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Study on the current rate of energy production and consumption in Medjimurje County

- Energy Audit report -

regionalna razvojna agencija međimurje
regional development agency međimurje

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Contents:

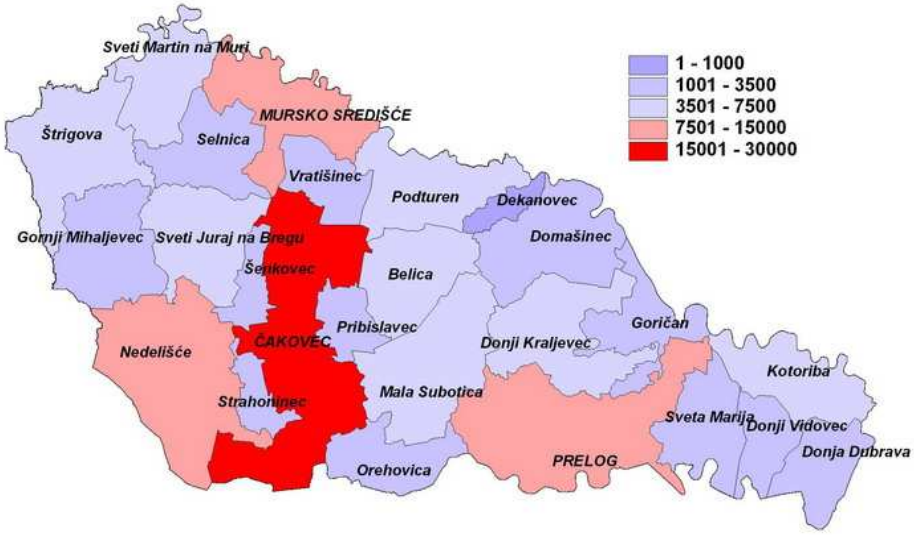
1 Introduction to Medjimurje County

The Medjimurje County is the most northern located county of The Republic of Croatia (Picture. 1-1.) The County is surrounded by the rivers Mura on the north and north-east, the Drava on the south, and the Slovenian border to the west. In western part of the county, there are slopes of Alpine foothills, while toward the east it touches the flat Pannonian plains.

Picture. 1-1 Position of The Medjimurje County in The Republic of Croatia

Of the whole area, (729,5 km²), 367,6 km² (50,40 %) are used in agriculture; 27.5 km² (3,80 %) are covered with orchards; 11 km² (1,50 %) of the hilly area are the vineyards. Pasturelands and forests cover 113 km².

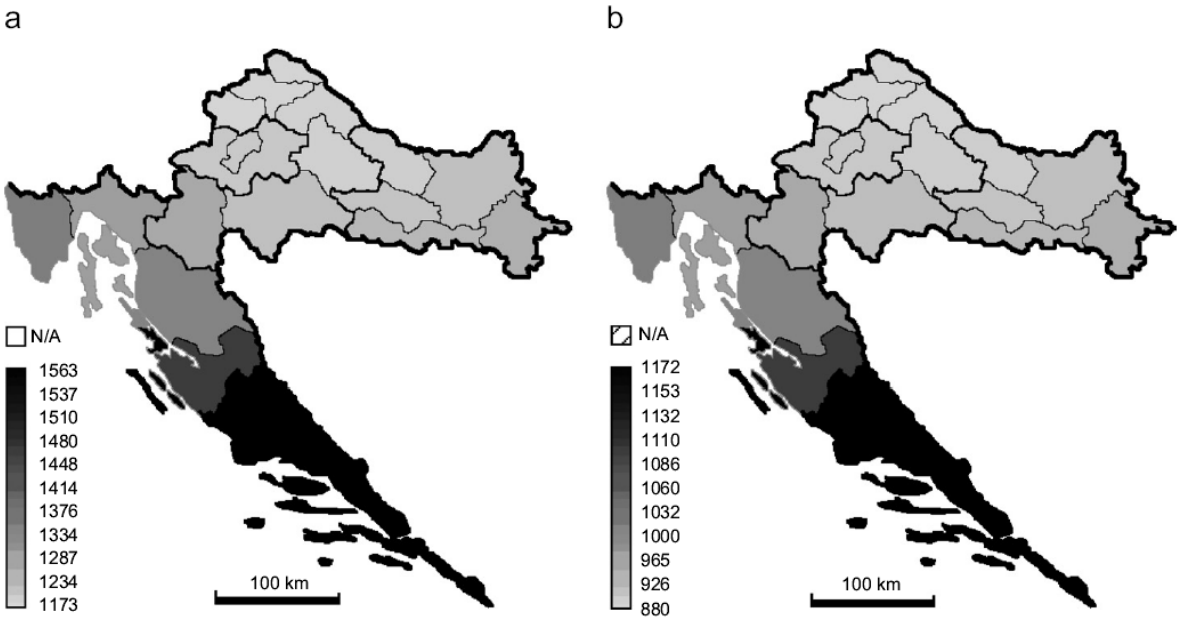
According to the population census carried out in 2001 Medjimurje has 118.426 inhabitants and it has the highest population density in Croatia (162.3 inhabitants/km^2). However there are significant differences in population density between different parts of the County (Picture 1-2). The population of Medjimurje accounts for 2,5% of total population of The Republic of Croatia. The average age of the inhabitants is 37.6 years.



Picture 1-2 Population density in Medjimurje County
Source: Regional Operative Programme of the Medjimurje County for the period 2006-2013

1.1 Solar energy

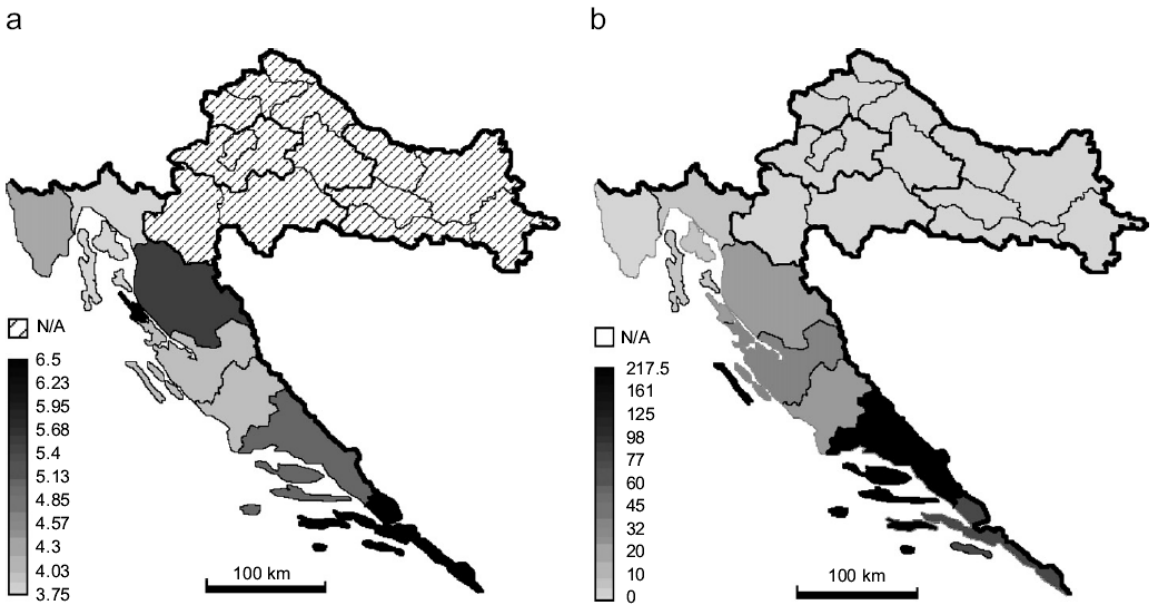
Picture 1-3shows the values of solar energy and the estimated possible power thrust of foto-voltage panels for The Republic of Croatia. According to this data Medjimurje has relatively adverse conditions for exploitation of solar energy (compared to the rest of Croatia). Taking into account the wider area (e.g. Central Europe uses solar energy on significant scale) it is reasonable to conclude that the solar potential of Medjimurje County (larger than the potential of the Central Europe) is not sufficiently used.



Picture 1-3 a) Solar energy (kWh/m^2/year i b) Thrust FN (kWh/year po 1 kW p)
Source: Hrastnik B, et al. SUNEN—solar energy utilisation program (national energy program). Zagreb: Energy Institute ‘‘Hrvoje Požar’’;1998.

1.2 Wind energy

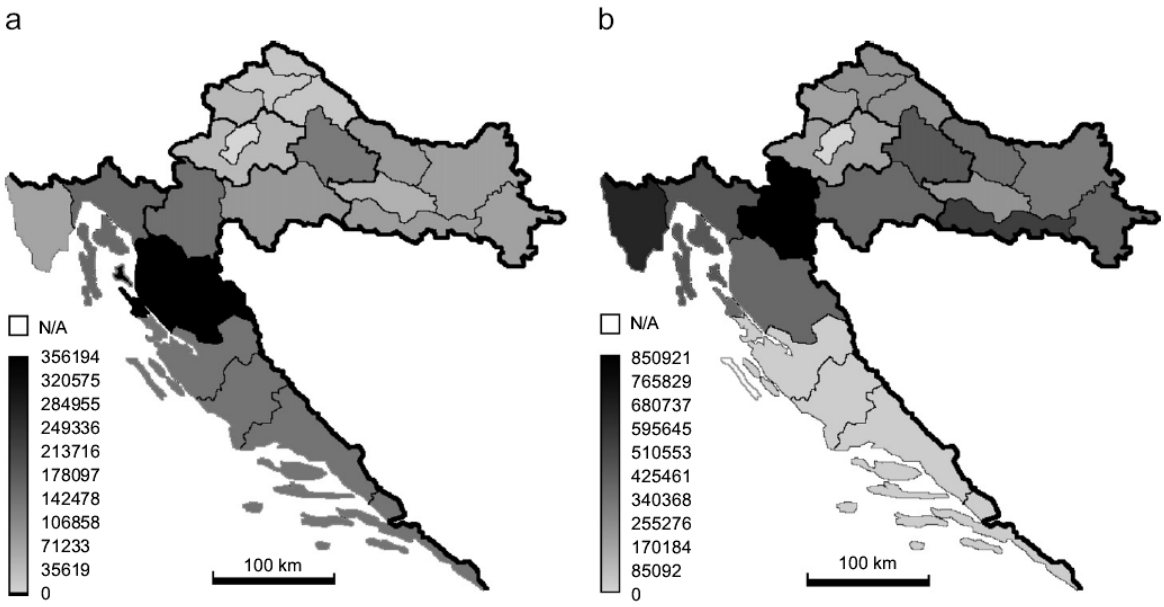
Situation with the wind energy is similar to the situation with solar energy although according to the data from 1998 there are no credible measurements on which the estimation shown on Sl. 1-4 is based. Considering the geographic properties and relatively large water surfaces in Medjimurje that affect the micro-climate it can be expected that there are preconditions for using wind energy.



Sl. 1-4 a) Average wind velocity (m/s) i b) Maximal power of potential power plants (MW) Source: Horvath L, et al. ENWIND—wind energy utilization program (national energy program). Zagreb: Energy Institute ‘‘Hrvoje Požar’’; 1998.

1.3 Biomass

In Medjimurje County there are 9734 ha of forests or 12,37% of total surface. Out of that 3341 ha or 37% is state owned and 6393 ha or 63% is privately owned. State owned forests are managed by the public company “Hrvatske šume” through Department in Koprivnica, Branch office Čakovec. Branch office has two economic units: Gornje Medjimurje (Upper Medjimurje) and Donje Medjimurje (Lower Medjimurje). Private forests are managed by their owners without any defined overall strategy. Picture 1. 1-5 shows the potential for producing biomass from forests and from processing industry. Currently a part of the biomass is used for heating households and other living spaces.



Picture 1. 1-5 a) Potential for biomass production (forests) i b) by-product from wood processing industry (m^3)

Yearly scale of felling in state owned forests (etat) (Table. 1) is determined for the Economic unit Upper Medjimurje at the amount of 3633 m^3 and for Economic unit Lower Medjimurje at 13 696 m^3.

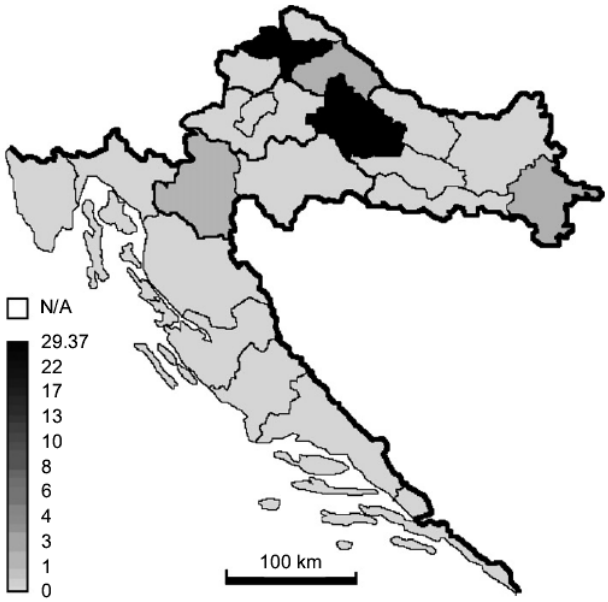
Table. 1 Wood resources of Medjimurje County according to the structure and economic units

Wood resources of Medjimurje County according to the structure and economic units in m^3			
Type of wood	Upper Medjimurje	Lower Medjimurje	Total
Oak	2462	0	2462
Red oak	10176	41838	52014
Beech	8867	0	8867
Hornbeam	10681	6840	17521
Acacia	16246	27556	43802
O.T.L.	2838	0	2838
E.A. Poplar	0	51160	51160
D. Poplar	0	18748	18748
C. Aider	0	15717	15717
B. Aider	0	4550	4550
Willow	0	28921	28921
O.M.L.	7996	0	7996
O.T.L.	0	11400	11400
O. Pine	12093	0	12093
Pine	10995	0	10995
O.C.	6424	2277	8701

Source: Hrvatske šume Ltd.

1.4 Geothermal energy

Oil company INA Naftaplin has conducted intensive activities in the Medjimurje County concerning the exploration of gas and geothermal water in the past decade. Currently the exploration is conducted in five locations in Medjimurje. Based on the results of exploration the report is going to be made with the data on the amounts, quality and economic justifiability of exploitation of these locations.
Thermal spring in Vučkovec with the water temperature of approximately 40 ℃ has been used for decades for health and recreational purposes. Newly found thermal water spring in Merhatovec with the temperature of approximately 120 ℃ is one of the best potential springs in Croatia which can be used for health and recreational purposes and for using the geothermal energy to produce electricity. The possibility of building a thermo power plant with the power of 2,5 to 25 MW is being considered, Picture 1-6.



Picture 1-6 Energy potential for using the geothermal energy (MW)

1.5 Climate

The climate in Medjimurje County is continental, with hot, often stormy summers, calm autumns, and severe winters. Table. 2 contains basic meteorological characteristics of Medjimurje (the data is for the Čakovec).

Table. 2 Basic meteorological characteristics of Medjimurje county

Measuring station/ year	Average yearly values						
	Air temperature (°C)	Air pressure (hPa)	Relative air humidity (%)	Amount of precipitation (mm)	Number of days with snow cover ≥ 1cm	Clear sky days	Cloudy days
Čakovec / 2006.	10,3	998,0	82	769,8	58	29	126
Čakovec / 2007.	11,4	997,0	79	822,8	27	35	109

Source: Meteorological and Hydrological Service (meteo.hr)

Table 3 An average amount of precipitation and temperature in Čakovec

Year	Amount of precipitation (mm)		Average air temperature (°C)	
	2006	2007	2006	2007
Yearly average	769,8	822,8	10,3	11,4
January	39,5	36,1	-4,1	5,1
February	31,8	49,4	-0,2	5,4
March	34,3	92,4	4,4	7,2
April	88,1	2,3	11,4	12,3
May	134,3	88,1	14,9	17,3
June	79,5	26,6	19,3	21,4
July	41,2	88,9	22	22,1
August	177	109,2	17,8	19,9
September	54,7	156,7	16,1	13,1
October	30,2	83	12	8,7
November	34,6	44,2	7,4	4,1
December	24,6	45,9	3	-0,2

Source: Meteorological and Hydrological Service (meteo.hr)

2 Audit and analysis of energy consumption in Medjimurje County

In order to give a clearer picture and relative relations in the consumption of energy in Medjimurje County all of the available data on all the consumers and all energy sources are given. Data on the consumption of electricity and natural gas is available and exact. The data on the consumption of fuels and biomass in transport, industry and agriculture are based on estimates because there is no monitoring system in place to gather more exact data.

2.1 Distribution and consumption of electrical energy

Medjimurje is getting its electricity through two substations: Čakovec and Prelog with total installed power of 122 MW. Integral part of electro-energy system consists of 10 substations 35/10 kV with 104,2 MW of installed power and 553 substations TS 10/0,4 kV with 142,8 MW of installed power. In Medjimurje the 1.713 km of medium-voltage ducts and low-voltage network is being exploited. The highest accomplished peak power is slightly under 49 MW and there are vast reserves of electrical energy for economic development.

Table 4 shows the availability of electrical energy to the end consumers and data on average consumption of households. The same data for the Republic of Croatia are also contained in the table to provide comparison.

Table 4 Basic data on the distribution of electrical energy

Year 2005	Percentage of the households connected to the electrical network	Percentage of the households that pays the electricity bills	Average consumption of electricity per household (kWh/year)	Average consumption of electricity in industry (kWh/year)	
				Medium voltage	SMEs
Croatia			2 976	1.902,556	39.339
Medjimurje County	99 %	100 %	2 768	1.022.456	31.638
Urban areas	99 %	100 %	2 790		
Rural areas	99 %	100 %	2 763		

Source: Hrvatska elektroprivreda, Regional Operative Programme of Medjimurje County pp. 42

Table 5 sums up the data on consumption of electricity in various sectors. Based on the data contained in the table it can be concluded that the number of end consumers is growing (by approximately 1%), but also that total amount of consumed electricity is growing at the rate of approximately 4.5%. The larger part of that growth is due to a growth of consumption in industry, while the growth of consumption in housing sector has decreased.

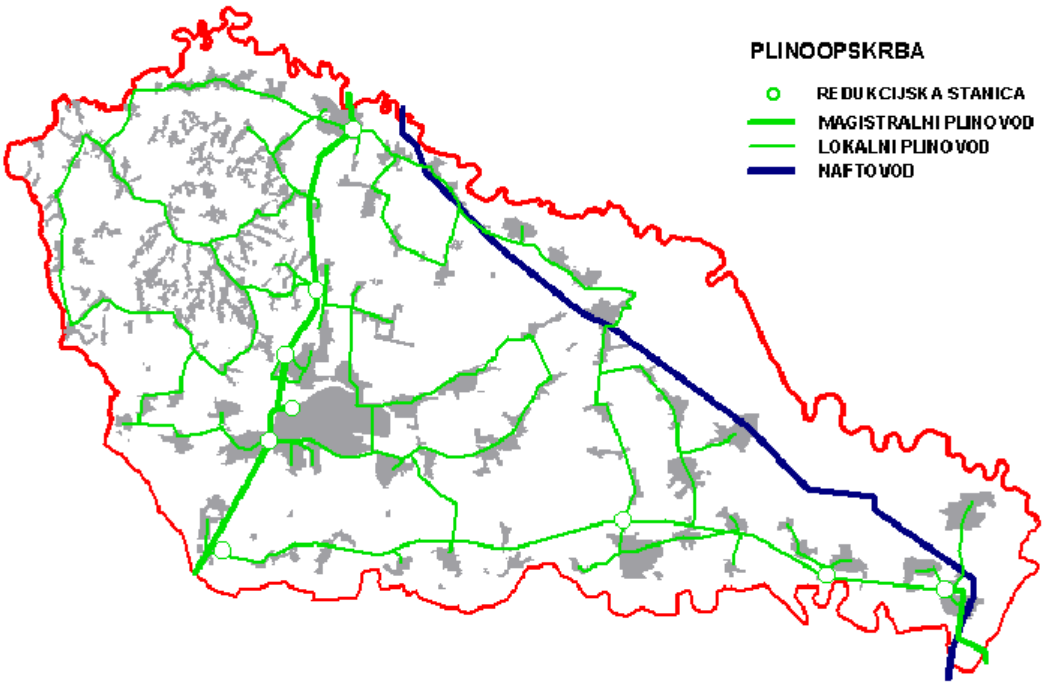
Table 5 Sales of electrical energy in Medjimurje County

	2006.		2007.	
	Number of consumers	Sales MWh	Number of consumers	Sales MWh
High voltage	-	-	-	-
Medium voltage	54	62.415	54	68.351
Households	39.884	120.008	40.307	119.319
SMEs	4.222	86.319	4.297	92.574
Public lighting	412	4.911	425	4.934
Total	44.572	273.653	45.083	285.178
				Status 31/12/2007

Source – HEP DP Elektra Čakovec, Publication „Medjimurje County in numbers 2007“ State Administration Office in The Medjimurje County, pp. 127

2.2 Distribution and consumption of natural gas

The natural gas is distributed to most of the towns and villages in Medjimurje County by medium-pressure gas pipeline (3-6 bars). At that point the pressure is reduced to low pressure of 100 mbars which is the working pressure in street gas networks of some settlements. In areas where the consumers are more dispersed the gas is distributed to some consumers using the medium-pressure gas pipeline of 3 bars, and the reduction to the required working pressure is done before entering the object where the gas is being used (Picture 2-1). Medjimurje ranks 5th by the amount of the consumed natural gas in whole of Croatia.



Picture 2-1 Distribution of gas in The Medjimurje County

Table 6 sums up the data on the number and type of consumers of natural gas in Medjimurje. It can be seen that majority of consumers are households (family houses and apartments). If that data is put into relation with the number of households in Medjimurje it can be concluded that more than 60% of households in Medjimurje has access to the natural gas through the connection to the gas pipeline.

Table 6 Number of consumer of natural gas

	2005.	2006.	2007.
Total	25.349	26.040	26.991
Family houses	20.720	21.158	21.669
Appartments	2.487	2.590	2.812
Industry	95	104	114
Services (institutions)	2.036	2.175	2.379
Agriculture	7	9	12
Boiler rooms	3	1	-
Other	1	3	5

Source: Međimurje plin, Publication „Medjimurje County in numbers 2007“ State Administration Office in The Medjimurje County, pp. 128

Table 7 contains the basic data on the natural gas distribution network, total consumption of natural gas and consumption of natural gas by sectors.

Table 7 Natural gas distribution

	2005	2006	2007
Gas pipelines – total km	952	973	987
From steel pipes	220	215	213
From plastic pipes	741	758	774
Total consumption in thousands m^3	65.303	66.650	59.523
Households	44.867	43.940	38.050
Processing industry	6.363	6.752	4.722
Other consumers	15.846	15.958	16.751
Number of measuring-reduction stations in the network	7	7	7

Source: Međimurje plin, Publication „ Medjimurje County in numbers 2007“, State Administration Office in The Medjimurje County, pp.128

The following part of the document contains the analysis of the energy consumption by sector.

3 Energy consumption by sectors

3.1 Energy consumption in housing sector

Table 8 contains the data on the number of households in Medjimurje and in Croatia. Based on the data it can be concluded that the average usage of living space (29.3 m^2/person) in Medjimurje is approximately 20% less than the Croatian average (23.7 m^2/person). Energy consumption in private sector grows in line with the growth of the number of households and wider use of electrical equipment (Table 9). Average consumption of electricity per person (2768 kWh/year) is approximately 7% lower than Croatian average (2976 kWh/year) due to climate and the mode of heating during the winter. Also the awareness of the necessity of energy efficient construction is rising and gradual modernisation of existing housing units is under way so it can be expected that growth of the energy consumption for heating will slow down despite the construction of new housing units.

Table 8 Number of households, types of households

Year 2001	Republic of Croatia	Medjimurje county	County in Croatia %
Number of households	1.477.377	35.459	2,40 %
Average number of persons per household	3	2,99	
Number of apartments	1.877.126	34.243	1,82
Size of apartments, thousands of m^2	133.307	3.000	2,25
Average size of an apartment m^2	71	87,63	

Source: Central Bureau of Statistics, Publication „ Medjimurje County in numbers 2007“,State Administration Office in The Medjimurje County, pp. 72.

Table 9 Housing construction in Medjimurje County

Year	2002	2003	2004	2005	2006	2007
Total number of built apartments	186	245	227	251	385	329
Size, m^2	25.045	33.325	38.709	39.712	48.806	53.589
Average size, m^2	135	136	171	158	127	163

Source: Central Bureau of Statistics, Publlication „ Medjimurje County in numbers 2007“,State Administration Office in The Medjimurje County, pp. 73.

3.2 Energy consumption in public sector

The majority of the energy consumption in public sector is for street lighting. The rest of the consumption is for heating and cooling of public buildings. Complex of public pools in Čakovec is one of the largest consumers of energy (from natural gas) in public sector.

More detailed data on the consumption of energy in public sector are not available.

3.3 Energy consumption in industry

The large part of energy consumption (mostly electricity) in industry in Medjimurje County is in metal processing industry and in textile industry.

The average consumption of electricity in industry is:

Medium voltage – 1022.456 kWh/year
SMEs - 31.638 kWh/year

If the Medjimurje data are compared with the The Republic of Croatia data it can be concluded that the average consumption of electricity in industry in Medjimurje is considerably lower than the average consumption of electricity on state level (50% lower for medium voltage; 20% lower for SMEs)

The natural gas is most widely used for heating. According to the data from year 2007, a total of 117 industrial consumers use natural gas. Average consumption of natural gas in production and industrial plants is 10.390 m^3/year.

More detailed data on the consumption of energy in industry in Medjimurje County are not available.

3.4 Energy consumption in agriculture

Agriculture in Medjimurje is characterized by small sized agricultural holdings which is a result of traditional inheritance practice. In order to increase competitiveness during last decade there has been a trend of consolidating the agricultural holdings. This trend is expected to continue in the future.

Table 100 contains the data on used and unused agricultural land in Medjimurje. Approximately 3.8% of total agricultural land is unused.

Table 100 Agricultural lands by categories

Category	Total ha
Ploughlands	36.899,94
Orchard	3.023,55
Vineyards	1.203,74
Meadows	10.109,85
Total arable	**51.237,08**
Pasture	1.825,24
Plashes	120,90
Total inerrable	**1.946,13**
TOTAL	**53.183,22**
	Status December 2007

Source: Republic of Croatia State Geodetic Administration, District office for cadastre Čakovec

Table 111 contains the data on the number of agricultural estates and their size. If we compare the data on total arable land from table 11 with the data on the land that is actually being used by agricultural estates it can be concluded that agricultural estates use approximately 58% of total arable land in Medjimurje.

Table 111 Agricultural estates and the used arable land

Size of the estate	Number of estates	Total size ha
0 – 1 ha	1.264	679,22
1 – 3 ha	2.132	4.139,38
3 – 5 ha	1.352	5.278,08
5 – 10 ha	910	6.073,39
10 – 20 ha	256	3.598,83
20 – 50 ha	93	2.834,94
Above50 ha	27	7.391,86
No land	513	-
total	**6.547**	**29.995,70**
Status 06/02/2008		

Source: State Administration Office in The Medjimurje County, Služba za gospodarstvo i imovinsko-pravne poslove (Data from Upisnika poljoprivrednih gospodarstava RH)

The estimation of energy consumption has been done based on empirical data on the consumption of diesel fuel. This data is just rough estimation because there are no actual records on the consumption of the fuel, and yearly consumption depends largely on the cultures being produced.

Estimated consumption of diesel fuel/1ha/year

- For orchards ≈ 150 l/ha/year
- For vineyards ≈ 200 l/ha/year
- Other crops ≈ 130 l/ha godišnje

Source: Hažić Family farm, Jurovčak 72, HR-40313 Sv. Martin na Muri

Based on previous estimation we can conclude that agricultural estates in The Medjimurje County use approximately 5 million litres of diesel fuel per year. If we make an estimate of the consumption of diesel fuel for total arable land the total consumption of diesel fuel in agriculture in Medjimurje can be estimated to 6 million litres per year.

More detailed data on the consumption of energy in agriculture are not available.

3.5 Energy consumption in transport

Energy consumption in transport has grown significantly in the last decade due to a growth in the number of vehicles, increased personal mobility and increased living standard.

(
Table 122) In public transport (bus, train) the number of passengers has decreased. It can be expected that in the future the number of passengers is going to increase due to an increase of the price of oil and gas.

If we assume that the average number of kilometres that the car makes per year is 10.000 and that the average fuel consumption is approximately 8 litres per 100 kilometres it turns out that the average consumption of fuel for car transport in Medjimurje is approximately 30.5 million of litres per year.

Table 122 Number of registered vehicles in Medjimurje

Year	Total	Vrsta vozila				
		Motorcycles	Personal vehicles	Buses	Trucks	Other vehicles
2005	50.138	2.849	36.038	86	4.428	6.737
2006	50.466	3.160	36.368	86	4.425	6.427
2007	53.599	3.907	38.000	85	4.541	7.066

Source: Ministry of internal affairs, Medjimurje County Police Department, Publication „Medjimurje county in numbers 2007“ State Administration Office in The Medjimurje County pp. 133.

More detailed data on the energy consumption in transport in Medjimurje County are not available.

4 Identification of energy production in the area

4.1 Energy from hydro power plants

Currently there are two hydro power plants in Medjimurje -HE Čakovec of 80,4 MW power built in 1982 and HE Dubrava of 80,6 MW power built in 1989. Both power plants are connected to the electro-energy system of Croatia through 110 kV connections and through 35 kV trunk with the distribution system of Elektra Čakovec. In average year both hydro power plants produce approximately 700 millions of kWh of electricity, which is approximately three times higher than yearly consumption of the whole Medjimurje.

4.2 Energy from geothermal sources

Thermal water spring in Medjimurje with the water temperature of around 32℃ and 30 m^3 of water per day is being used for health and recreational purposes. In the future it can be expected that the other found thermal water springs is going to be used for health and recreational purposes and for energy production.

4.3 Solar energy

Solar energy is being used only on small scale by private individuals for heating the water.

In Čakovec the pilot project of using the solar energy for public lighting of a part of the city is being implemented. Installed power is negligibly small.

4.4 Energy from biomass

As stated earlier the use of biomass is not done methodically. The biomass is used mostly for heating in households. Significant changes in the mode of using the biomass are not expected in the near future because of the fact that a significant part of forests are privately owned.

It can be concluded that only considerable energy production in Medjimurje is from hydro power plants. The production of the energy in all other sectors is negligibly small.

5 Summary

This report summarizes the data on the production (capabilities) and consumption of energy in The Medjimurje County. In the first chapter general information on Medjimurje County is given. This is followed by the presentation of the potentials for energy production with emphasis on the renewable sources. From the presented data it is evident that potential are not used or they are not used efficiently. This is the case especially in using biomass (wood) for heating in private sector.

To this date the gathered data about energy consumption gives only brief overview of share in total consumption or/and it can only be used to make some rough estimates. This is evident especially for fuel consumption which is in any case statistical problem. The analysis shows that the infrastructure for natural gas, water and electricity is available for most of the consumers. Comparison of the consumption per capita with the available data for Croatia shows that the consumption of the electricity in Medjimurje County is lower than the average of Croatia. This result is expected due to the favourable climate and living habits in Medjimurje County. The natural gas consumption is in other hand higher than in rest of the Croatia. The reasons for this are good infrastructure and the fact that the natural gas was the primary energy source for heating (private sector) in the last decade. Due to higher prices of the natural gas the consumption could decrease in favour to the biomass.

Conditions for using renewable energy sources are not favourable. In other words, production of energy from renewable energy potentials is minor. The reasons for this are probably in the energy policy and the fact that the liberalisation of the energy market is still not on the level that will animate private investors. It is expected that in the future this situation will change due to the higher energy prices, liberalized market and awareness of the necessity for using renewable energy.

6 Data sources

Housing sector, public sector, transport:

- Regional Operative Programme of Medjimurje County for the period 2006-2013
- Republic of Croatia Central Bureau of Statistics,
- Publication „Medjimurje County in numbers 2007“,State Administration Office in The Medjimurje County
- Ministry of internal affairs, Medjimurje County Police Department
- Hrvatska elektroprivreda d.d.
- Međimurje plin d.d.

Industry and agriculture:

- State Administration Office in The Medjimurje County, Služba za gospodarstvo i imovinsko-pravne poslove (Upisnik poljoprivrednih gospodarstava RH)
- Hažić Family farm, Jurovčak 72, HR-40313 Sv. Martin na Muri
- Republic of Croatia State Geodetic Administration, District office for cadastre Čakovec