PEOPLE: International Journal of Social Sciences
ISSN 2454-5899

Meryem Gecimli, 2018

Volume 4 Issue 2, pp. 1625-1641

Date of Publication: 30th October, 2018

DOI-https://dx.doi.org/10.20319/pijss.2018.42.16251641

This paper can be cited as: Gecimli, M. (2018). Energy Efficiency in Traditional Turkish Housing; Planning, Interior organization and Details. PEOPLE: International Journal of Social Sciences, 4(2), 1625-1641.

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ENERGY EFFICIENCY IN TRADITIONAL TURKISH HOUSING; PLANNING, INTERIOR ORGANIZATION AND DETAILS

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Abstract

Energy efficiency is an important component of ecological sustainability. Traditional houses constructed before the widespread use of reinforced concrete structures are compulsorily compatible with the nature. This is caused by lack of energy efficient technological options. The objective of this paper is to emphasize the planning, interior organization and the details of the Traditional Turkish Housing in terms of energy efficiency. All these factors are shaped by common design principles, climatic and topographic characteristics of the region. In this paper planning, the sun, prevailing wind direction and topography with the sofa (a kind of intermediate space between rooms), summer/winter floor and floor-top storey for living; in the interior organization, interior arrangement and positions of sitting unit sedir (a kind of couch) and the fireplace; in the details, bay window, upper window and so on are evaluated in terms of energy efficiency. The methodology of this paper is qualitative and it depends on literature review and examination of the general characteristics of the Traditional Turkish Housing in Turkey. The significance of this paper is adding interior organization and the details to the energy efficiency field, contrary to the previous research that mostly focuses on the planning piece. The findings of

this paper which are planning, interior organization and the details of the Traditional Turkish Housing support the ecological sustainability in terms of energy efficiency.

Keywords

Energy Efficiency, Traditional Turkish Housing, Planning, Interior Organization, Ecological Sustainability

1. Introduction

Energy efficiency is defined as ensuring comfort conditions in the house with minimum expenses. Goldstein (2007: 63) describes the energy efficiency as an ability to provide the same or higher level of energy services such as thermal comfort at lower energy consumption and cost. Zawada et al. (2017) highlighted that many countries restructuring their energy systems are influenced by the megatrends. Megatrends can be seen in country policies as renewable resources, new business models, and limited impact of the industry on health etc. (Zawada et al., 2017). Sustainability of minimum energy consumption and cost is essential for energy efficiency in housing. Energy efficiency can be classified as energy efficient design, energy efficient technologies, and energy efficient practices (Dawes, 2010).

Energy efficient design is the oldest one among the other two and it has been used since ancient times. Before technological developments, in traditional architecture design was being used to ensure residents' climatic comfort. In this paper the word *technology* will be used as a device, tool or material that consumes nonrenewable energy.

There are many studies about energy efficiency in housing in the literature. Yigit & Acarkan (2016) have examined assessment of energy performance certificate systems by a case study about two residential buildings (constructed before and after 2000) in Turkey. Yuksek & Esin (2013) have analyzed the energy efficiency of traditional rural houses in Turkey. They found that the ecological characteristics of the traditional rural houses can be applied to current buildings through evaluation and replication. Manioglu & Yilmaz (2008) compared the traditional and the contemporary houses in Mardin (located south-eastern part of the Turkey) in terms of climate responsive energy efficient design strategies. Jalilian (2015) studied sustainability in the climatic and social context of Iranian contemporary architecture.

This study examines energy efficiency in traditional houses in Turkey in terms of planning, interior organization and the details. Planning refers to general constructive features of the house; location, direction, structural form of the house, and the effects of climate, geography,

and material features on housing are examined in terms of energy efficiency. Interior organization of the house refers to interior arrangement and fitting; energy efficiency is evaluated by interior solutions. Finally, the details refer to special solutions in terms of energy efficiency in Turkish houses.

2. Traditional Turkish Housing

Turkish house was evolved from Central Asian dwelling tent and it bears traces of nomadic life (Kucukerman, 1996). Settlements are irregular and organic because of the topographic features and the land boundaries. In consequence of it, the ground floor has irregular and eccentric form, and free planning. At upper floors this shape becomes rectangular rooms by the means of slanting cantilever.

To understand Traditional Turkish Housing, we should firstly investigate Anatolian geography and its climate features. This geography is surrounded by the sea on three sides and it is seen as a junction point uniting Asia and Europa. In general, shorelines are rainy, but internal regions are dry. According to its climatic features, Turkey consists of seven regions: Mediterranean, Black Sea, Marmara, Aegean, Central Anatolia, Eastern Anatolia, and Southeastern Anatolia. Three main climate types and transitional climates are effective in Turkey. There are three main climates in Turkey.

- Black sea region climate is rainy every season and houses are made of timber.
- Mediterranean region climate is hot and dry in summers, warm and rainy in winters, and the houses made of stone.
- Continental region climate is hot and dry in summers, cold and snowy in winters, and the houses are made of brick.

Figure 1: *Turkey map according to house material*

Materials used in house construction are timber, stone, and brick/mud (Figure 1). These can be used as solo or mixed; timber-stone, timber-brick, stone-brick depending on geographic features, climatic conditions, and availability of materials.

2.1 Planning

Turkish house planning was affected by climatic conditions, geographic features and material availability as well as nomadic culture, belief features and family structure. This study explores the effects of climate, geography and material in terms of energy efficiency. As mentioned in the introduction, both climate and material availability is very important in house construction. Topography is the third significant factor of Turkish House planning. Anatolian geography is bumpy and mountainous. Having an organic form, Anatolian settlements are different from the European grid layout. Thanks to the bumpy geography and organic settlement, the plot where the house is built is eccentric. So, mostly the planning of ground floor is flexible by using structural features in contrast to the first and other floors if there are. In this way between upper floors that formed fixed principles and variable topographic data ground floor acts as a transition area.

Black sea region is one of the main regions in Turkey that has a mountainous geography (Figure 2). Mountains are parallel to the sea and fairly close to the coast. In this region, every season is rainy. Because of this type of geography, rainy climate cannot reach to the inner zones, but it is pretty much over the mountain slopes alongshore. Forests cover large areas in Black sea and it is the most woodland region in the Turkey. These effects make a special kind of house named "serender" (Figure 3). Serender is a timber house standing as if hanging in the air and has totally detached upper floor from ground (Öymen Gür, 2000). In this way energy efficiency is ensured by keeping away moisture (Figure 4).

Figure 2: *A view to Zigana Mountains in Black sea region*

Figure 3: *Serend*er

Figure 4: *A drawing shows relations of Serender with nature and topography (ARKITERA, n.d.)*

Another main region of the Turkey is Mediterranean which has hot-dry summers and warm-rainy winters. Mountains are parallel to the sea, but unlike Black sea region they are a little further from the sea. Stone is abundant material and it helps to keep hot days cooler (Figure 5). There are wide openings, high and spacious spaces to wind circulation (Figure 6-7). Aegean is located in west Anatolia, and Mediterranean climate is mostly effective there. Extending up the mountains to the sea allows warmth climate to influence the inner zones. Stone houses alongshore give place to brick and some mixed type houses toward inner sides of the region. Southeastern region has hot and dry summers, warm and rainy winters due to close Mediterranean effects. Houses in all of these three regions are mostly made up stone to provide energy efficiency.

Figure 5: *Bodrum Houses called scorpion repellent in Mediterranean region (Ballı, 2016)*

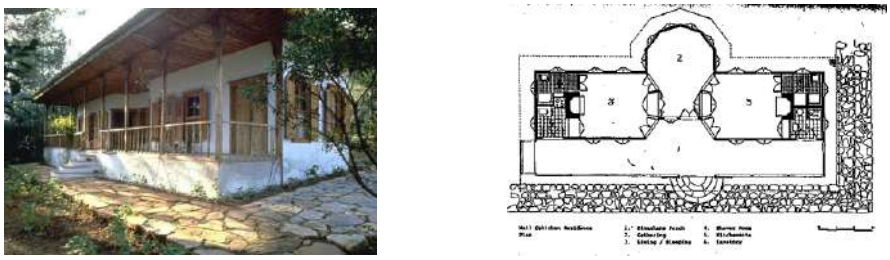

Figure 6-7: *Aga Khan award-winning Architect Nail Cakirhan's House in Akyaka*

Central and Eastern Anatolia are effected by continental climate which has hot-dry summer and cold-snowy and sometimes frozen winter. Especially central Anatolia has the most arid zones in the Turkey. Clay is available material so brick or brick-stone houses can be seen widely (Figure 8-9). Brick, as an energy efficient material makes the home warm in the winter and cool in the summer. Due to the harsh climate, ground floor is closed and used as a barn. Heat of the animals in the barn raises the temperature of the first floor. So, the energy efficiency can be ensured. Marmara has mixed climatic features between Black Sea, Mediterranean and Continental climate. Mostly timber houses at the neighboring shores of the Black Sea, white and stone houses at the neighboring shores of the Mediterranean, and mixed-material houses at internal areas are seen.

Figure 8: *Safranbolu Houses*

Figure 9: *A brick house from Central Anatolia (Anılsın, n.d.)*

Anatolia has variety of natural conditions. Although it is not seen as common as before, people generally live at different houses during different seasons. Summer house named "yaylak" is located in high regions and it is for spending hot summer time in a cooler way, and winter house named "kıslak" is located at the low regions and it is for spending cold winter time in a warmer way. Turkish house mostly consists of one ground and two top floors, but in consequence of different factors it may be one-story house as well. First floor is for winter and the second floor is for summer, or a summer room and a winter room in the same floor to save the energy efficiency (Table 1).

Table 1: *Comparisation the features of summer and winters rooms (Küçükerman, 1996)*

	Summer rooms	**Winter rooms**
Appropriate orientation within the building	Open to cool breezes etc.	Closed to cold winds
Relative position in the house	Upper storeys, corner location etc.	Mezzanine floor, no exterior walls etc.
Light construction, conductive properties	Thin walls, floors, ceilings etc.	Thick insulation construction materials
Appropriate dimensions	High ceiling, wide, open etc.	Low ceiling, narrow and enclosed etc.
Degree of open relationship between the interior and exterior	Large windows etc.	Small windows, shutters etc.
Special attention paid to the interior arrangement	Due to prolonged occupation, etc.	Simplicity of interior arrangement

Traditional Turkish House planning is based on two main spaces. First one is the rooms and second one is sofa. Sofa is a kind of intermediate and semi-private place between the rooms. In traditional Turkish families, grandparents and parents used to live together with their children. When children grow up and get married, man continues to live with his parents in the same house and the woman move to her husband's family house. In the house each parents have their own room which is designed to meet all daily needs. All the rooms are open to an intermediate and common space called sofa. Sofa is for the whole family, while rooms are for the nuclear families. Room is evaluated in-depth under the interior organization part.

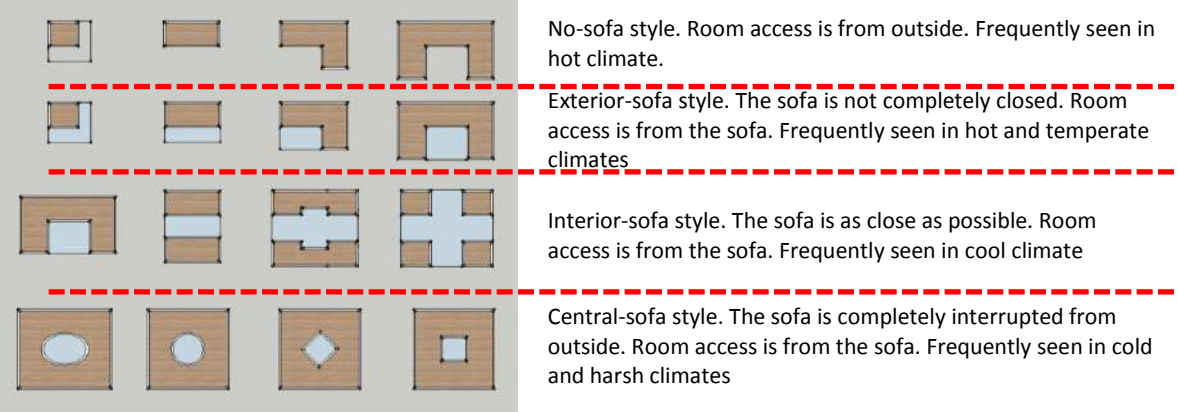

Figure 10: *Sofa-room relationships according to climatic differences (Kücükerman, 1996)*

The structure of the sofa can change from climate to climate (Figure 10). In this way energy efficiency is ensured. The house with no-sofa where room access is from outside shows hot region features. Direct relations with outside can make the room cooler. It is accepted that the exterior-sofa is the first stage of the Traditional Turkish House with sofa. In this kind, sofa is a semi-open space and it makes the wind circulation in hot and humid regions. Interior-sofa which is frequently seen in cold regions is closer than exterior-sofa. The last one is called central-sofa and it is the most advanced type. Sofa is surrounded by the rooms and there is no outer wall. This most sheltered type is common in cold and harsh climate regions to provide energy conservation.

Table 2: *Comparison of the planning features of Traditional Turkish House and Modern House according to climatic conditions*

According to climatic conditions;	**Traditional Turkish Houses**	**Modern Houses**
Changing construction materials	brick, wood, stone	only concrete
Changing construction technics	according to material	only reinforced concrete cons. tech.
Changing form of the house	scale and proportion of openings	some houses may have balcony
Changing orientation of the house	according to sun and north	almost always according to plot boundaries
Different floors or rooms for seasons	summer/winter rooms	no
Special place	sofa	no

On the other hand, modern houses are not generally planned according to climatic or local conditions as can be seen in Table 2. The planning of the modern houses largely depends on the plot boundaries. Instead of usable area design, square meters are increased. Because they frequently use the engineering machines which consume the energy for both production and using processes to warm up, cool down, and ventilate. And the local and natural materials

generally are not preferred in the construction process of the modern houses. The preferred one is mostly the concrete material. There are summer/winter rooms for different seasons and a special place called sofa in the Traditional Turkish Houses, in contrast to the modern houses.

2.2 Interior Organization

Most of the scientists accepted that Turkish House interior organization of the room is based on nomadic life tents (Figure 11). As nomad tent, each room satisfies the needs of sitting, eating, working and sleeping. So, the room can be seen as a homelike place on its own in Turkish house. Moreover, when one of the sons gets married and settles down with his wife in a room, by referring to the room, the married couples say that this is their house. Arseven (1955) published a one-room house which is equivalent to a house in Gebze. So, it can be said that a room is almost a house for Turkish life (Kuban, 1995).

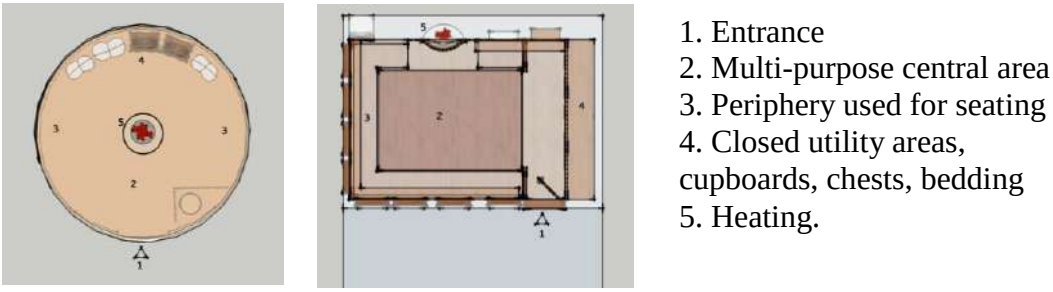

Figure 11: *Similarities between Central Asian nomad tent and the room in terms of spatial use (Kuban, 1995)*

The room is mostly rectangular and can be grouped into two functional spaces named sekialtı and sekiüstü. Sekialtı has lower floor and ceiling level differences than sekiüstü, and it is the entrance area of the room. There is a closet covering the entire wall. The closet consists of one small bath, storage areas for beds, clothes, some tools for daily living, and sometimes a fireplace. Sekiüstü is one step higher than sekialtı, and higher ceiling level is a place for sitting, sleeping, eating. There is a fixed seating unit called sedir, following the rest of the walls, multipurpose central area, windows in sequence, and a fireplace usually centrally located to the middle wall.

Figure 12: *Fireplace in the closet, fireplace from Topkapı Palace and sections of fireplaces from simple to flashy (Kücükerman, 1996).*

Because of harsh living conditions of nomads, energy efficiency is very important subject for them. This situation is reflected in Turkish house. Fireplace is at the center in the tent, on the other hand, in the room it is at the side wall. In both cases maximum benefit is provided. Central location of fireplace at tent provides equal heat distribution. On the other hand, especially in cold climate to reduce the cold winds effects, location of the fireplace in room is on the outer wall. It is also close to the living areas. In temperate climates, the fireplace may be part of the closet in sekialtı (Figure 12). Moreover, locating the small bath in the closet provides bathing in an already warmed room. So, it doesn't need to heat up another place for bathing.

Table 3: *Comparison of the interior organization features of Traditional Turkish House and Modern House according to climatic conditions*

According to climatic conditions;	**Traditional Turkish Houses**	**Modern Houses**
Changing orientation of heating unit	at outer/inner wall	depends on the visual aesthetic or user demand
Place for bathing solutions	no need for extra heating	need for extra heating
Common interior org. depending on energy efficiency	central organization according to heating unit	generally, organize according to TV

The modern house has no specific interior organization. It generally follows trends and it is mostly affected by economic conditions. So, there is no an energy efficiency solution or designs which organize the interior (Table 3). If there is, even the fireplace is not for the energy efficiency, but for the visual aesthetic. The bathroom is always built at separate place in contrast to the traditional house which has a small place for bathing within the closet in the room.

2.3 Details

Traditional Turkish Houses have some special details in order to adapt to climate and ensure the energy efficiency. One of the most attractive details is the window (Figure 13). Windows are triple or quintet in row and they are symmetrical per room. The summer rooms

have more and larger windows than winter rooms. They are also located on the one, two or three walls of the room. On the contrary of summer room, windows of the winter room are smaller, fewer in number, and they are mostly opened through one direction.

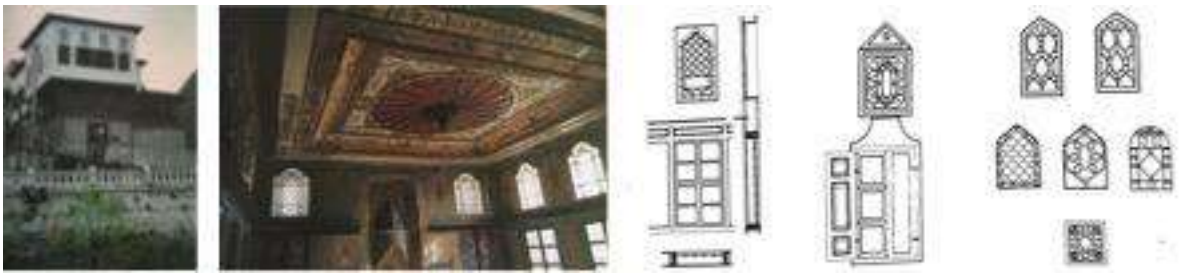

Figure 13: *Upper window images and drawings (Kücükerman, 1996)*

Upper windows being over-access and located above the windows are also used for energy efficiency as well as visual aesthetics. Winter inclined sun lights can reach out more space in the room thanks to the upper windows. Moreover, they have vivid colors of stained glass which makes the room visually warmer.

Figure 14: *A slanting cantilever image (Kucukerman, 1996)*

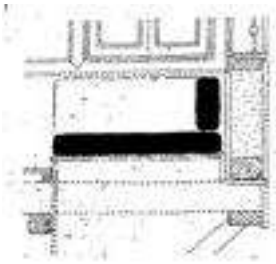

Figure 15: *Cantilever detail of summer room (Kucukerman, 1996)*

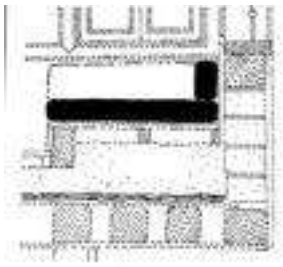

Figure 16: *Cantilever detail of winter room (Kucukerman, 1996)*

Protruding windows and cantilever are other details for the effects of climate on the room. Especially in the summer, a part of the wall or entire wall with windows or the room totally are pulled-out to make the room cooler. Houses with slanting cantilever are common in Anatolian houses (Figure 14). Not being gridal but organic layout of the settlements with sloping land causes eccentric plots to build on. Instead of carrying on the eccentric form to the first floor, the builder have made slanting cantilever onto the street to make the first floor rooms rectangular. This is a common situation. These cantilevers mostly take part in the summer rooms (Figure 15), so the room can be climated by the air flow coming from the floor in cavity. The winter room usually does not have any cantilever and there is closed firmly under the sitting unit (Figure 16).

Another detail to ensure energy efficiency is small size wing. Window, 3-5 windows of sequence with symmetrical order and equal size is very important to Traditional Turkish Houses. In condition, not to break the sequence, the winter room windows are smaller than summer room windows. Both summer and winter windows can have small size wings to air conditioning without changing the room temperature too much.

Table 4: *Comparison of the detail features of Traditional Turkish House and Modern House according to climatic conditions*

According to climatic conditions;	**Traditional Turkish Houses**	**Modern Houses**
Changing window type and detail	different sizes and upper windows	changes are generally for user demand
Developing a specific detail	protruding window, slanting cantilever	no
Using nature for climating	yes	very little or no
Dependent of technological devices	no	yes

Details that are used for energy efficiency in modern house are generally limited to insulation materials and layers. However, it can be said that the winter garden maybe the most effective way for energy efficiency in modern houses.

3. Results and Discussion

The study shows that Traditional Turkish House is more energy efficient than the Modern House in terms of planning, interior organization and the details. Because it uses only natural elements and follows the natural way which is renewable. The differences between Traditional Turkish House and Modern House can be seen in Table 5 in terms of design with nature or not. This paper basically shows that some general design features of Traditional Turkish House ensures energy efficiency. While showing these features, the interior organization and some special details are highlighted which makes this study different than the previous ones. For the future studies, it is recommended to conduct further quantitative studies to specifically measure interior organization and detail features.

Table 5: *Traditional Turkish House and Modern House general comparisation according to design with nature or not*

		Traditional Turkish House	**Modern House**
Planning	Cons. materials	+	-
	Cons. tech.	+	-
	House form	+	-
	House orientation	+	-
	Room location	+	-
	Special place for energy efficiency	+	-
Interior Organization	Heating unit orientation	+	-
	Interior and heating unit relations	+	-
	Bathing solutions	+	-
	Common interior	+	-
Details	Window type	+	-
	Window detail	+	+
	Specific detail	+	-
	Climate with nature	+	-
	Renewable resources	+	-
	Non-renewable resources	-	+

This paper also shows that only Traditional Turkish House is more energy efficient than Modern House, since it depends on nature and renewable resources. But when it comes to current conditions, the modern life forces human beings to live in a Modern House. One of the main reasons of it is that traditional houses always need maintenance and slow lifestyle. However, there are too many people who choose slow life, give up all modern arrangements and settle down a house which was built by traditional ways like Traditional Turkish Houses.

4. Conclusion

Minimum energy spending in the house which meets comfort conditions is energy efficiency. Energy efficiency can be ensured in three ways in a house. Engineering with technologic devices is one of these ways. This way can be the most costly one when considering the production process. Besides the production costs, these devices can cause some problems when they are broken. Other way is called design with passive techniques and it puts forward more basic and sustainable solutions. Moreover, design has effects on user behavior and can provide consciousness-raising. Traditional house design is an accumulating process over the year. Even todays house building technology slogs being both harmless to nature and save the energy in order to meet the needs. Traditional houses can achieve the this.

Central Asian dwelling tent is said to be ancestor of the Traditional Turkish House and it bears traces of nomadic life naturally. Settlements are irregular and organic; house forms are eccentric at ground, but rectangular at top floors. Anatolia is a junction point with three sides covered by sea and it has three different climate types with mixed climate in general; black sea, Mediterranean continental climates, and transition areas. In terms of geographic conditions Anatolia has mountain chains from east to the west, and the altitude increases from west to the east. Paralleling mountains along the shoreline at north and south prevents rainy Mediterranean and black sea climate from reaching to the inner zones. This changes in Aegean costs where mountains extend up to the sea.

Traditional Turkish house planning is based on geography, climate and material availability in terms of energy efficiency. There are three main types of house which have common features with regard to basic plan layout such as room, sofa and their relations. Due to the effects on construction method, material is a descriptive factor of these triple. In addition to them, especially in transition zones, mixed material usage can be seen.

- Timber houses of black sea region/climate called serender. Thanks to the lightness of the timber, they are frequently raised off the ground to avoid moisture from the soil and easily adapt to uneven terrain. Timber warm feeling material makes these houses warm during the cool and rainy days in all seasons.
- Stone houses of Mediterranean region/climate called scorpion repellent white houses. Stone massiveness obstructs raising and so these houses seems monumental. Stone usage, created gaps and large areas make these houses cool during long and hot summer days. Winter passes mildly, so there is no need to heat up, and stone can provide enough amount of warm.
- Brick houses of continental region/climate. These houses also cannot be raised off because of the material features. When compared to stone house, brick house seems naiver. Hot days/summers and cold nights/winters are the characteristic feature of the continental climate. Brick keeps the house cool during hot day/summer, and warm during cold night/winter.
- Mixed material usage can be seen in transition climate zones. Brick-timber, stone-brick, timber-stone etc.

Traditional Turkish house was built as one or two floors over the ground floor. Ground floor has free planning as previously mentioned, and it is used as a cowshed in harsh climates to rejoice in heating upper floor. Another planning solution to energy efficiency is the sofa. Interior sofa and central sofa are generally seen in cold regions, while houses with exterior sofa or no-sofa are seen in hot regions.

Considering interior organization of the room, energy efficiency has a priority. Fireplace location according to climatic features shows the priority obviously. Bathroom in closet is another indicator.

Some special details also point out the importance of energy efficiency. Changing window size, number and orientation defines ensuring energy. While upper windows are to get more winter sun, small size wing in a window are to ventilate the room without cooling. Protruding windows and parallel or slanting cantilevers are used to cool the room efficiently.

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