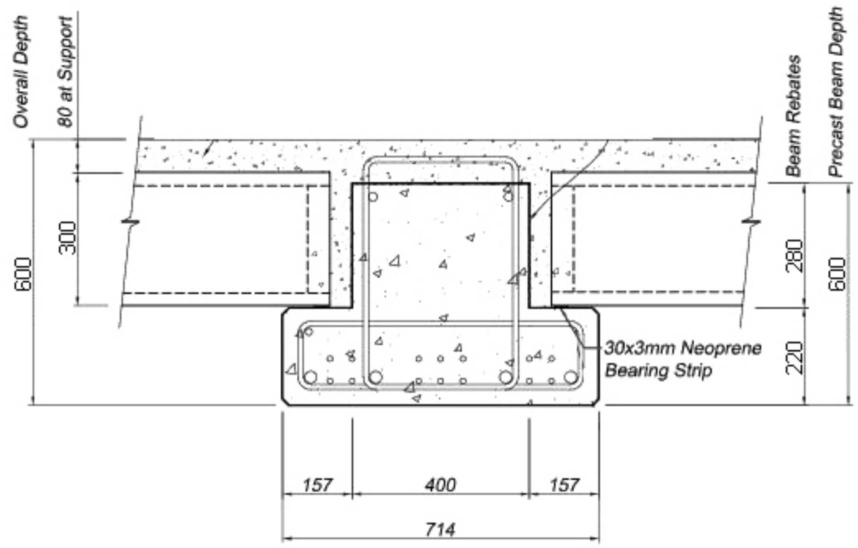
The section design for the beam is done by estimating first the bending reinforcement $A_s = \frac{M}{0.87 \cdot f_y \cdot z}$

The lever arm z is function of the ratio $k = \frac{M}{b \cdot d^2 \cdot f_{ck}} = \frac{278{,}7 \cdot 10^6}{700 \cdot 450^2 \cdot 40} = 0.05$➔ the lever arm z/d = 0.95; z = 427,5mm.

The required area of bending reinforcement will be 1498mm^2, thus if one considers the 7 wire strands of diameter 15.7mm and of 150mm^2 area each, it can be seen that the cross section will require 10 strands. For the reinforcement the difference with the manufacturer suggestion is in the assumption of the prestressing strength: 500N/mm^2 vs. 1500N/mm^2. The manufacturer makes a combination of reinforcement diameters and arrangement within the tensed part of the cross section

The condition of Mrd = 278,7kNm < Mu = $k_{lim} \cdot f_{ck} \cdot b \cdot d^2 = 567kNm$ is verified and the second check is for $A_{sreq} \geq 0.5\% \cdot b \cdot d = 1575mm^2$ which in this case is smaller and will be adopted the latest one.

For M > $0.167 \cdot f_{ck} \cdot b \cdot d^2 = 946\ kNm$ also the compression reinforcement is provided. Which in this case should not be full filed as the calculated moment is smaller than the design ones.



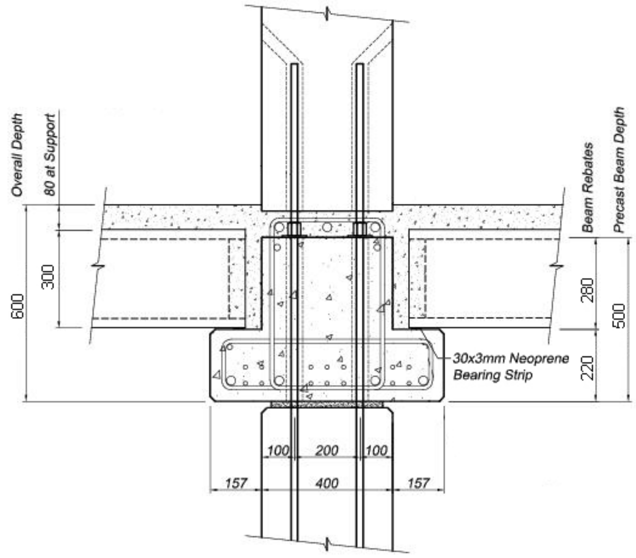
Beam final detail

For the deflection control the Eurocode 2 allows not to calculate the deflection of members if the span/effective depth ratio is less than the limits: $\frac{l}{d} = k[11 + 1.5 \cdot \sqrt{f_{ck}}\frac{\rho_0}{\rho} + 3.2 \cdot \sqrt{f_{ck}}(\frac{\rho_0}{\rho} - 1)^{3/2}]$

$\rho = \frac{A_S}{bd} = 0{,}005$ and $\rho_0 = \sqrt{f_{ck}}10^{-3} = 0{,}006 > \rho$

For end spans of continuous beams k=1.3, thus it results 29.2 > l/d=5000/450 =11.11. the verification being fulfilled the direct deflection calculation can be omitted.

The same calculation can be done for the other spans but in general the beam will be design for the maximum span and support value and constantly reinforced and prestressed. In general the detailed designed is done in the factory such that to account for all the activities and their impact on the element like: transportation and placed in work.



Typical beam to column joint.

In the good performance of the precast concrete structure is played by the connection between component members of the structure. For low rise precast concrete structures the columns and the wall panels are the ductile energy-dissipating elements with the floor and roof slabs designed to be stronger. The connection details for such structures should have a non-ductile behaviour in order to perform good during an earthquake. For frame structures, the column should be able to develop plastic hinging at their bases without suffering brittle failure mode such as shear, bond failure and loss of confinement of the core concrete. The floors, as well as carrying the gravity loads, need to transfer the imposed seismic forces to the supporting structure through diaphragm action. Should be avoided very flexible diaphragms. The beams seated on the columns need to have adequate connection between the beam ends and bearing areas to avoid the beam sliding off their supports.

Therefor the classes of joints to be considered function of their function in seismic behaviour:

- Nodes between floor/roof elements: diaphragm action of floor
- Nodes between floor elements and supporting beam: peripheral constraints to diaphragms
- Nodes between beams and columns: hinged behaviour in vertical plan
- Nodes between columns and foundation
- Nodes between in fill panels/cladding and the structure

The main parameters which characterize the seismic behaviour of the connections refer to the properties:

- Strength: maximum transferred force between elements
- Ductility: ultimate plastic deformation compared to yielding limit
- Dissipation: capacity to dissipate energy through load cycles
- Deformation: functional limit before failure
- Decay: strength loss through the load cycles

- Damage: residual deformation when unloading vs. maximum displacement at rupture

The ductile dissipative behaviour of the connection is generally provided by the central part of the node, usually via a steel connector.

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