Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
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Regional survey on the consumption in the tertiary sector buildings - Primorje - Gorski Kotar County (CRO) -

PROJECT TITLE:	***Enhancing Mediterranean Initiatives Leading SMEs to innovation in buildin efficiency technologies***
AXIS:	***Strengthening innovation capacities***
OBJECTIVE:	***Dissemination of innovative technologies and know-how***
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Executive Summary

EMILIE project is founded by the ˝Mediterranean˝ transnational cooperation Programme, and it aims to support the growth potential and capacity for innovation od SMEs in the field of energy efficiency in buildings in the tertiary sector at the transnational level, in order to actively contribute to growth, competitiveness, and employment in the Mediterranean area. This survey, as a part of the EMILIE project, provides review on the energy consumption in the tertiary sector buildings in Primorje- Gorski Kotar County. Sources of data were collected from published studies on energy consumption, legislation influencing energy efficiency and use of renewable energy in buildings and other available sources of energy data.
Data on typical building structure typologies in Primorje- Gorski Kotar County are included in a general description of the current status of buildings in tertiary sector. Review of those buildings is based on construction characteristics according to their building technology and overview on energy consumption. The most typical buildings in tertiary sector are schools, hospitals, public administrative buildings, hotels and shopping centres, for which are collected quantitative data of energy consumption and energy related systems, estimated potential for energy saving and refurbishment as well as potential for introduction of renewable energy sources and application of the pilot technologies from EMILIE project.

Sažetak (Executive Summary in Croatian language)

Projekt EMILIE, koji je financiran kroz Transnacionalni program Mediteran, želi pružiti podršku malim i srednjim poduzećima u povećanju njihovog razvojnog i inovacijskog kapaciteta u području energetske učinkovitosti u zgradarstvu tercijarnog sektora na međudržavnoj razini, te tako doprinijeti razvoju, konkurentnosti i povećanju zaposlenosti u zemljama mediteranske regije. Ovo istraživanje, u sklopu EMILIE projekta, daje osvrt na potrošnju energije u zgradama tercijarnog sektora u Primorsko- goranskoj županiji. Podaci su prikupljeni iz objavljenih studija o potrošnji energije, zakona i pravilnika koji se tiču energetske učinkovitosti i korištenja obnovljivih izvora energije i drugim raspoloživim energetskim podacima. U općem pregledu trenutnog stanja zgrada u Primorsko- goranskoj županiji nalaze se podaci o tipičnim zgradama u tercijarnom sektoru. Osvrt na zgrade temelji se na građevinskim karakterstikama ovisno o tehnologiji gradnje i podacima o potrošnji energije. Tipične zgrade u tercijarnom sektoru su škole, bolnice, javne upravne zgrade, hoteli i trgovački centri, te su za njh prikupljeni kvanititavni podaci o potrošnji energije i energetskim sustavama na koje se

potrošnja odnosi, procijenjeni potencijal za uštedu energije i obnovu, kao i potencijal za uvođenje obnovljivih izvora energije i primjenu pilot tehnologija iz projekta EMILIE.

Introduction

At the European level, the main policy driver related to the energy use in buildings is the Energy Performance of Buildings Directive (EPBD, 2002/91/EC). Implemented in 2002, the Directive has been recast in 2010 (EPBD recast, 2010/31/EU) with more ambitious provisions. Through the EPBD introduction, requirements for certification, inspections, training or renovation are now imposed in Member States prior to which there were very few. All EU countries now have functional energy performance certification (EPC) schemes in place.

Energy used in the non-residential sector provides a wide range of services: heating, cooling, lighting, refrigeration, cooking in some sectors, and various other end uses. This survey is conducted to provide an updated overview about tertiary sector buildings energy needs, equipment stock and energy consumption within existing buildings of the public, commercial, tourist and educational sectors in the participating regions. There are relevant target groups identified and all necessary information collected by means of a survey carried out in a representative sample of the region tertiary buildings.

The survey constitutes sets of regional reports that characterize most major tertiary sector types of buildings, their characteristics, energy consumption, equipment and potential for energy savings as well as application of the pilot technologies from EMILIE project and introduction of renewable energy sources. A more in deep analysis is performed in the buildings where the pilot plants are installed to allow later and reliable assessment of the pilot plant efficiency.

However, this survey does not directly gather other information that is important to forecasting future energy consumption, such as equipment cost information or efficiency ratings.

In order to clarify the meaning of term ‘tertiary’ or ‘non-residential’ buildings the following definitions could be used:

1) A building is regarded as a non-residential building when the minor part of the building (i.e. less than half of its gross floor area) is used for dwelling purposes. Non-residential buildings comprise: industrial buildings; commercial buildings; educational buildings; health buildings; other buildings. [Source: OECD Glossary of statistical terms]

2) Non-residential buildings are buildings other than dwellings, including fixtures, facilities and equipment that are integral parts of the structures and costs of site clearance and preparation. Historic monuments identified primarily as non-residential buildings are also included. Examples include warehouse and industrial buildings, commercial buildings, buildings for public entertainment, hotels, restaurants, educational buildings, health

buildings, etc. [Source: Eurostat, "European System of Accounts - ESA 1995", Office for Official Publications of the European Communities, Luxembourg, 1996]

The services sector includes both commercial service activities (banking, cinemas, hotels, retail outlets and swimming pools) and public services (universities, hospitals, local authorities and government departments). Buildings are the predominant point of energy consumption (for space heating, lighting and water heating) within the services sector, the balance being mainly represented by certain municipal and civic facilities. In this report, the tertiary sector refers to the public sector, healthcare, services and commerce. The tertiary sector accounts for a large share of GDP in most of countries across the European Union and MED region as well. More than two third of the total value added is generated by the services sector (including public sector) and this figure is also expected to further grow in importance during the next years.

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1. Sources of data

1.1. Published studies on energy consumption

Most important published national study is the Annual energy report Energy in Croatia which is also great source of energy data. Relevant local studies are: Energy development strategy of the Primorje - Gorski Kotar County, Sustainable Energy Action Plans (SEAP) made for Covenant of Mayor (COM) initiative of Rijeka, Krk, Opatija, Kastav, Small wind turbine and photovoltaic modules, Guide to using solar energy in Primorje - Gorski Kotar County, Study of potential use of space for the consumption of solar power plants in the area of Primorje - Gorski Kotar County.

1.2. Available sources of energy data

On the national level, Croatian Bureau of statistic publishes Statistical Yearbook of the Republic of Croatia. Energy consumption is unified in ISGE (Energy management information systems) which is web application for monitoring and analysis of energy consumption in public sector buildings, mostly schools and health institutions, has been developed as an integral and inevitable tool for systematic energy management as part of the Energy Efficiency in Croatia.

Important Agencies, Ministries and other organisations as sources of energy data are: Environmental protection and energy efficiency Fund, Croatian Environmental Agency, Ministry of Construction and Physical Planning, Ministry of Economy, Croatian Chamber of Economy and Institute for physical planning.

1.3. Legislation review influencing energy efficiency and use of renewable energy in buildings

Requirements for new buildings and major reconstructions are given in:
- Technical Regulation on Rational Use of Energy and Thermal Protection in Buildings (Official Gazette 110/08 and 89/09);
- Technical Regulation on Windows and Doors (Official Gazette 69/06);
- Technical Regulation on Ventilation Systems, Partial Air Conditioning and Air Conditioning in Buildings (Official Gazette 03/07);
- Technical Regulation on Chimneys in Buildings (Official Gazette 03/07);
- Technical Regulation on Heating and Cooling Systems in Buildings (Official Gazette 110/08);
- Ordinance on Energy Certification of Buildings (Official Gazette 36/10);
- Ordinance on Requirements and Criteria to be met by Energy Auditors and Energy Certifiers of Buildings (Official Gazette 113/08 and 89/09);

- Physical Planning and Building Act (Official Gazette 76/07, 38/09, 55/11, 90/11, 50/12);
- Technical regulation on energy economy and heat retention in buildings (Official Gazette 110/08, 89/09, 79/13, 90/13);
- Technical regulation on low- voltage electrical installations (Official Gazette 05/10);
- Legislation on energy in final consumption (Official Gazette 152/08 and 55/12);
- Technical regulation of contracting and implementation of energy services in the public sector (Official Gazette 69/12);
- Ordinance on the conditions and criteria for determining the quality of services and works for the certification of installers of renewable energy - photovoltaic systems (Official Gazette 79/13, 85/13);
- Energy low (Official Gazette 120/2012);
- Technical regulations on the use of renewable energy sources and cogeneration (Official Gazette 67/07);
- Ordinance on the status of eligible electricity producer (Official Gazette 67/07);
- Tariff system for the production of electricity from renewable energy sources and cogeneration (Official Gazette 33/07).

EU DIRECTIVES:

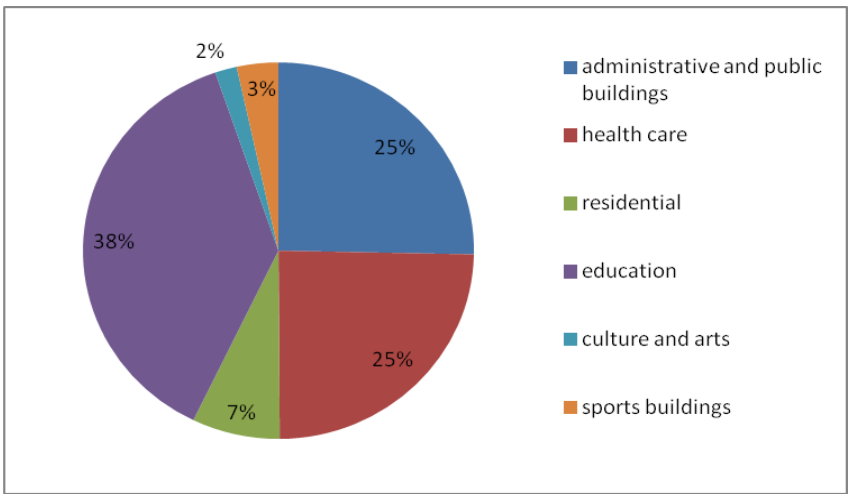
- Directive 2002/91/EC on the energy performance of building;
- Directive 2004/8/EC on the promotion of the cogeneration based on the useful heat demand in the internal energy market and amending Directive 92/42/EEC;
- Directive 2006/32/EC on energy end- use efficiency and energy services and repealing Council Directive 93/76/EEC;
- Directive 2009/28/EC on the promotion of the use of the energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC;
- Directive 2009/125/EC establishing a framework for the setting of eco design requirements for the energy- related products;
- Regulation (EU) No 244/2012 supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of the building by the establishing and comparative methodology framework for calculating cost-optimal levels of the minimum energy performance requirements for the buildings and building elements;
- Directive 2010/30/EU on the indication by labelling and standard product information of energy consumption of energy and other resources by energy-related products;
- Directive 2010/31/EU on the energy performance of the buildings;
- Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EC and repealing Directives 2004/8/EC and 2006/32/EC.

2. General review of tertiary sector buildings

There are no data for Croatia gathered by *Buildings Performance Institute Europe* for Croatia. For description of the current status of buildings we used data from civil engineering literature, and for energy consumption we used data given by Energy Institute Hrvoje Požar which one of the main tasks is expert and scientific research in the field of energy for the state.

2.1. General description of the current status of buildings

Non- residential buildings in Croatia have total used area of 42.400.000 m². Approximately 25% (11.464.261 m²) of this area are public buildings owned by the central and local government. The Breakdown of building usage is given in graph below. The largest share belongs to buildings for education.



The buildings built in period from 1940 to 1950 feature ruggedness and although heat uninsulated, they don´t have a particularly big problem in the terms of heat losses. The problems began to appear in the 1950 with the emergence of new building materials. The traditional construction of outer envelope, and thereby primarily meaning of the facade, was an element of architecture. This means that the primary purpose was the aesthetic appearance, rather than heat insulation. Nowadays it is an element of design that resists external influences and at the same time to maintain the predetermined, the necessary microclimate of the enclosed space.

Exterior walls were mostly either a brick structure of solid brick or of stone, wall thickness 25 cm, 38 cm or 50 cm or more, without thermal insulation. Nevertheless, they have the quality thermal stability during the summer because of the possibility of accumulating a considerable amount of heat. The introduction of standard space heating to a temperature higher than 18 °C, through such walls, caused loose of substantial part of energy and occurring problem of moisture manly because of the lack of moderns material (deterioration of existing) to stop rising dampness. The cold floors of a heated space on the ground were often exposed to the condensation on their upper surface. Roofs of old buildings were not usually isolated, and were just unheated attic space - the problem occurs with the reuse of attic space, as a heated living space. The first examples of thermal insulation for energy savings were wall interstices, filled with debris, and other construction debris. Windows and doors in old buildings are mainly wood performed, glazed with one or two glasses per sheet. Single or double windows with two laps, at a distance greater than 10 cm, nowadays cause large heat losses through the outer envelope. The average heat loss in these old buildings is ranged mostly between 200 and 250 kWh/m2. Research shows that increasing the insulation of outer envelope, primarily the outer wall, and replacing the windows, reduces heat loss by 60 - 90 kWh/m2 per year, which saves 70 % the consumption of thermal energy.

After 1950 it comes to a rapid expansion of construction, the application of the new materials and structural lightweight construction. This period of construction also introduced the biggest problems in the terms of energy consumption, such as:

- high energy consumption for heating,

- a sense of lack of heat in rooms that have been heated,

- a rapid cooling after cessation of heating,

- unbearable heat in rooms during the summer,

- moisture, mold, fungus on the walls, corners or above the windows and external doors,

- cracks in the construction parts and mortars.

In 1970, the ˝revolutionary˝ step was the issuance of the first regulations on thermal protection of building- Ordinance on technical measures and conditions for thermal protection of buildings (Official Gazette 35/70) in which the maximum allowable values of the coefficient of thermal conductivity ˝k˝ for individual building elements, for particular climate zone, were determined.

In 1980 there were new higher requirements in the terms of thermal protection of buildings. However, due to technical progress, the use of concrete and reinforced concrete, and the construction of ˝thin˝ structures and large glass surface satisfied the structural analysis but

had no energy concept, resulting in the construction of a large building stock that is from the standpoint of thermal protection and energy saving extremely unfavourable.

It begins with the modest use of thermal insulation, thickness of 2 - 4 cm, for concrete reinforced structural. On the other hand masonry, performed mainly of hollow brick blocks, 19 cm wide, or solid brick, 25 cm wide, were plastered on both sides satisfying the minimum requirements for thermal insulation. As the surface of the glass surfaces was increasing, it used solid windows with insulated glass, but with a very bad profile, without a thermal bridge, and with poor sealing. Almost no attention was to paid to resolving details of typical thermal bridges at the junction of reinforced concrete and brick, which often results in the appearance of moisture and mold on the inside corners of buildings. Roofs are often constructed as flat roofs with concrete slab and a minimum insulation. Thermal losses of buildings from this period are often higher than those in older buildings, built several years earlier, exceeding more than 300kWh/m2 per year.

All projects and all constructions from 1987 until today, have the same average thermal quality. They have been built with all available materials on the market, and applied thermal insulation, which meets the existing regulations. Most commonly rock wool and polystyrene (styrofoam) is used, 4- 8 cm thick, for the outer wall and 8- 12 cm thick for pitched roof.

In 2005 a new regulation was introduced- *Technical regulations on energy efficiency and thermal performance of buildings* (Official Gazette 79/05) which makes important advance in the philosophy and application of thermal insulation, energy saving and environmental protection. The energy saving target is to create all the conditions for systematic repair and reconstruction of existing buildings and the increase the mandatory thermal insulation of the new buildings, in regards to new buildings, the aim of European directives is to create requirements for the construction of low- energy ones (30 - 40 kWh/m2 per year).

One of the factors that could substantially affect the heating energy savings and thermal comfort in the buildings is area where the building is located. By the old regulations Croatian territory there were 3 construction-climate zones. New technical regulation takes as the criteria for the minimum thermal insulation of the building, average monthly air temperature in the coldest month of the year on the building site ($\Theta_{e, mon, min}$). There are two categories:

- $\Theta_{e, mon, min}$ exceed +3° C
- $\Theta_{e, mon, min}$ less than or equal +3 ° C

The area of the Primorje - Gorski Kotar County has a Mediterranean climate along the coast, sub- Mediterranean climate on the coastal slopes and highland climate (wind, rain and snow)

in the mountains area during the winter months. In the Mediterranean area, summers are hot and rainy period is interrupted in the fall, winter and spring.

There is a difference in average annual temperature between highland parts, coastal parts and islands. However, it should also be said that there are significant differences between the minimum and maximum temperatures, respectively the amplitude of the seasonal temperature between coastal/island and highland/continental regions. Amplitude for the coast and islands are generally smaller than the area of Gorski Kotar. The reason of this is the influence of the sea, which can be considered as the heat accumulator which reduces temperature fluctuations.

Table 1: Indicators for key types of buildings

Type of building	Indicator	Apsolute Value	% of total buildings area	Total (m2)
Schools, research, other educational buildings	Area Number of students	100	2,82	400000
Hospitals, retirement homes other health/social buildings	Area No. of rooms / beds	350	9,88	350000
Offices, administrative (municipal and other public administrative) buildings	Area	70	1,97	175000
Hotels, restaurants, other tourist buildings	Area No. of rooms / beds	2000	56,50	1120000
Shopping, retail centres	Area	1020	28,81	530000
TOTAL		3540	100	2575000

2.2. Overview of energy consumption

In the last twenty years was noted, in the observed stations in Croatia, the reduction on heating degree days and increasing the cooling degree days. Mainly, there are major changes of need in heating and cooling in the Adriatic area than in continental part of Croatia. It is especially emphasized in Primorje - Gorski Kotar County because of the great differences in geographical and climatic characteristics.

Heating and cooling days in Primorsko- goranska County			
T_V	Heating days	T_V	Cooling days
10	116,1	18	114
12	150,5	21	69,9
15	189,3	23	39,8

Table 2: Final energy consumption regarding heating types/fuels

Final energy consumption regarding heating types/fuels			
[PJ]	**2008.**	**2009.**	**2010.**
Total finaly energy consumption	**114,05**	**112,64**	**115,08**
General consumption			
Coal	0,20	0,18	0,26
Liquid fuels	31,65	29,93	28,06
Natural gas	29,40	30,16	32,29
RES	0,31	0,32	0,51
Distric heat	8,90	9,23	10,22
Electricity	43,59	42,82	43,74
Tertiary sector	**29,76**	**30,06**	**31,72**

Final tertiary buildings energy use, structure (share) of final energy consumption for tertiary sub sectors

Table 3: Final energy consumption in tertiary sector and share of total energy use per building type (sub sector)

	Total (sub sector) [MWh]	**% (of total sector)**	**Specific energy use [kWh/m^2 a]**
Schools, research, other educational buildings	32.500	5,60%	81,25
Hospitals, retirement homes other health/social buildings	112.000	19,31%	320
Offices, administrative (municipal and other public administrative) buildings	35.350	6,10%	202
Hotels, restaurants, other tourist buildings	343.840	59,30%	307
Shopping, retail centres	56.180	9,69%	106
TOTAL	579.870	100	

3. Energy analysis of building types

3.1. Current energy consumption

Five types of building were analysed: schools, hospitals, public administrative buildings, hotels and retail (shopping centres). Created survey about general construction characteristic and energy consumption was the same for each building type. Survey was given to responsible persons for the representative building in each sector. Based on collected data from survey, the mean values were estimated.

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3.1.1. Schools

Short description of the typical school building The average school in Primorsko - Goranska County is built 1950th with total area around 4000 m2. There are 97 primary and secondary schools, manly public with small percentage of private ones.					
Building heating area (m^2)		**90% of building area is heated.**			
Energy consumption of the building					
Electricity (MWh)		**35**			
Fuels, district heat, RES (MWh)		**29 000 lit (fuel oil)**			
TOTAL (MWh)		**325**			
Specific energy consumption for heating (kWh/m^2)		**81**			
Specific electricity consumption (kWh/m^2)		**10**			
	Heating	Cooling (VAC)	Hot water	Lighting	Other
Share in energy consumption [%]	50	5	5	30	10
Remarks Total area is estimated. Energy consumption based on average data from surveys.					
Short description of the energy related systems					
Envelope: Most schools do not have appropriate insulation of exterior walls and roofs. Insulation of roof is more common on flat roofs than pitched ones. Windows (mostly double glazing) and doors are mainly wooden, with small proportion of replaced pvc windows. There are mainly 230 openings (considering windows and doors) per building.					
HVAC systems: Central heating is most common method of heating. Installations are usually 30 - 40 years old with efficiency from 30 - 85 %. There are no ventilation systems in buildings, beside kitchen area. Ventilation in classrooms is natural. Also there are no cooling systems, except several air conditioners in offices.					
Energy management status in the buildings: Most schools are obligated to use ISGE (Energy management information systems) which is web application for monitoring and analysis of energy consumption in public sector buildings					

Trained energy manager employed in the building	Regular collection of energy consumption and cost data (bills)	Analysis of consumption (performance calculation, targets, etc.)	IT Energy management system installed (metering and on line collection of data)
No	Usually	Rarely	No

Potential for energy savings/refurbishment

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other (specify)
medium	high	high	medium	medium	(rate)

Comments:
It is required to replace the windows and insulate external walls and roofs to achieve potential energy savings. Also, there is potential of application of renewable energy sources used for heating.

Potential application of the pilot technologies from EMILIE project

Solar heating & cooling	HVAC optimisation	Energy management	PCM
Likely applicable	Likely applicable	Very applicable	Likely applicable

Comments:

Potential introduction of renewable energy sources (RES) in buildings
Potential for biomass systems: very applicable
Potential for solar systems: likely applicable
Potential for heat pump: likely applicable

Comments:

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3.1.2. **Hospitals**

Short description of the typical health building The average age of health building is 50 years and total area is 1000 m2. There are health centres, ambulances, retirement homes etc.	
Building heating area (m^2)	**70% of building area is heated.**

Energy consumption of the building					
Electricity (MWh)	**70**				
Fuels, district heat, RES (MWh)	**25 000 lit (fuel oil)**				
TOTAL (MWh)	**320**				
Specific energy consumption for heating (kWh/m^2)	**357**				
Specific electricity consumption (kWh/m^2)	**100**				
	Heating	Cooling (VAC)	Hot water	Lighting	Other
Share in energy consumption [%]	50	20	3	17	10

Remarks
Total area is estimated.
Energy consumption based on average data from surveys.

Short description of the energy related systems

Envelope:
Most health buildings have appropriate insulation of exterior walls and roofs which are often flat and usually made of concrete. Windows (mostly double glazing) and doors make an average area of 500 m 2 of building. There are estimation of 80 openings (considering windows and doors) per building.

HVAC systems:
Central heating is most common method of heating. Installations are usually 25 years old with sufficient efficiency.
Ventilation is mostly natural in smaller health centres opposite to hospitals.
Also there are usually installed split systems for cooling the area.

Energy management status in the buildings:
Most health buildings are obligated to collect energy consumption and cost data.

Trained energy manager employed in the building	Regular collection of energy consumption and cost data (bills)	Analysis of consumption (performance calculation, targets, etc.)	IT Energy management system installed (metering and on line collection of data)

No	Usually	Usually	Usually

Potential for energy savings/refurbishment

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other (specify)
medium	medium	high	medium	high	(rate)

Comments:
There is potential of application of renewable energy sources used for heating such as photovoltaic power plants and and using of biomass.

Potential application of the pilot technologies from EMILIE project

Solar heating & cooling	HVAC optimisation	Energy management	PCM
Likely applicable	Likely applicable	Very applicable	Likely applicable

Comments:

Potential introduction of renewable energy sources (RES) in buildings
Potential for biomass systems: likely applicable
Potential for solar systems: very applicable
Potential for heat pump: likely applicable

Comments:

3.1.3. Public administrative buildings

Short description of the typical public administrative building The average age of public administrative building is 90 years and total area is 2500 m2. There are government buildings, local and regional self-government buildings, legal entities with public authorities buildings etc					
Building heating area (m^2)		**90% of building area is heated.**			
Energy consumption of the building					
Electricity (MWh)		**109**			
Fuels, district heat, RES (MWh)		**33 000 lit (fuel oil)**			
TOTAL (MWh)		**506**			
Specific energy consumption for heating (kWh/m^2)		**230,127**			
Specific electricity consumption (kWh/m^2)		**75,86**			
	Heating	Cooling (VAC)	Hot water	Lighting	Other
Share in energy consumption [%]	50	20	3	17	10
Remarks Total area is estimated. Energy consumption based on average data from surveys.					
Short description of the energy related systems					
Envelope: Most public administrative buildings do not have appropriate insulation of exterior walls and roofs.. Windows (mostly double glazing) and doors are mainly wooden, with small proportion of replaced pvc windows. There are estimation of 120 openings (considering windows and doors) per building.					
HVAC systems: Central heating is most common method of heating. Installations are usually 25years old with efficiency from 30- 85 %. Ventilation is natural, with installed recuperators in major sales. Also there are usually installed split systems, usually 1- 10 years old, for cooling the offices.					
Energy management status in the buildings: Most public buildings are obligated to use ISGE (Energy management information systems) which is web application for monitoring and analysis of energy consumption in public sector buildings					

Trained energy manager employed in the building	Regular collection of energy consumption and cost data (bills)	Analysis of consumption (performance calculation, targets, etc.)	IT Energy management system installed (metering and on line collection of data)
No	Usually	Usually	Usually

Potential for energy savings/refurbishment

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other (specify)
high	high	high	medium	medium	(rate)

Comments:
It is required to insulate external walls and roofs to achieve potential energy savings. Also, there is potential of application of renewable energy sources used for heating such as photovoltaic power plants and using of biomass.

Potential application of the pilot technologies from EMILIE project

Solar heating & cooling	HVAC optimisation	Energy management	PCM
Likely applicable	Likely applicable	Likely applicable	Likely applicable

Comments:

Potential introduction of renewable energy sources (RES) in buildings
Potential for biomass systems: likely applicable
Potential for solar systems: likely applicable
Potential for heat pump: likely applicable

Comments:

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3.1.4. **Hotels**

Short description of the typical school building The average hotel in Primorsko - Goranska County is built in 1960th with total area around 10 000 m2. There are around 500 hotels and large percentage of these hotels were reconstructed, because tourism is the most important economic activity.					
Building heating area (m^2)	**90% of building area is heated.**				
Energy consumption of the building					
Electricity (MWh)	**3000**				
Fuels, district heat, RES (MWh)	**70 (fuel oil)**				
TOTAL (MWh)	**3070**				
Specific energy consumption for heating (kWh/m^2)	**8**				
Specific electricity consumption (kWh/m^2)	**300**				
	Heating	Cooling (VAC)	Hot water	Lighting	Other
Share in energy consumption [%]	35	25	10	20	10
Remarks Total area is estimated. Energy consumption is estimated from previous research studies.					
Short description of the energy related systems					
Envelope: Most older hotels do not have appropriate insulation of exterior walls and roofs, the exceptions are the ones which are reconstructed and new ones. Windows (mostly double glazing) and doors are mainly wooden, with small proportion of replaced PVC windows. The large part of the outer facades are openings (considering windows and doors) because hotel standard require the minimum of one window per room.					
HVAC systems: Central heating is most common method of heating. Installations are usually 20 years old with efficiency from 30- 85 %. Ventilation is natural and mechanical (forced) depending on the previous and current purpose of the space. Mechanical ventilation is usually by the thermal pressure ventilation. Also there are usually installed split systems, because higher category hotels are obligated to have installed air conditioner in every room.					

Energy management status in the buildings:
Most hotels have the technical service responsible for the monitoring of energy consumption in the building.

Trained energy manager employed in the building	Regular collection of energy consumption and cost data (bills)	Analysis of consumption (performance calculation, targets, etc.)	IT Energy management system installed (metering and on line collection of data)
No	Usually	Rarely	No

Potential for energy savings/refurbishment

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other (specify)
high	medium	high	high	high	(rate)

Comments:
there is potential of application of renewable energy sources used for heating and cooling and it is recommended to improve the existing lighting system

Potential application of the pilot technologies from EMILIE project

Solar heating & cooling	HVAC optimisation	Energy management	PCM
Very applicable	Very applicable	Likely applicable	Likely applicable

Comments:

Potential introduction of renewable energy sources (RES) in buildings
Potential for biomass systems: likely applicable
Potential for solar systems: very applicable
Potential for heat pump: very applicable

Comments:

3.1.5. Retail (shopping) centres

Short description of the typical retail centres The average age of building in whose areas are small retail centres is 50 years with total area of average 150 m2. These areas are usually commercial spaces, which are given for hire by auction system. There are thousands spaces like this in Primorsko - Goranska County. In contrast there are big shopping centres, built in the last ten years with an area up to 120 000 m2 and 8 storeys.					
Building heating area (m^2)	**70 % of building area is heated.**				
Energy consumption of the building					
Electricity (MWh)	**7000**				
Fuels, district heat, RES (MWh)	**100 (fuel oil)**				
TOTAL (MWh)	**7100**				
Specific energy consumption for heating (kWh/m^2)	**20**				
Specific electricity consumption (kWh/m^2)	**85**				
	Heating	Cooling (VAC)	Hot water	Lighting	Other
Share in energy consumption [%]	15	25	2	51	7
Remarks Total area is estimated. Energy consumption based on average data from surveys.					
Short description of the energy related systems					
Envelope: Most public buildings, where are retail centres, do not have appropriate insulation of exterior walls and roofs. On the other hand, big shopping centres, which are most recent reinforced concrete construction have appropriate envelope made of rock wool, 6 - 8 cm thick. Mentioned centres have usually flat roofs which are insulated epoxy resin. Windows (mostly double glazing) and doors are wooden, PVC and aluminium. There is estimation of total openings area which is 27 m2 per retail space. Shopping centres have bigger area of total openings because in modern architecture windows are part of the structural facade with possible area of 600 m2.					

HVAC systems:
Central and local heating are methods used depending on the size of area and number of rooms in retail centres. Installations are usually not older than 20 years old with efficiency from 30 - 85 %.
Shopping centres have heat pumps, more recent production.
Ventilation is natural and mechanical (forced) depending on the previous and current purpose of the space. Mechanical ventilation is usually by the thermal pressure ventilation.
Also there are usually installed split systems, usually 1 - 10 years old.

Energy management status in the buildings:
Most public buildings are obligated to use ISGE (Energy management information systems) which is web application for monitoring and analysis of energy consumption in public sector buildings. Private shopping centres have management of the facility used by automated central control.

Trained energy manager employed in the building	Regular collection of energy consumption and cost data (bills)	Analysis of consumption (performance calculation, targets, etc.)	IT Energy management system installed (metering and on line collection of data)
No	No	Usually	Usually

Potential for energy savings/refurbishment

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other (specify)
medim	medium	medium	medium	high	(rate)

Comments: For smaller retail centres, according to energy certificates, it is recommended systematic energy management, use of renewable energy for heating and choosing an alternative electricity supplier.
In shopping centres, it is recommended to improve the existing lighting system, because it is part which spent the largest share of the energy consumption.

Potential application of the pilot technologies from EMILIE project

Solar heating & cooling	HVAC optimisation	Energy management	PCM
Likely applicable	Likely applicable	Likely applicable	Likely applicable

Comments:

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Potential introduction of renewable energy sources (RES) in buildings
Potential for biomass systems: likely applicable Potential for solar systems: likely applicable Potential for heat pump: very applicable
Comments:

3.2. Assessment of diverse technologies effects on the supply chain

Measures for financial stimulation of use of RES in heating, in most cases solar thermal systems, but also modern biomass system and heat pumps were mostly implemented on individual actions undertaken by county/municipality in cooperation with local energy agencies and Fund for environmental protection and energy efficiency. These actions are in form of public tender for co- financing defined number of projects on defined area (i.e. territory of one county or municipality). Typical financial measures include co financing up to 40% of cost of system, with limit set on around 12 000 HRK per system, but there are some variations from county to county.

3.3. Assessment of the effects of diverse technologies in terms of energy savings and overall environmental impact

Advances in technology are the best thing for meeting increasing energy demands while also protecting the environment. The energy industry is making great strides in how energy sources are extracted, created and used — always with the aim of using less to do more. As regional population grows and less developed parts of the region become more technologically advanced, the energy industry's commitment to new technology will make it possible for more and more people to have access to the energy they need while keeping the environment safe and healthy and with.

Region has several local SEAP plans in which they state that the energy and CO_2 reduction will be less by 20 % till 2020. Region is obligated with those local SEAP plans. Technologies and measures are very different. RES that will be implemented are wind, solar, biomass, photovoltaic cells, electric cars etc.