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Research Article

Comparison of Energy Consumption of the 12 Classroom Typical School Buildings in Selected 4 City in Turkey

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Abstract: School is a special place where students come together to become productive individuals of society, acquire basic skills and acquire citizenship knowledge. With the introduction of the new education system (4+4+4) in Turkey in 2012-2013, some difficulties occurred in the spatial structure of the schools.

After the new system, increasing number of students and decreasing student requirements have been tried to be solved with temporary solutions. At the same time that millions of students studying in primary schools all over Turkey have the same architectural feature as one type of architectural school project, regardless of the geographical and social situation began to be implemented in all parts of the city. Therefore, the increase in consumption varies depending on the geographical reasons where the type projects are implemented. Selected regions of the four thermal zones in Turkey for this research are provided below:

1st Thermal district in Antalya; 2nd Thermal district in Bursa; 3rd Thermal district in Elazığ; 4th Thermal district in Kars.

The calculation of the energy consumption created by the above cities by means of BEP-TR program and comparing them according to energy consumption classes.

Keywords: Typical school project, Thermal districts, Effective energy consumption, Building energy consumption, BEP-TR

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1 Introduction

Due to the changes in nature, environmental pollution, global warming and depleted energy sources, energy is one of the most debated issues that need to be solved every day in the world. According to the International Energy Agency, 47% of the energy produced in the world is consumed by the construction sector and 28% by the industrial sector[1]. Therefore, increasing the effective use of energy in buildings has become an important approach in terms of providing sufficient energy resources in the future.

Conservation of existing energy sources and efficient use of energy in Turkey has gained great importance. Approximately 45% of energy consumption in Turkey is used by the construction industry. The direction of building, shape of building, location and location of the structure relative to other structures are among the determining factors in improving energy efficiency. Energy is used for the purpose of providing comfort conditions such as lighting, ventilation, heating and cooling in buildings, and there are various levels of energy usage throughout the whole life cycle of the building, from raw material acquisition to demolition and destruction. Building stock in Turkey is around 8.8 million has a fairly large share in building units with approximately 62000 school buildings existing building stock[2].

School buildings in Turkey are designed as same architectural structure style like typical projects. These projects are implemented in the same way in all regional cities regardless of social conditions and geographical location throughout our country[3,10].

The purpose of this study, Turkey across the

geographical and social conditions regardless of the applied four thermal area "type project schools with 12 classroom" calculating with BEP-TR software of the energy consumption of buildings is to compare the energy consumption occurs in the heating, cooling, lightening, hot sanitary water consumption.

The selected four thermal region provinces are as follows: 1st Thermal district in Antalya, 2nd Thermal district in Bursa, 3rd Thermal district in Elazığ, 4th Thermal district in Kars.

2 Typical school structure with 12 classrooms

The most important factor of education, which is accepted as the most important tool of development in today's world, is to increase the productivity with the creative power of the society by giving opportunity to development according to the capabilities of individuals[4].

In the whole of Turkey, according to the Ministry of Education data 10,347,263 students are studying in 23.074 primary school[5]. The increase in the number of students with the transition to the new system creates the need for a new school buildings.

Primary education school buildings in Turkey are mostly designed as a single type of projects done in a similar architectural features[6].

The main factor in the design of educational buildings as a single type project because of II. Five-Year Development Plans (1968-1972). Because, during this period, a large part of the education expenditures go to construction investments, it has started to be applied as a single type project in all regions by showing the reason that a large amount of savings will be made[7].

Floor plans and elevations on the - Primary School with 12 Classroom – single type of projects that are being used in Turkey are given in Figure 1 and Figure 2[8].

In addition, data on the shell components of the single type school building are given in Table 1.

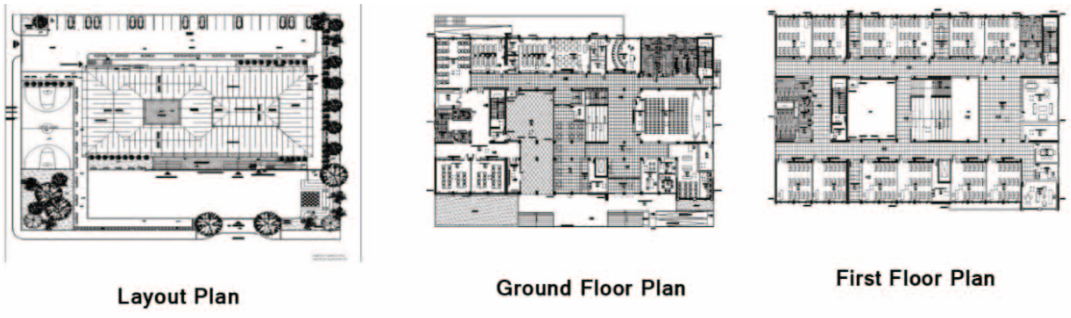

Figure 1. Floor plans of - Primary School with 12 Classroom - type project

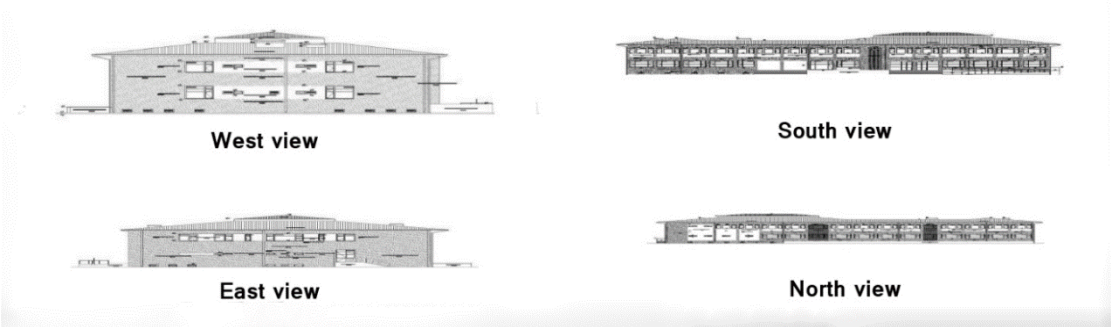

Figure 2. West, east, north, south elevations of - Primary School with 12 Classroom – type project

Table 1. Data of the shell components of a single type school building project

Shell Composition	Layer Details Details	Heat Transmission Coefficient U (m) K/W 1. District	Heat Transmission Coefficient U (m) K/W 2. District	Heat Transmission Coefficient U (m) K/W 3. District	Heat Transmission Coefficient U (m) K/W 4. District
WALL: outside DD1	0.02m gypsum plaster+0.2m ab class wall+0.05m heat insulation+0.3m external plaster	0.458	0.458	0.405	0.329

WALL: outside DD2	0.02m gypsum plaster+0.3m reinforced masonry+0.05m heat insulation+0.00m external plaster	0.538	0.538	0.467	0.368
WALL: Inside nonheating ID1	0.02m gypsum plaster+0.2m ab class wall+0.00m external plaster	1.277	1.277	1.277	1.277
WALL: Inside heating ID2	0.02m gypsum plaster+0.3m reinforced masonry+0.02 m gypsum plaster	2.181	2.181	2.181	2.181
WALL: Inside heating ID2	0.02m gypsum plaster+0.3m reinforced masonry +0.02 m gypsum plaster	2.181	2.181	2.181	2.181
WALL: Direct contact with soil TDU1	0.02m gypsum plaster+0.3m reinforced wall +0.03m heat insulation cover+0.05m extrude polistren foam	0.507	0.507	0.434	0.434
CEILING: Roof ÇA1	0.15m concrete slab+0.03m cement rendering+0.07m heat insulation	0.436	0.388	0.269	0.269

In the scope of the study, the single type school building project that is given guidance and form;

•Floor area 1610.30 m²,

•The building height is 11.95 m² and consists of a basement, ground floor and a normal floor.

•Building form factor (building length / depth in plan) is 3.60 m²,

•The transparency ratio of the building (Total transparent area / Total facade area) is 36%.

•Heating system fuel is natural gas.

•Fan coil and natural ventilation are used in the ventilation system.

•Indoor comfort temperature is accepted as 21°C for the desired period of heating and 25°C for the desired period of cooling. It is considered that natural ventilation will be active if the indoor air temperature is above 23°C during the period to be cooled.

3 Energy performance calculation software in buildings (BEP-TR)

•The purpose of energy performance calculation software in buildings is below[9];

•Determining the calculation rules for the assessment of the total energy expenditure of the structure; Internal requirements, external climatic conditions, local conditions and cost effectiveness,

•Classification of CO_2 emissions and primary energy,

•Determining the minimum energy consumption requirements for existing or new buildings,

•Evaluating the applicability of renewable energy sources,

•Ensuring control of cooling, heating system,

•Limiting greenhouse gas emissions,

•Determination of performance criteria and execution principles in buildings,

•Regulation of environmental protection.

The primary energy mentioned above involve total consume of sanitary hot water, ventilation, heating and cooling. A requirement of this regulation is the preparation of an energy identity certificate for each structure. Evaluate the energy performances for all existing and new building types within the scope of the building types (house, education buildings, hotels, offices, health buildings and shopping centers) and the parameters affecting the energy consumption for the building to be used in preparing the energy identity certificate. A, B, C, D, E and F are designed to determine the energy class.

4 Calculation of energy consumption of the 12 classroom typical school buildings in selected 4 city in Turkey

In this study, the heat of the four thermal district selected in Turkey, Antalya, Bursa, Elazig and Kars provinces in - single type project school with 12 classroom - energy consumption is calculated. For this study, BEP-TR software was used to calculate energy consumption in selected provinces. The calculation

calculates the building's energy class and CO_2 annual emissions to the building, as well as the annual heating, cooling, sanitory hot water, ventilation and lightening energy consumption.

4.1 Thermal district Antalya

The first thermal zone of the city of Antalya, BEP-tr program was used in the calculation of the type of school building energy consumption. In accordance with TS 825 rules; building exterior surface areas, directions and information about which material is made of the program is defined. Within the scope of BEP-tr accounting program;

Energy and CO_2 class according to the amount of energy consumed together with the building's Annual energy consumption for Heating, Cooling, Sanitory Hot Water, Ventilation and Lightening of the typical school building in Antalya city are given in Table 2.

Table 2. Annual energy consumption and class of the city of Antalya

	Annual	**Energy**	**Consumption**			
	Final (kWh/year)	Primary	kWh/m^2 year	Kg (CO_2/m^2 year)	Building Class Ekbclass	CO_2 Class
Total	**219565.90**	**277939.63**	**86.55**	**25.84**	**B78**	**C91**
Heating	60668.05	69439.94	21.62	6.97	B67	
Sanitory Hot Water	113492.25	114419.29	35.63	10.15	C83	
Cooling	16375.88	33930.83	10.57	3.15	B58	
Ventilation	6992.32	114488.1	4.51	1.34	D114	
Lightening	22037.39	45661.48	14.22	4.23	D107	

As a result of the analysis, the lighting energy consumption in the 1st Thermal Region Antalya province is 45661.48 per year and it is located in building class D107. This shows that when the working hours of the school building, which is a public building, are considered to be six in the morning, the energy consumption of the lighting is high and therefore natural light sources are not used effectively in the design of the building.

In addition, annual sanitary hot water and ventilation energy consumption is observed to be high. This shows that the applications such as north-south orientation and dominant wind direction in the land where the structure is located are applied without reducing the energy loss in the structure.

4.2 Thermal district Elazığ

The second thermal zone of the city of Bursa, BEP-tr program was used in the calculation of the type of school building energy consumption. In accordance with TS 825 rules; building exterior surface areas, directions and information about which material is made of the program is defined. Within the scope of BEP-tr accounting program;

Energy and CO_2 class according to the amount of energy consumed together with the building's Annual energy consumption for Heating, Cooling, Sanitory Hot Water, Ventilation and Lightening of the typical school building in Bursa city are given in Table 3.

Table 3. Annual energy consumption and class of the city of Bursa

	Annual Final(kWh/year)	**Energy** Primary kWh(year)	**Consumption** kWh/m^2 year			
				Kg CO_2/m^2 year	Building Class	CO_2 class
	Final	Primary	m^2	MCO_2	Ekbclass	CO_2 class
Total	**284799.32**	**3040515.58**	**106.03**	**32.32**	**B77**	**C95**
Heating	133663.64	148099.10	46.12	14.94	B65	
Sanitory Hot Water	113492.25	114419.29	35.63	10.15	C83	
Cooling	6766.29	14019.76	4.37	1.30	B70	
Ventilation	6992.32	114488.10	4.51	1.34	D115	
Lightening	23884.81	49489.33	15.41	4.59	D107	

4.3 Thermal district Elazığ

The third thermal zone of the city of Elâzığ, BEP-tr program was used in the calculation of the type of school building energy consumption. In accordance with TS 825 rules; building exterior surface areas, directions and information about which material is made of the program is defined. Within the scope of BEP-tr accounting program;

Energy and CO_2 class according to the amount of energy consumed together with the building's Annual energy consumption for Heating, Cooling, Sanitory Hot Water, Ventilation and Lightening of the typical school building in Elazığ city are given in Table 4.

Table 4. Annual energy consumption and class of the city of Elazığ

	Annual Final(kWh/year)	**Energy** Primary Kwh (year)	**Consumption** kWh/m^2 year			
				Kg CO_2/m^2 year	Building Class	CO_2 Class
	Final	**Primary**	**m^2**	**mCO_2**	**Ekbclass**	**CO_2 Class**
Total	**330441.97**	**389144.24**	**121.18**	**37.26**	**B75**	**C93**
Heating	176262.78	190421.61	59.30	19.29	B67	
Sanitory Hot Water	113492.25	114419.29	35.63	10.15	C84	
Cooling	1048.25	21725.45	6.77	2.01	B68	
Ventilation	6992.32	14488.10	4.51	1.34	D115	
Lightening	23209.36	48089.79	14.97	4.46	C87	

4.4 Thermal district Kars

The third thermal zone of the city of Kars, BEP-tr program was used in the calculation of the type of school building energy consumption. In accordance with TS 825 rules; building exterior surface areas, directions and information about which material is made of the program is defined. Within the scope of BEP-tr accounting program;

Energy and CO_2 class according to the amount of energy consumed together with the building's Annual energy consumption for Heating, Cooling, Sanitory Hot Water, Ventilation and Lightening of the typical school building in Kars city are given in Table 5.

Table 5. Annual energy consumption and class of the city of Kars

	Annual	**Energy**	**Consumption**			
	Final(kWh/year)	Primary kWh (year)	kWh/m^2 year	Kg CO_2/m^2 year	Building Class	CO_2 Class
	Final	Primary	m^2	mCO_2	Ekbclass	CO_2 Class
Total	**499468.53**	**553246.31**	**172.28**	**54.22**	**B76**	**D100**
Heating	354103.77	372787.17	116.08	37.95	B71	
Sanitory Hot Water	113492.25	114419.29	35.63	10.15	C85	
Cooling	1988.89	4120.99	1.28	0.38	F156	
Ventilation	6992.32	14488.10	4.51	1.34	D116	
Lightening	22891.29	47430.76	14.77	4.40	C93	

5 Comparison of energy consumption of the 12 classroom typical school buildings in selected 4 city in Turkey

According to the calculation data using the BEP-tr program, the highest energy consumption and CO_2 emission in type school buildings in four thermal zones;

Heating, Lightening and Sanitory Hot Water are also shown below. Annual energy consumption distribution in school buildings is given in Figure 3.

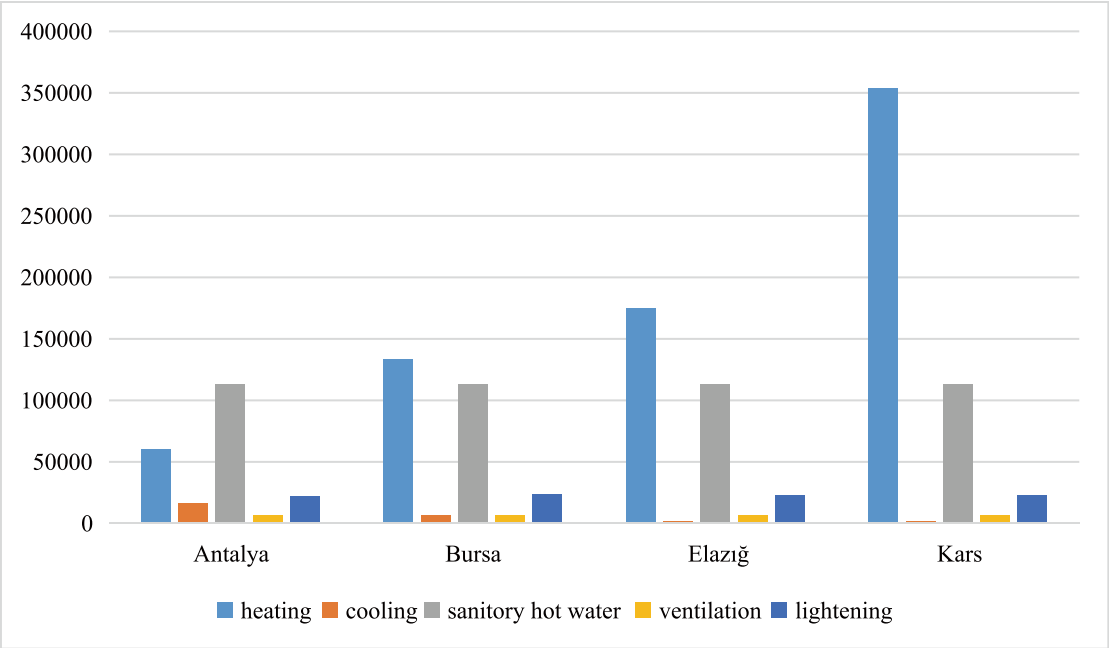

Figure 3. Energy consumption graph of the single type school buildings in four thermal zones in Turkey

When the energy consumption values of the heating in buildings are compared, the results are as follows;

•Antalya consumes 60668.05 kwh/year of energy. Furthermore, it is the province that needs the least heating energy among the four cities.

•Bursa consumes 133663.64 kwh/year of energy.

•Elazığ consumes 176262.78 kwh/year of energy.

•Kars consumes 345103.77 kwh/year of energy.

When the energy consumption values of the sanitory hot water in buildings are compared, the results are as follows;

The consumption of sanitory hot water in all four cities is 113492.25 kwh/year.

When the energy consumption values of the cooling in buildings are compared, the results are as follows;

•Antalya consumes 16375.88 kwh/year of energy.

•Bursa consumes 6766.29 kwh/year of energy.

•The city of Elazığ consumes the least energy among 4 cities with 1048.25 kwh/year.

•Kars consumes 1988.89 kwh/year of energy.

When the energy consumption values of the ventilation in buildings are compared, the results are as follows;

The consumption of ventilation energy in all four cities is 6992.32 kwh/year.

When the energy consumption values of the lighting in buildings are compared, the results are as follows;

•Antalya consumes 22037.39 kwh/year of energy

•Bursa consumes 23884.81 kwh/year of energy.

•Elazığ consumes 23209.36 kwh/year of energy.

•Kars consumes 22891.29 kwh/year of energy.

As a result of the calculations, the most consumed energy per year in type school buildings in the four thermal district provinces; heating energy is followed by sanitary hot water and lighting energy.

As a result of analyze, heating energy consumption of typical school building of Kars and Elazığ cities is high. It is observed that the type of school buildings in Antalya and Bursa cities have sufficient heating energy consumption.

6 Result

Selected from four thermal zones in Turkey - Single Type School Project with 12 Classroom - a comparison of energy consumption, as a result of our work on; rational use of energy, the most important substance on earth. As in all areas, it becomes clear that it is an important planning issue that needs attention.

Consequently, the type projects of the educational, social, cultural structures to be produced for different climatic and geographical regions spread all over the country should be revised and different types of projects should be developed in different regions.

In the calculations which done in this study for the four thermal regions discussed above, a difference of results more than one hundred percent was calculated between the geographic regions consumed.

This differentiation also affects CO_2 emission. The final energy consumption for the city of Antalya is 219565.90 KW/H per year and for Kars it is 499468.53

KW/H per year. Building costs in investment plans, which is considered as a solution to prevent the emergence figure to more than made up for all regions in Turkey caused by the same type of large school projects are absolutely necessary to control energy costs.

For this reason, it is clear that the impact of the above mentioned II. Five-Year Development Plans (1968-1972) has no validity. Nowadays, for each different geographical and climatic region, it is necessary to prepare the regulations of different Passive and Active Architectural Plans and Projects by the competent Architects and Engineers.

Maybe that's how we can recover a livable world. In any case, we spend our contribution to warm up in Turkey to save billions of foreign currency will be realized.

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