Applying Energy Efficiency Standards in Kosovo's Residential Buildings

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ACRONYMS

AUK American University in Kosovo
ECLO European Commission Liaison Office
ECT Energy Community Treaty
EBRD European Bank for Reconstruction and Development
EC European Commission
EE Energy Efficiency
EPBD Energy Performance of Buildings Directive
ERC Energy Regulatory Commission
EU European Union
EWG Energy Working Group
FIs Financial Institutions
MEM Ministry of Energy and Mining
MESP Ministry of Environment and Spatial Planning
NEEP National Energy Efficiency Plan
PHE Public Housing Enterprise
RIT Rochester Institute of Technology
SOK Statistical Office of Kosovo

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Executive Summary

This Capstone Project addresses the important problem of low energy efficiency in residential buildings in Kosovo. The building sector is one of the biggest energy users and therefore a cause for being a CO_2 emitter. According to the Kosovo Statistical Office of the Ministry of Public Administration, the total number of households in Kosovo is 370,000, of which 10% or approximately 36,400 are apartments. This percentage of the housing stock consists of privatized apartments from the formerly public rental housing and new apartments' buildings block, and the other 90 % is individual housing. Based on the information of PHE of Prishtina [18] the privatized housing stock is up to 50 years old and not refurbished, due to the lack of funds and longtime absence of complete legal framework. Also, after the war the new housing construction has increased, increasing home ownership and therefore electricity consumption.

In Kosovo, concrete initiatives regarding energy efficiency are limited both from the public and private sector. Actually, the Government of Kosovo has approved several laws and regulations for energy, but there has been very little research and development activities undertaken to show energy efficiency importance and especially the direct impact of housing and construction regulation on the energy efficiency.

The construction sector of Kosovo over the past ten years was not working based on a defined construction norms and regulations. This is besides the fact that Construction Law 2004/25, proposed by the Ministry of Environment and Spatial Planning was approved since 2004. The Law on Construction Products also was proposed by the Ministry of Trade and Industry. These two laws create the legal bases for approval of advanced norms and standards for construction sector.

The rules however related to the energy sector in Kosovo are regulated by Energy Law Nr.2004/8. The Ministry of Energy and Mines is responsible for implementation of provisions of this law. It defines the basic principles for an energy strategy and energy programs in Kosovo and promotes the efficient use of energy and the use of renewable energy sources.

Clearly defined institutional and legal framework, and improved energy efficiency in the housing sector in Kosovo can contribute to improving energy efficiency and environmental protection. It can also help to avoid social exclusion, as an increasing number of low-income households can no longer afford the costs of heating. This is often the largest part of total expenditures on housing. This project provides a tentative road map for responsible government structures on the future policy decisions regarding energy efficiency in housing.

1. Energy Efficiency in Kosovo Existing Residential Buildings

This chapter introduces present trends in the increase of energy consumption in the household sector in Kosovo, institutional framework regarding EE policies, laws, regulations and institutional structure. In Kosovo the increasing trend for energy consumption in household is caused by continuous growth of the population and the rise of living standards.

1.1 Energy Demand and Energy Consumption

According to the Statistical Office of Kosovo (SOK) the population of Kosovo grew 23.5% between 1981 and 1991 and 7.4% between 1991 and 2006. These numbers shows continuous growth of the population in Kosovo which constantly increases the number of apartments, energy consumption and the negative environmental impact.

According to the SOK of the Ministry of Public Administration, there are 36400 apartments which represent 10% of the total number of approximately 370000 households. This percentage is about the same in the MESP data base [19] for existing housing situation in Kosovo 2006, where the number of apartments is approximately 34414 based on the fact that data are not collected from all municipalities in Kosovo. However, based on Kosovo NEEP 2008-2016 of MEM, [13] number of households will increase from 295695 in 2008 to 347106 in 2016 taking into consideration that the growth rate till 2016 will be 2.3-1.97% in each year.

Regarding energy consumption of the residential buildings sector and other sectors in Kosovo there is some information in the MEM studies and SOK publications. Kosovo NEEP 2008-2016 [13], presents the energy consumption of all sectors in Kosovo including residential sector. This Energy Consumption Shares of all sectors (%) is presented in the Table 1.1 where the consumption percentage of residential sector occupies the first place in the total energy consumption for space heating, cooking, lighting, hot water, electric appliances and air conditioning. The same table presents the average Energy Consumption Shares contribution of all sectors in EU countries.

Table 1.1: Energy Consumption Shares Contribution of All Sectors in Kosovo (%)

Country Sectors	Kosovo Energy Consumption (%)	Average EU Countries Energy Consumption (%)
Households	33.34	26.28
Services	13.34	12.47
Industry	22.35	27.77
Transport	26.52	30.91
Agriculture	5.06	2.54

Source: Reference No.13

Also, the household's energy consumption shares contribution of all sectors, based on the Statistical Office of Kosovo for the year 2009 [2] per month, is presented in the table No. 1.2. In this table the amount of 1,768,724 MWh[1] consumed energy for the households sector represents 55% of the total consumption for sectors presented.

Table 1.2: Energy Consumption in Kosova for 2009(MWh)

11.2 Consumption (Public, Commercial and Industry, Public Ent. and other MWh, Consumers in the 220-110kV (MWh) of electricity (MWh) by month during 2009

Year - Month	Consumption				
	Household	Commercial	Industry	Publi ent.& other MWh	Customers in 220-110 kV (MWh)
2009-01	163.971	47.084	22.290	11.632	32.063
2009-02	168.213	50.108	24.355	11.317	35.454
2009-03	155.781	44.056	20.541	11.680	39.489
2009-04	143.946	39.856	17.633	9.724	39.412
2009-05	132.585	37.608	16.726	10.248	39.491
2009-06	134.913	41.225	17.693	10.234	38.522
2009-07	117.603	37.511	15.684	10.166	41.494
2009-08	127.525	42.135	18.969	10.156	51.191
2009-09	134.652	43.316	16.376	10.707	49.275
2009-10	138.908	41.039	16.553	11.893	62.543
2009-11	175.527	53.079	19.251	11.864	60.892
2009-12	175.101	50.894	21.407	12.900	54.216
2009	**1.768.724**	**527.910**	**227.478**	**132.521**	**544.041**

Source: SOK, Economic Statistics

Source: Reference No.2

[1] 1,768,724 MWh = 152.08288908 ktoe (1ktoe=11,630MWh)

Table 1. 3 show the household energy consumption for the period 2003-2008 based on the NEEP.

Table 1.3: Kosovo's Total Energy Consumption in Household Sector (in ktoe)

Energy sources	2003	2004	2005	2006	2007	2008
Coal (lignite)	4.6	2.2	3.9	3.6	2.2	8.3
Oil by products	35.4	30.1	38.4	39.7	25.0	34.8
Biomass	108.2	108.2	108.2	108.2	108.2	108.2
Electricity	178.5	188.2	203.3	211.1	198.9	210.4
Solar energy	0.05	0.05	0.06	0.08	0.09	0.09
District heating	4.1	4.7	6.0	6.3	5.1	6.2
Total	**330.8**	**333.4**	**359.8**	**368.9**	**339.4**	**368.0**

Source: Reference No.13

Data's of the Public Housing Enterprise of Kosovo shows that more than 50% present of the apartments are 40 years old, [18] and the data base of the MESP 2006 for existing housing situation in Kosovo 2006 shows that only 10% of total number of houses, build before the year 1999 are insulated, and after 1999 this percentage increased to 60%. The residential buildings are made by bricks and walls of thickness typical to the majority of SEE residential buildings. These buildings have thermal conductance[2] between 0.872(W/m3oK) for buildings with more than 20 apartments and 2.151(W/m3oK) for detached single houses. The average value for buildings constructed in 1990s are 1.51(W/m3oK) - 2.08(W/m3oK).[20]

However, housing sector and projected demand is analyzed in the Kosovo Energy Strategy 2009-2018 [3] and it is discussed with the great attention because of the highest percentage in the total energy consumption. Table 1.4 below shows the main parameters based on which the demand is projected.

[2] A measure of the ability of a material to transfer heat per unit time, given one unit area of the material and a temperature gradient through the thickness of the material. It is measured in watts per meter per degree Kelvin.

Table 1.4: Forecast for Energy Demand of Housing Sector

The main parameters for forecasting of energy demand for housing sector			
Year	No. of Apartments	Inhabit/Households	Population
2003	360,000	5,429	1954,000
2004	372,407	5,310	1977,448
2005	385,521	5,191	2001177
2006	399,305	5,072	2025192
2007	413,816	4,953	2049494
2008	429,099	4,834	2074088
2009	445,217	4,715	2098977
2010	462,235	4,595	2124165
2011	478,329	4,476	2141158
2012	495,332	4,357	2158287
2013	513,324	4,238	2175553
2014	532,390	4,119	2192958
2015	552,625	4,000	2219501
2016	571,967	3,885	2228184
2017	595,696	3,770	2246011
2018	619,318	3,656	2263979

Source: Reference No.3

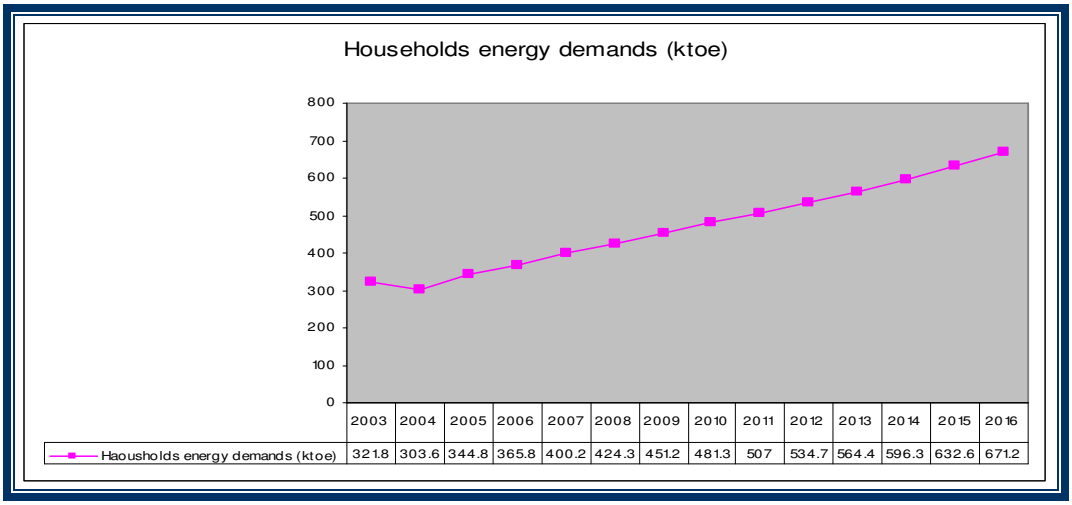
Forecast for energy demand based on the MEM projection **for all sectors including Households' sector**, for the period 2007-2016, is presented in the Table No.1.5 and in the Figure No.1.1 below. Based on this data the housing sector percentage participation in total energy consumption is 33%.

Table 1.5: Forecast of energy demand in Kosovo for the period 2007-2016 in ktoe[3]

Year	Households	Service	Industry	Transport	Agriculture	Total sectors
2003	321.79	133.94	210.58	342.35	52.54	1061.2
2004	303.63	118.99	169.6	341.08	43.65	976.94
2005	344.82	140.05	218.39	390.29	53.41	1146.97
2006	365.84	152.01	227.92	403.67	54.83	1204.27
2007	400.23	158.33	233.17	408.16	57.65	1257.54
2008	424.25	171.65	243.37	421.3	59.13	1319.7
2009	451.2	186.35	254.05	437	60.62	1389.22
2010	481.26	202.42	265.2	452.31	62.12	1466.112
2011	507.04	218.93	276.84	465.92	62.78	1537.421
2012	534.68	234.84	288.99	481.9	63.42	1613.156
2013	564.35	255.89	301.71	494.62	64.03	1693.66
2014	596.25	272.17	315	513.72	64.61	1778.93
2015	632.6	293.09	331.75	525.49	65.15	1869.76
2016	671.17	323.65	347.43	541.78	67.95	1978.62

Source: Reference No.28

Figure 1.1: Household Energy Demand



[3] The **tonne of oil equivalent** (**toe**) is a unit of energy: the amount of energy released by burning one tonne of crude oil, approximately 42 GJ (the exact value of the *toe* is defined by convention, (1 ton diesel = 1.01 ktoe). 1 tonne of oil equivalent = 11 630 kilowatt hour = 11.63 megawatt hour

Based on this data the household's energy consumption will increase from 321.8 ktoe in the year 2003 to 671.17 in the year 2016 resulting in huge CO2 emissions and the overall increase of the greenhouse effect Therefore it is in the interest of Kosovo to adopt a comprehensive energy efficiency policy to guide the consumption of energy in Kosovo, especially the consumption of the residential buildings, to identify there EE potential and to implement the measures in building structure designs.

1.2 Institutional Framework-EE Policies, Laws and Regulations

Kosovo legislation is oriented towards the harmonization with the European legislation. The harmonization process is a long and complex process, it means integration of the laws, regulations and standards also for the EE sector. Actually, EE issues in Kosovo are not covered by the Program of the Kosovo Government, but it is a part of the strategic documents for the energy sectors, draft laws and by laws, technical regulations and other governmental documents initiated in most of the cases by international projects. In these document's European standards are partially applied. Therefore, it is clear that there is a need for a comprehensive approach from the institutions towards planning and creating energy efficiency policies for Kosovo.

Kosovo Energy Strategy 2009 – 2018

The Kosovo Energy Strategy 2009- 2018[3] was approved by the Kosovo Parliament this year in April. The main goals of the Strategy are overall economic growth, security of supply and environmental protection. The Strategy is drafted in accordance with Law 2004/8 "On Energy" and it identifies the measures and policies that should be undertaken for further development of the energy sector in Kosovo and integration of Kosovo energy systems into the European and regional systems [3]. Among important issues of management and development of energy supply, it addresses also the energy efficiency and renewable energy resources as one of the Strategy objectives. It emphasis that, energy efficiency and renewable energy sources production should contribute to the goals of the national energy policy of Kosovo. Due to these reasons, the strategy aims at creating of an appropriate legislative framework but doesn't specifically address energy savings in key areas, such as reinforcing energy efficiency legislation on buildings and enhancing the role of energy performance certificates.

Law on Energy No 2004/8

The Energy Law "defines the basic principles for an energy strategy and energy programs in Kosovo; the rules for ensuring the efficient use of energy and the use of renewable energy sources; the rules for establishing an energy market; and other measures necessary to ensure the proper functioning of activities in the energy sector"[6]. The law stipulates that the Ministry on Energy each year should establish indicative targets for consumption of electricity and heat generated from RES.

These targets are published by MEM in 2007 and are presented in the table 1.6.

Table 1.6 Indicative targets for RES electricity consumption (GWh)

Source of Energy	Indicative targets for RES electricity consumption (GWh)										Extrapolation
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2020
Hydro	125,8	134,6	145,0	156,3	167,0	178,4	190,5	203,2	216,7	230,4	302,1
Wind	0,0	0,0	0,0	32,6	68,7	108,5	151,9	199,8	252,1	309,9	652,1
Solar	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Biomass	0,0	0,0	0,0	0,0	11,6	17,5	19,8	23,3	29,1	29,1	38,4
Total	125,8	134,6	145,0	188,9	247,4	304,4	362,2	426,2	497,9	569,4	992,5

Source: Reference No.3

Administrative Instruction No. 09/2008 on Energy Auditing

To help achievement of the targets for reduction of Energy set in the National Energy Efficiency Plan (NEEP) the Ministry of Energy and Mining has adopted Administrative Instruction 09/2008 on Energy Auditing. Its purpose is "institutionalisation of auditing and setting categories of consumers that are obliged to be audited'. [7] "This Administrative Instruction makes audits compulsory for categories of energy consumers who are fully or partly financed by the Kosovo budget and have annuall energy consumption from 20 toe 50 toe also more than 50 toe" [7]. However it leaves out of this obligation certain categories of buildings that would be required to perform audits (in order to obtain energy performance certificates) according to Directive 2002/91/EC on the energy performance of buildings. Amendments have been proposed to include these categories and to identify proper legal basis in cooperation with MESP. Based on existing legislation MEM doesn't have legal a basis to draft this Administrative Instruction **and implementation of energy efficiency measures proposed by the energy auditors leads to reduction in energy consumption and greenhouse gas emissions, reduced import dependency and reduced energy bills.**

Law on the Energy Regulator No 2004/9

Energy Regulatory Law No. 2004 / 9 defines the duties and responsibilities of the Energy Regulatory Office for economic regulation of the activities in the electricity sector, district heating and natural gas sector[22] Based on this law "ERO, is an independent institution which is responsible for setting a regulatory framework for a transparent energy market" [22]. This Regulatory package to date is in line with the acquis qomunitaire of the European Union and the obligations stemming from the Energy Community Treaty.

Law on Construction No 2004/25

The law "determines the main requirements for design, construction, and use of construction materials, professional supervision as well as procedures for construction permits, use permits and building inspection"[4]. The law addresses different participants, the professional administrators at

the municipal and ministerial level being in charge of preparing and issuing the construction and use of permits, the inspectors guiding and supervising the construction process, the investor, the designer, the reviser, the executor and the supervising engineers. For all of them the Construction Law is binding and all of them are obliged to apply the Construction Law, administrative instructions based on this law and technical regulations. Technical Regulation No 03/2009 on thermal Energy Savings and thermal protection in buildings and other Technical Regulation regarding EE in buildings have to drafted based on this law by MESP.

Technical Regulation No 03/2009 on thermal Energy Savings and thermal protection in buildings

Technical Regulation No 03/2009 on thermal Energy Savings and thermal protection in buildings came into force in May 2009. Its objective is "limitation of the maximum allowed annual heat demand per m2 of the building Qh (expressed in kWh/m2a), depending on the form factor of the building[4] based on the use of required technical norms determined for design and construction products usage for thermal energy saving" [23]. Technical Regulation also defines types of construction for which thermal energy saving is mandatory and obliges investors to complete the technical documentation for the building construction with the elaborate for energy savings and thermal protection.
It consists of:

a. Technical demands on heat energy savings and thermal protection to achieve in design of new buildings and refurbishment and reconstruction of existing ones which are heated on space temperature higher than 12°C
b. Technical demands for building products
c. Project content regarding heat energy savings and thermal protection
d. Building maintaining regarding heat energy savings and thermal protection

Requirements of this regulation are valid for all new buildings and existing buildings undergoing reconstruction which are heated on space temperature higher than 12°C.

A residential building to be heated at the temperature of 18 °C or higher should be designed and constructed so that its **annual heat demand per unit of useful floor area** of the building, Qh" [kWh/(m2a)], depending on the form factor of the building, fo, does not exceed the following values:

1. for $f_0 \leq 0,2$ $Q_h'' = 51,31$ kW·h/(m^2·a)
2. for $0,20 < f_0 < 1,05$ $Q_h'' = (41,03 + 51,41 \cdot f_0)$ kW·h/(m^2·a)
3. for $f_0 \geq 1,05$ $Q_h'' = 95,01$ kW·h/(m^2·a).

[4] Form factor of the building (fo) is the ratio between the area of the building's envelope (heated space) and the building's volume. The heat transfer coefficient for windows and balcony doors in buildings heated to the temperature of 18°C and above is limited to a maximum of U=1.80 W/m2K.

The values heat transfer coefficient for family houses with space area less than 400 m2 should be lower than:

Table 1.7: The values heat transfer coefficient for houses

Nu.	Parts of building	*U* [W/(m²·K)W	
		$\Theta_{e,mj,min} > +3$ °C	$\Theta_{e,mj,min} \leq +3$ °C
1	Outside walls, walls from garage side, ceilingt	1,00	0,80
2	Walls from step side un heated with temperature higher than 0 °C, walls from alcove cannot be heat	1,30	1,30
3	Walls by ground side	1,00	0,80
4	Floors over ground (till to base depth of alcove in 5 m)	0,80	0,65
5	Roofs between the apartments , roofs between heating alcoves of different users	1,40	1,40
6	Roof to the ceiling , roof fro side of alcove unheated beneath	0,85	0,70
7	Roofs to basement , roof from side of alcove unheated underneath	0,65	0,50
8	Plane and bending roof over heated alcove	0,70	0,55
9	Roofs over outside surface, roof over garage	0,45	0,40

Source: Reference 23

Law No.03/L-091 on Use Management Maintenance of Building Joint ownership

As it is mentioned EE measures should be applied in new and existing residential building. Regarding these EE measures and other important issues related to residential buildings some countries created Institutional and Legal Framework that enable the system of housing management and maintenance. This strong framework of capacities and incentives is needed to deliver better energy efficiency.

Kosovo Assembly recently approved the Law No.03/L-091 on Use Management Maintenance of Building Joint Ownership with the purpose of creating mechanisms for management and maintenance of buildings according to the EU standards [5]. These mechanisms are necessary for creation of conditions for investments in the existing buildings regarding EE. The law is completed with secondary legislation and additional promotional documents but its implementation requires lots of professional knowledge and effort.

1.3. Institutional Structure

Ministry of Environment and Spatial Planning (MESP)

The MESP was established in 2002 based on UNMIK Regulation 2001/19 on the Executive Branch of Provisional Institutions of Self Government in Kosovo'. MESP is responsible for policy and strategic development of the environment, spatial planning, housing and construction sector, preparing the program for implementation of construction strategy, and coordinating activities to implement these policies and strategies. MESP responsibilities regarding construction are defined in the Law on construction. Regarding Energy performance in the buildings based on the Law on Construction, MESP has approved Technical Regulation No 03/2009 on thermal Energy Savings and thermal protection in buildings. MESP is responsible for transposing EU Directives regarding Energy Efficiency in buildings.

Ministry of Energy and Mines (MEM)

MEM was established in 2004 based on UNMIK Regulation no. 2005/15 amending Regulation 2001/19 on the Executive Branch of Provisional Institutions of Self Government in Kosovo'. MEM is responsible for policy and strategic development of the energy sector, preparing the program for implementation of energy strategy, and coordinating activities to implement these policies and strategies. MEM role is clearly defined in the Law on Energy no. 2004 / 8 and in Annex XIII of UNMIK Regulation Nr. 2005/15. Basis for establishment of structure responsible for EE will create Energy Efficiency Law. The draft law foresees establishment of the Kosovo Agency for Energy Efficiency and the establishment of EE Fund for encouraging funding mechanism for implementation of concrete projects, co-ordination of government programmes, development of energy efficiency and renewable energy policy and establishment of a national database system for energy consumption, efficiency energy, and use of renewable energy sources This fund according to this law will be funded by government and foreign donations.

2. Targets for Energy Savings in Kosovo Household sector

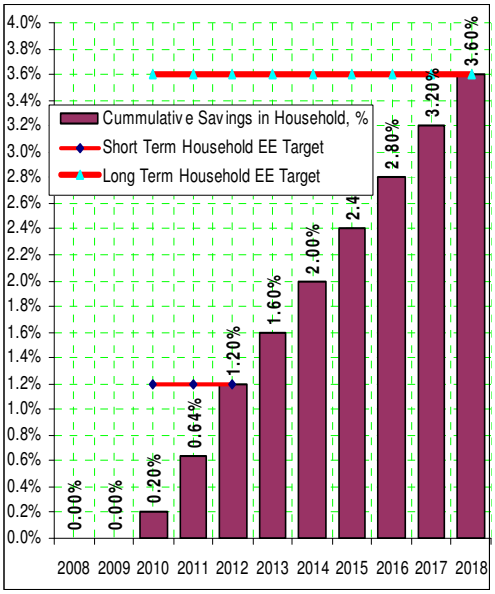
"The first important step regarding energy efficiency in Kosovo, was undertaken following the Kosovo signature of the legally binding Treaty on Establishment of the Energy Community of South East Europe in October 2005[5] and the establishment of the Task Force on Energy Efficiency in June 2007" [13]. At that time, the Ministry of Energy and Mining updated Energy Strategy in 2008 (Energy Strategy for Kosovo 2009-2018) and finalized the Strategy Implementation Program SIP 2009-2011. Also, as a contracting party of the Energy Community Treaty, MEM has submitted its National Energy Efficiency Plan (NEEP) to the Energy Community Secretariat in Vienna, which responded with its remarks. The remarks are being reviewed by a working group of this Plan, in close coordination with MEM advisors.

This chapter introduces the short-term and long-term targets for energy savings in Kosovo which are set in Kosovo NEEP. As important energy consumption sector, within NEEP it is identified also the household sector.

2.1. National Energy Efficiency Plan of Kosovo

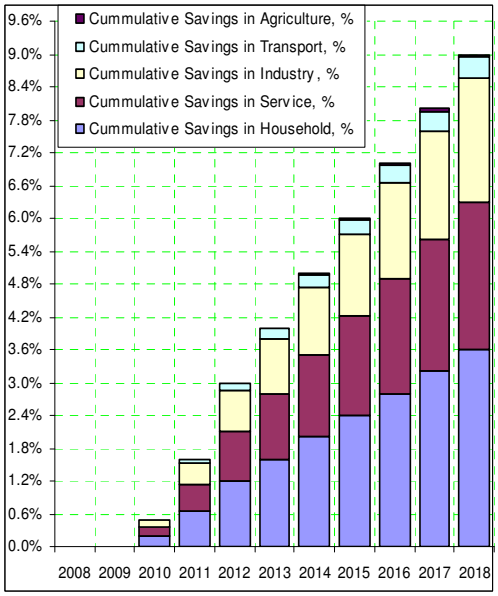
NEEP represents the first long-term energy efficiency plan which covers the period from 2008 till 2016. It sets indicative target for energy saving for the period 2008-2016 and midterm (intermediary) indicative target for energy saving for the period 2009-2016, based on the article 4(1) of Directive 2006/32/EC. Short Term Target and Long Term Target for energy saving in residential sector based on the revised NEEP is presented in the Figure 2.1, and Total Energy Saving Target in % for each sector is presented in the Figure 2.2.

Figure 2.1 Targets of EE for household sector in (%)



Source: Reference 13, NEEP of Kosovo

Figure 2.2 Saving Target for each sector (%)



Source: Reference 13, NEEP of Kosovo

[5] The Treaty was ratified in July 2006

Based on this measures it is **planned that the percentage of household sector participation in the total energy consumption is to decrease by approximately 3%, from 33.34% in 2009 to 29.55% in 2016. However,** in the future thee EE will be increased for reaching the objective of total 9%.

Based on this information the residential sector requires more attention from the government institution and need to be addressed in their future activity. Building envelope improvements, efficient lighting and water heating are some of the measures that consumers need to apply to reduce household electricity needs.

Therefore giving recommendations, which are one of the objectives of this capstone project, for further development of the Kosovo national energy efficiency is very important.

3. Energy Efficiency Strategies in other countries

This chapter comprises a short review of EE strategies enforced in EU countries and informs for some EE initiatives of the countries in the region. In EU countries EE strategies exists as a result of over a decade of energy efficiency initiatives, therefore, there current levels of residential electricity consumption.

The policy measures that are implemented from most of the countries from the central level are: information and awareness raising programmes, mandatory minimum energy performance standards and energy labeling. Financial incentives, as instruments, are used only for limited period of time and are mostly implemented by local authorities.

3.1 The case of Vienna

The most important policy document in Austria for improving energy efficiency is **the Government Programme 2007- 2010.** The objective of this program is to improve the energy intensity by 20 % by 2020. Based on the Austrian National Energy Efficiency Action Programme which is coordinated by the Austrian Energy Agency this "objective of improvements **will be reac**hed by thermal renovation of all post-war buildings (1950-1980) by the year 2020, promotion of low-energy and passive-house standards by Austrian government and by securing financial aid for residential building, provided only for large residential construction projects if they conform to the passive-house standards" [13].
The responsibilities regarding EE in Austria are defined clearly. Based on the programe "monitoring of energy policy developments, development of laws and subsidy schemes, development of energy statistics, provision of municipal expertise relating to EE are responsibilities of the central level (federal province of Vienna) and development and implementation of specific programs are responsibilities of the cities level"[13].

Vienna is the first European city to draft and implement an Urban Energy Efficiency Programme (SEP). SEP was drafted by the Municipal Department 27 - EU Strategy and Economic Development (MA 27) and adopted by the Vienna City Council in 2006. Municipal Department 27 is also charged with co-coordinating the implementation of SEP, for which purpose a special SEP co-ordination point is set up. The objective of SEP is "reduction of energy consumption without curtailing the citizens' standard of living in households, public and private service providers as well as industry and manufacturing enterprises.
The sectors for intervention where identified based on the data evaluated by the Austrian Sector of Energy Audit" [13]. The Annual Average Consumption (AAC) of final energy for the period 2001-2005 is presented in the Table No. 3.1.

Table No. 3.1: Annual Average Consumption (AAC)

in TJ[6]	Annual Average Consumption	Proportion of AAC %
Iron and steel production	7,495	0.8
Chemicals and petrochemicals	17,806	2.0
Non-ferrous metals	6,749	0.6
Minerals and ores, glass	13,585	1.5
Vehicle construction	9,172	1.0
Machine	17,231	1.9
Mining	6,090	0.7
Foodstuffs and luxury foods, tobacco	18,586	2.1
Paper and printing	14,086	1.6
Wood processing	12,419	1.4
construction	37,720	4.2
Textiles and leather	4,907	0.5
Other production sector	8,153	0.9
railway	9,014	1.0
Other on-ground transportation	271,870	30.4
Inland waterway transportation	346	0
Public and private services	140,685	15.7
Private households	273,933[7]	30.7
agriculture	24,558	2.7
Annual average consumption	893,406	100.0

Source: Reference No.15

SEP foresees more than 100 measures for reduction of the energy consumption in the area of energy awareness, increasing the rehabilitation rate of buildings, including energy-relevant aspects in spatial and urban planning, increasing the energy efficiency of heating and cooling systems, fostering the increased use of energy-efficient devices, etc.

Actually, Vienna is the Europe largest landlord with 220,000 hosing units under public control. With its hosing energy efficiency policy which covers subsidies and allowances, approximately 7,000 apartments annually receives subsidies for refurbishment and as a result, most new housing estates in Vienna have much better thermal performance than the requirements of the Building Code.

[6] TJ (**Terajoule**)= 10^{12} J is the derived unit of energy in the International System of Units
[7] 1 TJ=277.77777778 MWh; 273.933TJ=76092.500000 MWh=6.5427773001ktoe

3.2. The case of Bulgaria

Based on the NEEP of Bulgaria, Bulgarian housing stock is private, 65% of which are apartments in multifamily buildings characterized by low thermal efficiency. "Bulgarian authority initiated energy efficiency policy for the Renovation of Multifamily Buildings that consists of conditional subsidies to condominiums for renovation, access to loans for renovation and technical assistance to voluntarily homeowners' associations based on the National Energy Efficiency Fund being developed as a mechanism"[16]. More in detail, based on the "Policy Framework for Renovation Bulgarian Authority approved Energy Efficiency Act, March 2004 –Tax incentives for energy efficiency residential buildings with certificates A and B, National program for renovation of residential buildings(Decision of the Council of Ministers No 395, May 14,2004) and measures included in the EU Accession Strategy of Bulgaria"[16].

"The most important measures are, development of a national program for refurbishment of the 18,900 blocks of flats, existing prefabricated panel buildings in Bulgaria, National Program for improvement of the regulations for construction and construction control of new and existing buildings for rational utilization of energy–building insulations, space heating, lighting, ventilation and cooling"(Decision the Council of Ministers October, 28, 2004) and development of a strategy and program for financing of buildings insulation for energy efficiency improvement"[16].
Three years ago Bulgaria accepted an annual target of 3% during the period 2007-2010 or 72 ktoe annually.[8] Savings of heat energy are estimated at 35-40%.

Furthermore, the **Bulgarian Energy Efficiency Fund (BEEF)** is established by the Energy Efficiency Act, 2004. Its Main sponsors are GEF / World Bank –10 million USD, Bulgarian Government -€1.5 million, Austrian Government -€1.5 million. The BEEF financial products are loans, technical assistance for project development dedicated to municipalities, companies and physical persons [16].
The table No.3.1 is presenting the current source of financing and amount for EE activities in Bulgaria, based on the information of Bulgarian Energy Efficiency Plan 2008-2010.

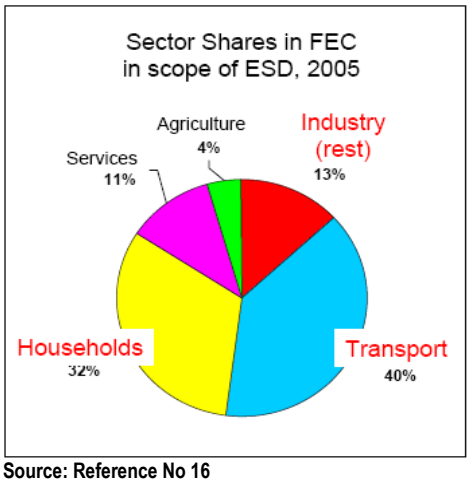
Table: 3.2 Current Financing of EE Programs in Bulgaria

Source of financing	Total value of projects, million Euro
With state budget participation	
Programs for certification of public buildings, 2006/2007	**~ 2.0**
Programs for auditing of enterprises, 2006/2007	**~ 1.7**
Bulgarian Energy Efficiency Fund	**~ 7.5**
Fund (KIDSF)	**~ 5.4**
Credit line in industry(EBRD)	**~ 33.3**
Credit line in households(EBRD)	**~ 22.5**
GRAND TOTAL	**~ 72.4**

Source: Reference No. 16

[8] The average annual savings according to the Directive 2006/32 is 1% and target energy saving is ≥ 9%

Figure 3.1: Sector Shares in energy consumption in Bulgaria



Source: Reference No 16

3.3. EE policies in the countries in the region

Some countries in the region have been more successful than others in designing and implementing adequate EE policy. The comparative analysis of this chapter will focus on the development of EE related policy in several areas:

Table 3.3: The comparative analysis of county EE policies, instruments and measures

Country	Legislative	Normative (Technical regulations	Financial	(Auditing& Certification)	Awareness/ Information
Albania	x	x		x	
Macedonia		x		x	
Bulgaria	x	x	x	x	x
Austria	x	x	x	x	x
Kosovo		x			

The Table No 3.3 summarizes the main areas regarding EE policies in regional countries and it makes comparison with the EU countries have received attention in recent years. It shows that in some progress is made in developing legal frameworks and auditing training.

Albania, Bulgaria, Austria have introduced legislation as most EU countries but even the legislation exists the enforcement is inadequate. Also, financial incentives exist there is no consistency based on the fact that EE policies in the countries in the region are not priority and energy audits programs are financed by international financial organization

There are several EU documents concerning energy efficiency, EU directives which have binding status to the Member States, leaving to them to make the decision on the binding force in their national legislation, other documents like green papers which are discussion papers on specific issues that are important for EU-policies that do not have binding status to the Member States and White Papers which are documents that contains proposals for a specific area and are used as vehicles for their development.

4.1. Green Paper on Energy Efficiency [COM (2005) 265]

Green Paper on Energy Efficiency was published in June 2005 based on the needs of EU countries for meeting the targets of implementing the Kyoto Protocol. It "introduces the target of a 20 % efficiency improvement in the use of energy by the year 2020 compared with the current efficiency level [24]. The highest potentials for efficiency improvements are estimated to be in transportation, buildings and the "other"-sector.

4.2 Directives on Energy Labeling

The directive on energy labeling provides a legislative framework based on which other directives can be introduced to require marking of energy performance levels for domestic equipment. It requires that labeled equipments have **to show their power consumption** in order to be possible for consumer to see the consumption of the equipment.

The groups of equipment for which EU approved Directives on energy labeling are the following;

- hot water boiler efficiencies (92/42/EC)
- household equipment (92/75/EC)
- refrigerators and freezers (96/57/EC)
- ballasts for fluorescent lamps (2000/55/EC)

4.3 Directive on the energy performance of buildings (2002/91/EC)

The energy use of buildings makes 40 % of the total energy demand within the EU region. The objective of the Directive on the energy performance of buildings is to ensure, that building standards across Europe place a high emphasis on minimizing energy consumption. This directive sets requirements on the calculation of the energy demand of buildings, the introduction of energy certificates and regular inspections of boilers and air-conditioning equipment.
Member states shall apply a methodology of calculation of the energy performance of buildings on the basis of the general framework set out in the Annex of the Directive. Directive 2002/91/EC has been recast. Energy performance of buildings is a key to achieve the EU Climate & Energy objectives, namely the reduction of a 20% of the Greenhouse gases emissions by 2020 and a 20% energy savings by 2020. Improving the energy performance of buildings is a cost-effective way of fighting against climate change. The Directive on Energy Performance of Buildings (2002/91/EC) is the main legislative instrument at EU level to achieve energy performance in buildings. Under this Directive, the Member States must apply minimum requirements as regards the energy performance of new and existing buildings, ensure the certification of their energy performance and require the regular inspection of boilers and air conditioning systems in buildings. This Directive is obligatory for Kosovo under the Energy Community Treaty.

Kosovo still didn't bring into force laws to comply with this directive. The revisions in the current construction law aim at transposing the Directive.

4.4. Directive 2006/32/EC on energy end-use efficiency and energy services,

The purpose of this directive is to make the end-use of energy more economic and efficient by establishing targets, incentives and the institutional, financial and legal frameworks. The Directive is applicable among others to the institutions of the member states which are responsible to provide energy efficiency programs and improvement measures, and which commit themselves to making efforts to achieve the indicative target figure of 9% for energy savings. These institutions also shall ensure the availability of efficient, high-quality energy audit schemes to identify potential energy efficiency improvement measures, and should set a good example regarding other investments, on energy services and energy efficiency improvement measures by initiating energy-efficiency pilot projects.

Moreover public institutions should take care of the overall monitoring of the process set up to achieve the targets.

Based on this directive Member States submit to the Commission their Energy Efficiency Action Plans. This Directive is obligatory for Kosovo under the Energy Community Treaty.

4.5. Energy Community Treaty

In October 2005, following the Athens process, the European Community and Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Montenegro, the Former Yugoslav Republic of Macedonia, Romania, Serbia and UNMIK on behalf of Kosovo signed the Treaty establishing the Energy Community. The Treaty requires the Contracting Parties to implement important parts of the acquis communautaire, to create sustainable legal framework, attractive market for investment in power generation and transmission networks, to promote the use of Renewable Energy Sources (RES) and improve Energy Efficiency (EE). The EnCT foresees that, until 2015 Kosovo should fulfill 10-12% of its electricity energy needs from renewable sources.

The Ministry of Energy and Mining (MEM) is coordinating all activities and the EWG, established in Kosovo after the EnCT entered into force, is the country forum of stakeholder where progress of meeting the EnCT obligations is assessed and joint work is being performed. Members of the EWG include MEM, Energy Regulatory Office, KOSTT, KEK, Ministry of Environment and Spatial Planning, Ministry of Labor and Social Welfare and Ministry for European Integration.

4.6. UNECE & Energy Efficiency Plan

UNECE & Energy Efficiency Plan study serve as a basis for the further development of UNECE energy efficiency programs for supporting the Governments in creating policies for energy efficient housing. The Plan provides a policy framework for both individual member states' actions and international cooperation because knowledge exchange and experience with international organizations during energy efficiency policymaking is very important. The Plan identified several priority areas for developing energy policies in housing.

Based on the study improved housing energy efficiency may be decomposed into eight elements or pillars, as follows:

1. Existing housing's retrofitting to excellent energy standards.
2. Excellent energy standards for all new-built homes.
3. Energy efficient utility systems providing services to housing.
4. Low-energy housing management systems and practices.
5. Replacement of inefficient appliances and lighting systems.
6. A minimized carbon footprint for the housing sector.
7. Environmentally-friendly building practices.
8. Housing energy affordability.

The main aim of this Action Plan is to establish the necessary institutional conditions for these pillars to be built or strengthened and thereby to achieve a sustainable transition to a low-energy housing sector (and eventually to zero energy and zero carbon housing).

5. Energy Auditing in Kosovo

This chapter introduces energy auditing as energy management tool for determining the energy saving potential of buildings, energy auditing program as a most important component of the national policies towards reaching the national indicative targets and energy audit model which is presented in this capstone project to better understand the energy auditing process.

5.1. Energy Auditing Program

Energy audit program is considered important element of national energy policies for the countries that have improved there situation regarding reduction of energy consumption.
Based on **the Guidelines and Models for Energy Auditing,** "energy audit programs, in order to be implemented, the goal of each energy audit programs has to be connected with the specific sector and its average energy saving potential, to create conditions for realization of the measures recommended and target proposed. Moreover program could contain laws, subsidies administration audit models, monitoring and promotion. Energy audit program connected with building energy efficiency among building codes and administrative instructions needs effective energy management tool for identifying means to achieve energy efficiency" [26].

5.2. Energy Audit

As energy management tool, Energy Audit is an examination of an energy consuming system which tells us if energy used in the buildings is used in efficient way.
It is also used to define potential of energy-saving and later to produce the Energy Efficiency Certificate of the building.

In Kosovo Energy Audit process has been initiated through the European Commission Liaison office to Kosovo capacity building project for the Ministry of Energy and Mining (MEM). MEM adapted secondary legislation, AI nr. 03/2007 on Energy Audits which requires regular energy auditing for the energy consumers that are partially or fully subsidized by KCB and who have an annual energy consumption of 20 toe to 50 toe. Energy Auditing Process through training energy auditors was initiated this year in compliance with national plan for energy efficiency with the overall objective to support the implementation of the Energy Community Treaty (ECT) requirements for Energy Efficiency. Its expected results are establishment of Energy Auditing process by delivery of a training program for trainers on energy auditing.
As a participant of this training program and certified auditor in the following text I will present the concept of the building energy audit process which can be used as instruction for energy audit, as the concept to energy audit for all types of the buildings is similar in nature. The presented concept is based on the training material [20] and field work. Energy Audit consists of three parts:

(Data collection)Field work which comprise a interviews with building managers and occupants regarding comfort conditions, fill in questioners, selection of energy consumption data (energy bills), site survey, orientation with the object and efficiency of the technical systems.
The Energy Audit covers all energy consumption objects:

a. Building facades
b. Heating systems
c. Radiator system
d. electrical systems

e. domestic water systems
f. Lighting
g. ventilation systems
h. renewable energy applications

Data analysis which comprise description of the current situation regarding heat demand, (the annual consumption of heat and electricity by means of metering devices used for invoicing) identification of the points for energy saving and energy efficiency measures, the results of which are compared with the current situation.

Reporting comprises the Report that in the future should include the Energy Efficiency Certificate for the building. The contents of the Certificate will be exactly specified later. An Energy Audit Report of a Public Building Preschool Institution is presented in this capstone project which could be used as a model for further work regarding auditing in the institutions.

5.2.1 Field work

Field works starts with the distribution of the questioners for the residents of the buildings by the auditors. It is assumed that the residents should fulfill the questionnaire and return to the auditors.

Interviews

The interviews are conducted with person responsible for the technical service of the building. All systems of the building are studied from the energy-efficiency point of view. The name and position/occupation of interviewed persons should be marked in the Report.

Collecting of data

Collection of data is necessary for creation of a model for the current situation of the building regarding its use, operation of the technical systems and energy consumption. Further steps that need to be developed based on this model, are identification of potential points of energy saving, possibilities of energy saving measures implementation in these points and impact of the implemented measures.

In the process of collection of data for energy audit of an apartment building, Based on the Guideline for energy auditing "the minimum number of visited apartments has to be ten-percent of the total quantity. The selected apartments within the percentage have to represent the extreme cases regarding ventilation and space heating. During the auditing the principles of operation and use as well as saving possibilities of building as a whole has to be understood and not of a separate apartments. In addition to the apartments, data has to be collected also for all storage and equipment rooms, such as boiler room, garages, etc. regarding:

a. indoor temperatures (measuring of the parameters of space heating when the weather conditions allow making right conclusions for whole heating season, and, clarifying operation of heating equipment, its energy efficiency considering the use of domestic fuels, etc.),
b. hot water systems,

c. air flows in the case of mechanical ventilation systems and natural ventilation(the total ventilation volume have to be compared with recommended values of the building code),
d. water flows (in case of big flows of the fixtures it has to be considered the possibility for installment of valves for constant pressure or water flow limiters)
e. the installment of electricity consumption when all points of consumption have to be identified like lighting, electric heating, laundry and refrigerated rooms"[26].

5.2.2 Data analyses

The objective of data analysis is to make a model that describes the building in general regarding the above mentioned conditions not only the model that identifies the consumption of electricity. In this stage the potential of energy saving measures have to be checked and compared with the current situation.

Processing of the proposed energy saving measures

In order to estimate the energy saving potential of the building it is necessary to present thermal simulations for the existing conditions and for proposed energy saving measures. This has to be done by using adequate program for calculation or produced excel spread sheet, based on which it is estimated the daily and annual heating load of a building. Also, the total heating energy demand for the building has to be calculated for different cases such as;

a) Base case
b) thermal insulation of outside walls measure
c) replacement of windows measure
d) thermal insulation of roof/ground floor measure
e) thermal insulation of main heating pipes inside boiler room measure
f) energy efficiency heating boilers

5.2.3 Reporting

The report introduces the auditing process in general, explains the methodology and instruments used in the process, presents the data analysis and findings including graphs and plots and, identified saving measures and costs.

5.3. The Model of Energy Audit Report

This Energy Audit Report presented as a model in this capstone project was conducted by a group of trainers of the Training for Energy Auditors in Kosovo organized by the Ministry of Energy and Mining and the European Commission on establishing an energy audit system in Kosovo. The auditing process started on 5 of May 2010 and lasted one week. It was developed based on the energy auditing training lectures. The key systems studied were building facades, heating system, radiator system, hot tap water system and lighting. This model presents the data analysis, findings and identified saving measures and cost based on the

a. Collection of detailed information about facility operation
b. Performance of a more detailed evaluation of energy conservation measures
c. Collection of a 12 to 36 month period data for evaluation of the facility's

energy/demand rate structures and energy usage profiles

d. Interviews with facility operating personnel

General Description

The Preschool institution “Ardhmëria 2” in Gjilan was built in 1981. It is a one floor building with the floor area of 627.57 m2. It is used on daily a basis and its occupancy is 8 hours of operation by 93 children and 17 staff members. The building sidewalls are built with blocks and plastered inside. The external the façade is deferent depending of the architecture. Thermal insulation was not used in the construction. The windows are all of wooden frames and double glazed but very old although maintained at some points and at least painted. Table 5.1 depicts the most important geometric features of the Preschool Institution building.

Table 5.1 Geometric Features of the Preschool Institution building.

					Side walls- Directions (m)						
FLOORS	Height (m)	Floor Surface (m^2)	Roof Surface (m^2)	Pilotis (m^2)	E	N	W	S	Total Side Wall Surface (m^2)	Underground Side Wall Surface (m^2)	Window Surface (m^2)
Ground floor	3.2	432.25	603.75	0	35.5	31.5	34.5	31.5	425.6	212.8	152.95
Ground floor	2.5	135.32	135.32	0	10	14.7	23	14.7	156	0	71.86
Ground floor	1.3	60	60	0	8	8	8	8	41.6	0	22.4
SUM		627.57	799.07		53.5	54.2	65.5	54.2	623.2	212.8	247.21
Total external surface (m^2)					149	147.95	178.3	147.95	623.2		
Wall surface (m^2)		60%			97.32	92.33	94.01	92.33	375.99		
Window surface (m^2)		40%			51.68	55.62	84.29	55.62	247.21		

Source: Reference No. 20

ENERGY CONSUMING DEVICES

The main electrical energy consuming devices of “Ardhmëria2” registered during the energy audit where lighting, cooking, refrigerating and cloth washing. These consuming devices are presented in the following table 5.2:

Table 5.2 Energy consuming devices of the Preschool Institution building

Type	No.	Nominal Rating (kW)	Total Installed Capacity (kW)	Annual Hours Used	Estimated Energy Consumption (kWh)
Washing Machines	2	1	2	1000	2.000
Electric Ovens	1	3	3	1200	3600
Boilers 80 lt	2	2	4	800	3.200
Deep Freezers	1	1	1	3000	3.000
Refrigerators	1	0.75	0.75	4000	3,000
Electric heaters	5	2	10	400	4,000
Air Conditioners	5	3	15	800	12.000
Small Kitchen	4	1	4	200	800
Commuters and TV	11	0.2	2.2	440	968
TOTAL					**32568**

Source: Reference No. 20

Details of the type, number of lighting for different areas, rated power and operating hours of the building are presented in the Table 5.3.

Table 5.3 Type, number, rated power and operating hours of lighting

Location		Type of Lamp	No.	Rated W	Operating Hours per day
1st Floor	Class rooms	Incandescent lamps	4x8	100	2
	Kitchen	Fluorescent lamps	1x6	20	2
	Workshop	Incandescent lamps	1x6	100	2
	Office	Incandescent lamps	1x3	100	2
	Corridors	Incandescent lamps	2x3	100	2
	Bathrooms	Incandescent lamps	6x2	100	2
	Front door	Incandescent lamps	1x2	100	2

Source: Reference No. 20

RECORDED ENERGY CONSUMPTION

The table 5.4 shows the monthly electrical energy consumption (kWh) of the building according to the KEK's billing statements for January 2007 onwards.

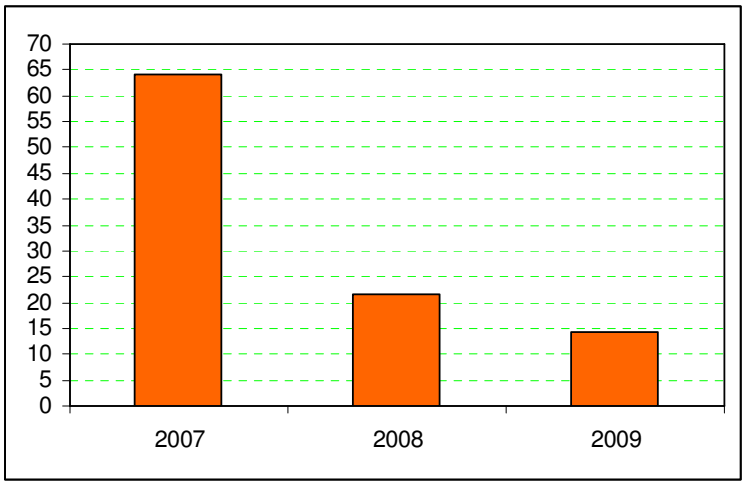
Table 5.4 Monthly electrical energy consumption kWh

Month/Year	2007	2008	2009
Jan	8022	3133	1711
Feb	6933	2056	1089
Mar	3611	1267	700
Apr	2722	711	456
May	2222	456	389
Jun	978	356	322
Jul	833	311	300
Aug	667	333	289
Sep	1111	478	378
Oct	1700	589	833
Nov	3622	1400	1089
Dec	7844	2456	1489
TOTAL	**40266**	**13544**	**9044**

Source: Reference No. 20

The annual electrical energy per square meter is given in the following diagram:

Figure 5.1 Annual Energy Consumption per kWh/m²



Source: Reference No.20

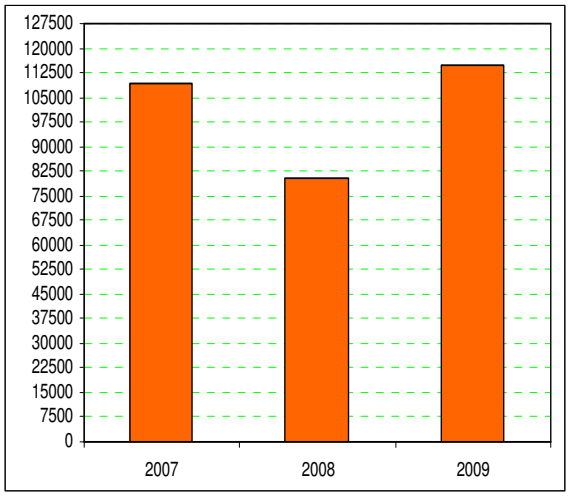
The electrical energy consumption is for the year 2007 per square meter is 64.2 kWh, for the year 2008 per square meter is 21.2 kWh and for the year 2009 per square meter is 14.4 kWh.
The building consumes diesel for heating, hot water and operating the backup generator. The annual thermal energy consumption for the years 2007 to 2009 is presented in the following table 5.5 and figure 5.2:

Table 5.5 Monthly thermal energy consumption kWh

kWh	2007	2008	2009
Jan	26151	15945	22625
Feb	18158	14318	20260
Mar	12653	10445	14518
Apr	6573	5242	6999
May	0	0	0
Jun	0	0	0
Jul	0	0	0
Aug	0	0	0
Sep	0	0	0
Oct	7312	5436	6206
Nov	13310	12046	18715
Dec	24825	16759	25291
TOTAL	**108982**	**80191**	**114614**

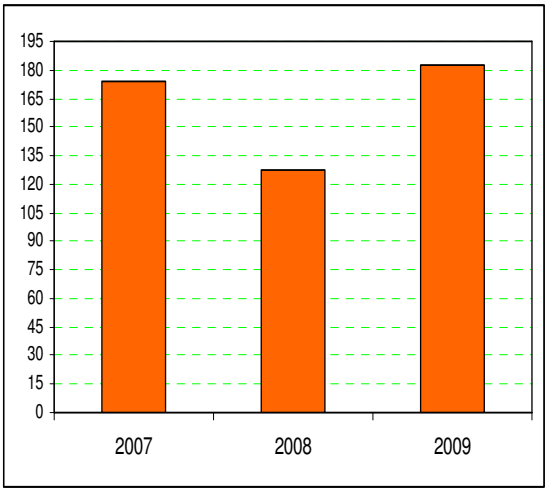
Source: Reference No 20

Figure 5.2: Annual Energy Consumption for Space Heating (kWh/year)



Source: Reference No.20

Figure 5.3 Annual Energy Consumption per kwh/m²



Source: Reference No.20

The average annual thermal energy consumed per square meter for the year 2007 is 173.5, per year 2008 is 127.3 and for the year 2009 is 182.6 kWh/m^2.

Identified Energy Saving Measure

The following interventions are proposed for this building after the detailed audit:

a. The most significant problem with regard energy consumption of the preschool institution is definitely the building's thermal insulation. In the detailed audits, the building's envelope facades overall heat transfer coefficient, U Value is estimated. The U value can be reduced by introducing appropriate wall and roof thermal insulation.
b. The slope and flat roof should be refurbished applying appropriate thermal insulation.
c. It is proposed a renovation of the heating system, with new equipment and piping system. This will improve the heating/steam requirements of the preschool institution.
d. Introducing solar panels for hot water production. Electrical/thermal loads will be replaced by renewable energies.
e. Check the appropriateness of the lighting system and replace all incandescent lamps with fluorescent lamps.

.

The technical specifications of the applied energy efficiency measures are presented in considerable detail in Table 5.6.

Table 5.6. Technical specifications and build procedures of the existing condition and the proposed interventions

No	Measure	Existing Condition	Description of Application	Uold	Unew
1	**External walls**	The existing wall consists of the following: Lime plaster 2,5 cm Block wall 25 cm Lime plaster 2cm	Add: Extruded polystyrene 8cm	1.75	0.39
2	**Windows**	Wooden windows with double glass	PVC Windows with double glass	3.5	2,2
3	**Roof and Floor**	Roof: Wooden battens 1cm Mineral wool 3cm Wooden battens 1cm Metal sheet 7mm Floor: Gravel 14cm Concrete slab 7cm Hydro insulation 1cm Concrete slab	Add to the Roof: Extruded Polystyrene 4cm Add to the Floor: Extruded Polystyrene 4cm	0,89 0,65	0,47 0,4

Source: Reference No. 20

Based on the above assumptions the results of the thermal simulation for the four scenarios are summarized in Table 5.7.

Table 5.7._ Simulation results for the four scenarios

Scenarios	Surface of additional Interventio n (m^2)	Heating Load (kWh)	Specific Heating Load (kWh/m^2)	Energy Saving (kWh)	% Energy Saving	Diesel consumpti on n=0.65 (lt)	Energy Cost n=0.65 (€)	Diesel consu med n=0.90 (lt)	Energy Cost n=0.90 (€)
1. Existing Condition	627.57	173125	275.87	0	0	17313	17313	12503	12503
2. External wall insulation	375.99	149660	238.48	23465	13.55%	14966	14966	10809	10809
3. External wall, floor and roof insulation	2430.20	111619	177.86	61506	35.53%	11162	11162	8061	8061
4. External wall, roof, Floor insulation and windows replacement	2677.41	75394	120.14	97731	56.45%	7539	7539	5445	5445
n=efficiency of the boiler(s)				Cost of diesel 1 €/lt					

Source: Reference No. 20

CONCLUSION

During of the energy auditing in building of the preschool institution “Ardhmëria 2” in Gjilan, are identified below characteristics:

- The overall thermal conditions in the building are not satisfying.
- The outside envelop of the building is not thermal insulated;
- A big area of the outside envelope is made of concrete and thermal bridges;
- The windows of the building are in very bad conditions;
- The lighting mostly is with incandescent lamps
- The heating system is not satisfying because boiler itself and piping system in the boiler room aren’t thermo insolated;

The proposed interventions are:

- Thermal insulation of side walls, basement and roof:
- Replacement of the windows;
- Installation of new boiler with capacity of 75 kW and thermal insulation of the pipes of the heating system in the boiler room;
- Installation of the solar system for hot water;
- Replacement of the incandescent lamps with the fluorescent efficient lamps;

As a result of this energy performance audit the recommended energy conservation measures, annual energy savings and cost savings are presented in the table 5.8.

Table 5.8 Annual energy savings and cost savings for Preschool Institution "Ardhmeria".

Recommended Measure	Estimated annual energy savings, **kWh/year**	Estimated annual cost savings, **Euro/year**	Estimated implementation cost, Euro	Payback period, **Year**
Building facades	**23,465**	**2,346**	**9,400**	**4.41**
Roof/Floor	**38,041**	**3,804**	**19,977**	**5.78**
Windows	**36,225**	**3,623**	**29,665**	**9.01**
Heating system	**27,679**	**2,768**	**18,827**	**7.48**
Hot tap water system	**17,682**	**1,768**	**8,100**	**5.04**
Lighting	**2,440**	**219.60**	**732.00**	**3.67**
TOTAL	**145,532**	**14,529**	**86,701**	**6.56**

Source: Reference No. 20

a. The interventions measurements will provide the total energy saving approximately equal to **145.532 kWh**

b. In the financial terms the saving will be **14.529 Euro** without taking to account the solar hot system.

c. Estimated Implementation Cost **86.701 €.**

d. The simple payback period of the investment is 6.56 **years.**

e. The IRR will be equal to **15.92 %.**

f. The environmental benefit from the purposed energy efficiency measures is the reduction in green house and acid rain gases. The reductions of the CO2 will be 57.47 **ton.**

6. Costs & Financing instruments for Kosovo

6.1. Recommended EE Measures & Costs

Reduction of the energy consumption of the Household sector according to targets defined in the Kosovo Energy Efficiency Action Plan could be possible with the following recommended main quantitative and qualitative measures:

a. Thermal insulation of dwellings that will contribute into the reduction of the electricity and fuel wood for space heating for building stock of Kosovo.

b. Penetration of solar heater systems, for meeting domestic hot water energy demand, which will reduce the electricity consumption.

c. Higher penetration of efficient bulbs that will reduce of electricity consumed

Each of these measures regarding Energy efficiency has its costs and could be achieved only with the support and based on the programs initiated by the governments. Further information for the costs of these measures is presented in the table below:

Table 6.1.Recommended EU Measures

No	Recommended Measure	Description of application	Estimated implementation cost	Approximate Energy Savings[9] %
•	External wall insulation	Extruded polystyrene 8 cm	25.00 Euro/m2	25
•	External roof/floor insulation	Extruded Polystyrene 4cm	15.00 Euro/m2	20
•	Windows replacement	PVC Windows with double glass	120.00 Euro/m2	15-25
•	Heating system HS	New EE boiler, thermal insulation of the pipes of the HS in the boiler room	18.827 Euro	10-20
•	Renewable energy sources	Solar hot water system	450 Euro/m2	10
•	Substituting of existing incandescent lamps, systematic maintenance	Efficient lamps	12 Euro	10

[9] The percentage of the energy that could be saved for each of the measures is presented in the brochures of the training materials from the source with reference No.20. They are estimated based on several audits of the public buildings in Kosovo.

It is estimated that the investment needed for implementation the EE measures in households sector (for space heating, cooking, lighting, hot water, electric appliances and air conditioning) based on which the short term targets 2009-2011 of NEEP of Kosovo could be reached, are reaching the amount of 15 MEURO.

In Kosovo Based on the Kosovo Energy Strategy 2008-2019 KEK receives large financial support from KB and donors. From 1999 until 2008 KEK received € 1,0528 million in the form of subsidies, from which €459 million from Kosovo Budget(KB) and €593 million from donators (€415 from European Agency for Reconstruction). The last three years KEK received from KB approximately €70 million yearly which represented 11% of total budgetary expenses. This financial support based on the strategy has raised the coal production and electricity production, however based on the energy consumption growth and low performance of the energy consumption control and collection of revenues, KEK have had negative impact in public finance and in creation of good business environment since it spends the public budget and it absorbs donor support. Low quality service which KEK offers creates also obstacles for foreign investment. Based on the Mid Term Expenditure Framework (MTEF) 0f Kosovo for 2009-2011 total expenditures in the energy sector from the year 2000 are reaching the amount of 898.4 million Euros. The expenditures for each year with the description of the resources are presented in the table 6.2.

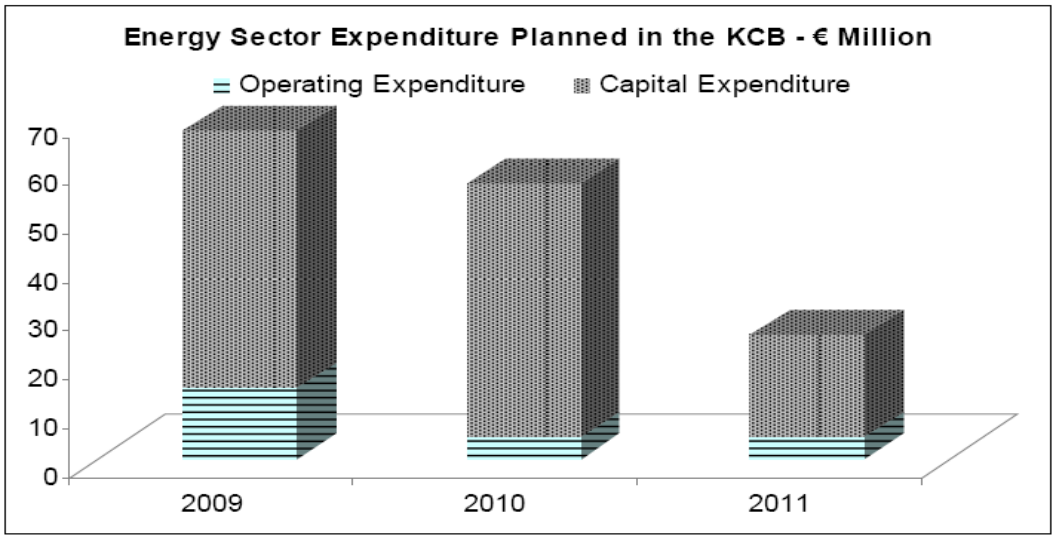
Table 6.2. Total expenditures in the energy sector, in million Euros

Description	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
1.Donations	**-**	**-**	**66.4**	**138.5**	**48.2**	**10.4**	**28.2**	**-**	**-**	**291.7**
Subsidies	-	-	4.1	-	-	-	-	-	-	4.1
Technical assistance	-	-	9.8	90.3	10.9	10.4	-	-	-	121.4
Capital investments	-	-	52.5	48.2	37.3	-	-	-	-	138
2. KCB	**11.6**	**45.9**	**108.1**	**56.3**	**41.4**	**67.2**	**47.1**	**65.6**	**163.5**	**606.7**
KCB funds	11.6	45.9	108.1	56.3	41.4	67.2	47.1	65.6	84.1	517.3
Loans									79.4	79.4
Total 1& 2	**11.6**	**45.9**	**174.5**	**194.8**	**89.6**	**77.6**	**75.3**	**65.6**	**163.5**	**898.4**

Source: Reference No.17

Energy Sector Expenditure planned in the KCB for the next three years based on MTEF is presented in the figure No. 6.1.

Figure No. 6.1 Energy Sector Expenditure Planned in the KCB, in Million Euros



Source: Reference No.17

Regarding the further financial initiatives it is planed in the Kosovo Energy Strategy, where one of the is development of the financial framework for EE sector. For this reason MEM and MEF should work closely to offer EE programes, to initiate application of EE measures and create favorable market which will promote and raise EE and RES use.

The final chapter of this capstone projects presents the capstone project methods, its goals objective and benefits. Furthermore it discuses the project findings and it gives recommendations.

7.1 Project Methods and findings

The work plan of this capstone project was to critically analyze the energy efficiency policy and practice in Kosovo and identify priority areas for strengthening energy efficiency in the building sector with the focus on residential buildings. The identification of areas was done based on the comparison of Kosovo and selected regional and European countries EE situation.

This comparison involved three steps:
1) Critical analysis of current state EE policy
2) Comparative analysis of polices
3) Identification of the recommendation for future energy efficiency policy and project for Kosovo.

The first two components required analysis of publicly available information, including other information from state agencies, private organizations, published books and brochures. The experiences and practices of other countries, available as web information, provided a baseline for evaluation of Kosovo energy efficiency policy and practices. The recommendations for further development of energy policy are based on the components that represent differences between Kosovo and other two states based on which the two states improved/developed there situation.

Analytical process for Kosovo based on the selected countries policies in terms of the state responsibility regarding EE and institutional framework is illustrated in the table below:

Table No. 7.1 Analytical process for Kosovo EE policy

Energy Efficiency Policies	Yes	No	Partly
Developed EE Policy?		**X**	
EE Law?			**X**
EE fund?		**X**	
National Targets?	**X**		
International Cooperation?	**X**		
Technical regulations?	**X**		
EE Directives transposed?		**X**	
Building Auditing?			**X**
Building Certification?		**X**	

Goals and objectives

CP analyzes the current energy efficiency policies and programs of the state of Kosovo and other states in the region and recommends further steps that need to be undertaken.
There are three major objectives for this Capstone project. The first objective is to analyze current Kosovo energy efficiency policy. The second objective is to compare of these policies to other states in the region, and the third objective is to develop a recommendation for further development of the energy efficiency policy of Kosovo.

Benefits

The overall benefit of this Capstone Project to the Government of Kosovo/MESP will be to add to the body of research in energy efficiency policy with a focus on energy efficiency in residential buildings. Specific benefits of this Capstone Project include the clear identification of measures that needs to be undertaken for further development of the energy efficiency sector and identification of benefits that may result if these measures are applied. Benefits from improved energy efficiency in residential buildings are:

Environmental benefits: Improved energy efficiency in residential buildings alleviates pressure on global climate change by reducing the energy consumption and greenhouse gas emissions.

Energy availability: Improved energy efficiency in residential buildings secures more energy for growing energy demands not only for the residential sector but also for all other sectors.

Economic benefits: Improved energy efficiency in residential buildings contributes to the savings on running costs for tenants

Social effects: Improved energy efficiency in residential buildings means also improved living and public health conditions.

7.2 Assessment Results

The assessment identified the following barriers to further strengthen the energy efficiency standards implementation in Kosovo.

7.2.1Lack of legal and regulatory base

Based on the analysis of the existing legislation and comparison with the legislation of the countries in the region and EU countries it is identified that in Kosovo, at present there is a lack of a proper legal base for establishment of the responsible EE structures for development and promotion of EE policies and applications. Also there is lack of national programs and projects for EE buildings and lack of coordination between institutions for the initiated projects.

The goal of Kosovo to increase the percentage to 7% of the energy derived from renewable resources in its total generation portfolio by 2016, which commitment is under the provisions of the ECT (Energy Community Treaty), could not be achieved without an **Energy Efficiency Law** as a main tool.

The Energy Efficiency Law actually is approved by the Government and it is sent in the Kosovo Assembly for further discussion. Approval of the Energy Efficiency Law and further transpose of the European Directives for EE and RES is very important because it will create a regulatory basis for EE and RES for achieving long-term indicative targets already set. The draft law foresees establishment of the Kosovo Agency for Energy Efficiency and the establishment of an EE Fund for encouraging funding mechanisms for implementation of concrete projects, co-ordination of government programmes, development of energy efficiency and renewable energy policy and establishment of a national database system for energy consumption, efficiency energy, and use of renewable energy sources This fund according to this law will be funded by government and foreign donations. Energy Efficiency Law will also determine the responsibilities of state organizations dealing with EE, including the EE Fund.

Furthermore, the results of the analysis show that there is a need for the Government of Kosovo to adopt the **National Programme with the objective for Renovation of the Residential Buildings.** The Program priority has to be the multi-families residential buildings build in the period 1960-1970. The number of buildings that have to be renovated each year have to be defined based on the budget and also based on the NEEP, also the implementation period of the projects. Based on the budget the State could support the dwelling owners by means of direct subsidy of 20% from the renovation total value (case of Bulgaria and Vienna). The Programme implementation has to be responsibility of the Ministry of Environment and Spatial Planning. MESP would coordinate the program and would plan and propose every year needed budget for implementation of the program.

Municipalities will have responsibilities to support technically the activity on the organization and implementation of investment projects for residential buildings renovation, with participation of Condominiums administrators as legal persons, energy service companies and other interested persons.

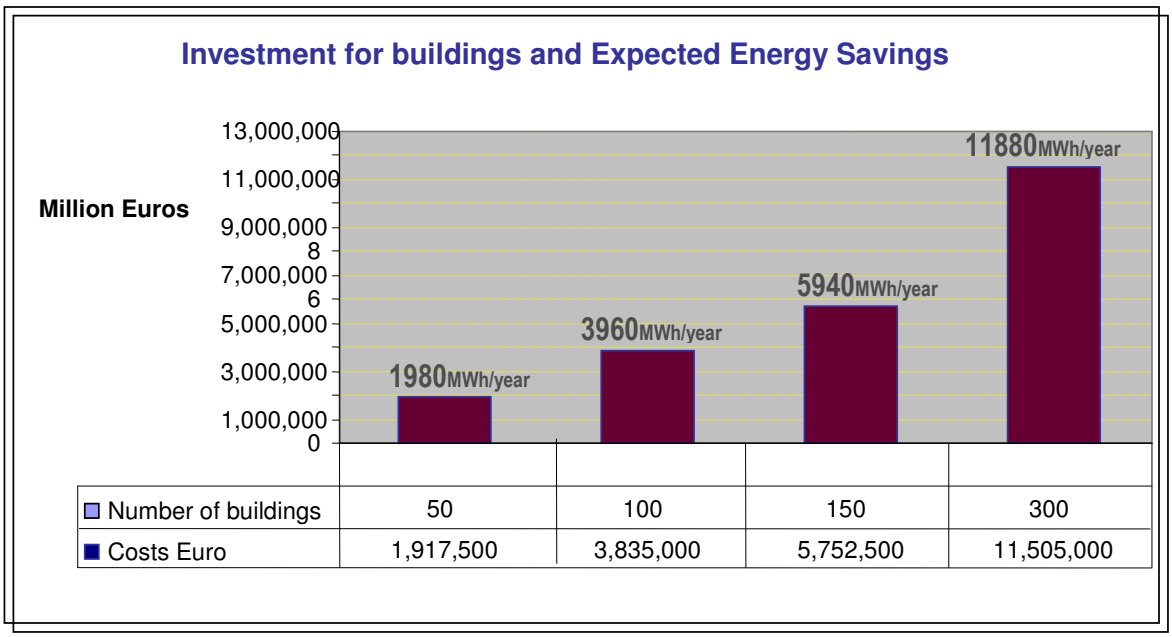
Impact evaluation and results

The preliminary impact evaluation is based on technical calculations and assessment of the expected average annual energy savings of 1 m2 building floor area. Based on the model presented in this CP and the project implemented by Kosovo Association for Renewable Energy and Energy Efficiency, KAREEE expected savings for Residential buildings could be approximately 30 kWh/sq.m/year.
And, the expected savings of greenhouse gas emissions from 1 MWh saved energy are 1088(kg/MWh).Expected energy savings and emissions reduction for the number of residential buildings build 1960-1970 are presented in the table below.

Table No. 7.1 Expected energy savings and emissions reduction for the number of residential buildings

Year	Number of buildings	Floor area	Costs[10]	Expected Energy Savings	Expected CO2 reductions
		m2	Euro	MWh/year	tCO2/year
2012	**10**	13 200	**383 500**	**396**	**430. 84**
2013	**20**	26 400	**767 000**	**792**	**861. 69**
2014	**50**	66 000	**1 917 500**	**1 980**	**2154. 24**
2015	**50**	66 000	**1 917 500**	**1 980**	**2154. 24**
2016	**50**	66 000	**1 917 500**	**1 980**	**2154. 24**
2017	**50**	66 000	**1 917 500**	**1 980**	**2154. 24**
2018	**20**	26 400	**767 000**	**792**	**861. 696**
total	**250**	**369 600**	**9 587 500**	**9 900**	**10 771. 2**

Figure No. 7.1 Investment for buildings and Expected Energy Savings



Important parts of the legislation are other Technical Regulations which should incorporate additional mandatory standards regarding EE.

The respective **by-laws have to** include:
a. Technical Regulations Concerning Energy Economy and Heat Retention in Buildings
b. Technical Regulations on Heating and Air-conditioning Systems of Buildings

7.2.2 Lack of enforcement of EE legislation and complicated administrative procedures.

There is a progress in defining and adopting the secondary legislation of EE, but t is a clear that implementation is lagging behind. Therefore there is a need for enforcement measures. Furthermore, some administrative procedures are still to be tested since there is no single project realized yet.
Ministry of Environment and Spatial Planning should be assisted in preparation and review of secondary legislation by providing best practices of other countries and in preparing of new secondary legislation.

The certification body for energy audits is one of the procedures that need to be clarified. Based on the Administrative Instruction 09/2008 on Energy Audits and its requirements, the Certification Body would need to be accredited in order to be entitled to provide certification for certain energy consumers. The certification body has not been established in Kosovo and no progress has been achieved in this respect. The reason for this is that this body in order to be accredited there a procedure condition that it has to be a separate legal personality, however, based on the actual legislation the certification body is required to be established within the Ministry of Energy and Mining. Actually, under the draft Law on Energy Efficiency, this certification is called Energy Audit Certification Council.

The certification body has to comply with Standard ISO/IEC 17021. This is a standard used by accreditation bodies who certify organizations against QMS and EMS management systems standards (usually ISO 9001 and ISO 14001).

Based on the Law No 2008/03 – 069 on Accreditation **"Accreditation"** is the procedure of receiving official acknowledgment from an authorized body with respect to the competence of a body, which shall perform conformity evaluation with the standards and technical rules for the purpose of carrying out such duties such as testing, calibration, certification and inspection.
By this law is established the Accreditation Directorate and are determined rules for functionality of the system for accreditation of the competent body for conformity assessment.
Based on the Draft Law on Energy Efficiency **MEM** shall establish the Commission for Certification of Energy Auditors and Managers, and, by secondary legislation, shall set its organizational structure, responsibilities and duties. Ministry is responsible for the institutional development and progress of the energy auditing profession until suitable conditions are created, so that this profession could independently be organized. After these improvements there is a need for support for a preparation of a comprehensive investor guide that should include all steps for developing RE projects and disseminate it to all relevant institutions and stakeholders. There is a need for streamlining the legal and institutional framework, including proving best practices from other countries.

Professional examination, licensing, and authorisation process is regulated with bylaws based on the Law on Construction but it has never being implemented based on this laws.
Persons that participate in the construction process based on the Construction Law should be properly qualified. MESP is in charge of setting the procedure and requirements for the professional examination and for the licensing of the participants of the construction process.
The public control of the participants is important as the MESP and the municipalities cannot control all activities themselves but have to rely upon the professional expertise. In countries like Kosovo where legal systems and the rule of law are in the process of being implemented the balance between public (i.e. MESP and municipalities) control and delegation of responsibilities to the private participants, ("deregulation" of state activities) is a delicate issue.

Mandatory energy efficiency standards in buildings are among the most effective instruments for increasing energy efficiency especially in developing countries where economic growth is leading to extensive new construction.
Kosovo efforts to establish uniform measurements and standards began in as 2005 when the Kosovo Standardisation Agency was established. The Kosovo Standardization Agency (KSA) was established as an executive institution in April 2005, based on the Law on Standardization 2004/12 and the Administrative Instruction on the organization and operation of ASK 2005/15 under the Ministry of trade and industry The development of voluntary standards is the responsibility of the KSA as a governmental organization that develops standards across all industries in Kosovo. Kosovo standards are developed through KSA's own technical committees. Membership in KSA and its committees and working groups, which develop standards, is open to organisations and individuals who are certified profesionals. Technical committees write and recommend standards in selected areas. Each country must ratify the standard before they are adopted in that country.

Voluntary standards can be adopted as mandatory technical regulations by any of the Ministries. Ministry of Environment and Spatial Planning adapted as mandatory Technical Regulation No 03/2009 on thermal Energy Savings and thermal protection in buildings which still is not being implemented. Further understandings of the complex regulation requirements and review OF existing building standards will help the implementation and will strengthen energy performance standards in buildings.

Also, the implementation of this new technical regulation requires the accessibility of computer programs coordinated with new demands and data. The development of computer programs should be initiated from the MESP. The computer programs will enable the making of necessary calculations. The new regulation as well as the new computer program has to be presented professional public.

Incorporation of Housing and EE in spatial development plans is identified as an important activity from the countries that are committed to EE. In Kosovo Spatial Planning process is shown as very difficult and slow based on the lack of capacities and funds in local level. Actually only 12 Municipalities have approved MDP and without appropriate housing sector planning process.

Implementation of the Law No.03/L-091 on Use Management Maintenance of Building Joint ownership regarding creation of the housing associations and initiation of the procedure for licensing of the companies which will have responsibilities to manage and maintain the residential buildings. These mechanisms are crucial for applying EE measures based on the fact that on these bases the creation of the saving funds for capital investments in the building will be initiated.

Unclear responsibilities of the institutional structure

Improvements regarding energy efficiency in housing sector in Kosovo could start only when the responsible Ministries and other governmental institutions define clearly there responsibilities regarding EE and also when other nongovernmental structures which will work for EE sector will be established.

Kosovo government ministries have a role in the implementation of the strategy for EE in buildings. The Ministry of the Environment and Spatial Planning regarding the implementation of the Building Code and drafting programs based on which subsidies for the residential buildings regarding EE measures could be applied. The Ministry of Energy and Mining regarding implementation of the Energy Strategy and KEEP regarding national targets for energy saving.

“Local level through there responsibilities of local spatial planning and building have an impact on energy consumption. In the future Municipalities will have responsibilities to allocate the government subsidy money for renovation of apartment buildings regarding the investments in energy conservation.

Other structures like Energy Agencies and Environmental Protection Agencies will have to implement projects regarding information and awareness, training work as well as projects dealing with energy conservation in the public and private sectors” [27].

Impact evaluation and results

By settling of correlations in legislative framework within the area of energy , spatial planning, building construction and by implementation of the existing Technical Regulation Kosovo will have first results in savings energy and environmental protection and will create possibilities to monitor, analyze and compare results.

7.2.3 Lack of awareness of the economic benefits of EE and RE

Based on the analysis of practices of other countries, it is obvious that in Kosovo there is a lack of awareness and information in general professional public and residential consumers, on the efficiency of EE investments and technology. The change of approach to this subject in wider and general professional public will draw attention to the importance of the necessary thermal energy savings in building sector in general.

The informational instruments that based on the Draft UNECE Action Plan for Energy Efficiency are suggested to be used to positively affect energy efficiency, based on the international studies done, are divided in hard and soft instruments and they are:

a. "hard instruments are legally binding informational instruments and
b. soft instruments are informational campaigns; capacity-building, educational and training measures; policy guidelines, good practice and informational handbooks; energy information centers (i.e. State-sponsored offices giving free advice to citizens on energy investment); advertising and promotion of energy-efficiency buildings and technologies"[9].

The developments of the information instruments for energy efficiency in Kosovo should be continues. It is expected from this instruments that will help to continuously strengthen the energy performance in buildings.

7.2.4 Lack of Fiscal instruments

Fund raising for investment in energy efficiency technology is difficult responsibility of developing countries. Each country has its specific possibilities of creating financial framework regarding energy efficiency that could include subsidies, grants, loans, public investment programs or leasing for stakeholders including, owners, tenants, builders, etc. These incentives are applicable in different countries and Governments are playing crucial role in designing them.

Examples of energy efficiency financing models:

State and local energy loan programs,

- multi-family housing development financing model, which involves a formal application process, credit review, and an energy audit performed by an energy expert.
- EE loan for single-family markets which doesn't have up-front costs and loan repayments are paid via an energy bill, with energy savings generally covering the cost.
- Energy improvement loans for over 10 to 20 years repayment through a line item on the property tax bill. As of now, 14 states have already passed the Property Assessed Clean Energy (PACE) legislation.
- The energy efficiency mortgages (EEM) model released based on energy audit tools.

Public subsidies and grants

Subsidies from the state budget could be available for energy efficiency based on the Energy Audit Programs. By this subsidies partially could be covered the **energy auditing costs**, **energy conservation investment costs and promotional activity costs.**

Taxation

Fiscal policy is needed for the application of customs relief connected with efficient technologies. Good example is the example of Bulgaria for raising awareness through an energy inefficiency tax scheme under which owners are required to pay energy inefficiency tax on their property unless they are able to document that it complies with certain minimal energy requirements. Also, this provides building tax exemption for up to 10 years to owners of buildings who have obtained energy performance certificates of one of the higher classes.

Several other European countries have dramatically reduced taxation on energy efficient products for the renovation of buildings.

For this purpose, MEF and MEM should work to deliver a program of fiscal incentives for support towards EE, in order to promote and increase energy efficiency.

Moreover, Ministry of Energy and Mines, Ministry of Environment and Spatial Planning Environmental Protection Agency, Ministry of Trade and Industry and Ministry of Economy and finances as stake holders have to be involved in primarily Regulation formulation for promotion of energy efficiency in housing.

Recommendations:

1. **To complete legal framework for energy efficiency in residential buildings**, by settling of correlations in legislative framework within the area of energy, housing, spatial planning and building construction. Get approval of the Energy Efficiency Law, approval of the Construction Law and transpose of the Directive 2010/30 on energy performance in buildings. Drafting and approval of new technical regulation regarding energy efficiency and changes on existing regulation on thermal energy saving.

2. **To enforce the existing legal framework for energy efficiency** by undertaking necessary action for implementation of enacted technical regulations and introduction of the appropriate standards, implementation of the Law No.03/L-091 on Use Management Maintenance of Building Joint ownership to allow energy efficiency projects in multi ownership buildings. Strengthen human capacity at central and local level and coordination between organizations is crucial.

3. **To develop energy efficiency programs for energy efficiency** improvement and management in residential buildings followed by the appropriate raising awareness campaigns, to help change the approach and understanding of the wider professional public which could draw attention to the importance of the necessary thermal energy savings in building sector in general.

4. **To develop innovative financing for energy efficiency investments in residential buildings** through introduction of fiscal policy needed for the application of customs relief connected with efficient technologies, and subsidies which could cover the energy auditing costs, energy conservation investment costs and promotional activity costs.

Appendix 1
Consultants Resumes

1. **Mahir Yağcılar, Minister, Ministry of Environment and Spatial Planning,** e- mail address: Yagcilar@ks-gov.net

Education: Graduate Engineer of Route Communication, Sarajevo University
Functions and activities: President of Kosovo Turkish Democratic Party KDTP (from 2000), Parliamentarian in Kosovo Assembly, first and second mandate 2001 – 2007, Member of Kosovo Transition Council 2000 – 2001, Supervising Manager of "Kosovatrans" P.E. in Prizren, 1984 – 2001**,** Chief of Parliamentary Group ' 6+ '**,** Current member of Constitutional Commission
Functions in the Kosovo Assembly: Member of Kosovo Assembly Presidency, 2006, Second deputy head of Economy, Trade, Industry, Energy, Transport and Telecommunication Commission, Second deputy head of Minority Rights and Interests and Returns Commission, Member of the Assembly Work Regulation Commission, (KDTP member)

2. **Mohinder Gulati, World Bank expert,**
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Formal Education: 1999 - Executive Development Program - (Completed). Management, Finance from Harvard Business School (US), 1987 - M.B.A - (Completed). Finance from University of Delhi (IN), 1984 - Post Graduate Diploma in Personnel Management - (Completed). Human resource management, Industrial relations from University of Delhi (IN), 1984 - Certificated Associate Indian Institute of Bankers - (Completed). LAW / ACCOUNTING / Banking, Commercial Law, Accountancy, Finance from Indian Institute of Banking and Finance (IN) **Bank Experience:** Country sector coordinator, October 2008, ECS-ECA Sector Units, Sustainable Sector Unit, Lead Energy Specialist, January 2007, EAS-East Asia & Pacific Sector Units, Transport, Energy & Mining Sector, June 2005, Sr. Financial Analyst, April 2002,
Publications: Corruption in the Electricity Sector: A Pervasive Scourge, November 2007, Power Subsidy for Agriculture: An Alternative Business Model, October 2007, Reforming the Power Sector: Controlling Electricity Theft and Improving Revenue, September 2004.

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