Regional survey on the consumption in the tertiary sector buildings - SLOVENIA -

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INDEX

Executive Summary

This survey is part of the EMILIE project, funded by the “Mediterranean” transnational cooperation Programme and aiming to support the growth potential and capacity for innovation of small and medium enterprises (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. The document provides review of existing data sources on energy consumption in the tertiary sector in Slovenia (as one of the 6 participating regions within the project), with special focus on studies and sources of data on energy consumption in buildings and related legislation, standards and supporting mechanisms, as well as an updated overview about the key tertiary sector buildings energy needs, status and potential for energy refurbishment.

A general description of the current status of buildings in tertiary sector contains data on typical buildings structure typologies in Slovenia and buildings specifics according to their building technology. Quantitative data of energy and heating sources, energy consumption and status of energy related systems, as well as potential for energy savings and application of pilot technologies from EMILIE project are collected for five the most typical types of buildings in tertiary sector like schools, hospitals, public administrative buildings, hotels and shopping centres. In addition to this, general analysis and assessment of the potential for tertiary building energy refurbishment is elaborated.

This survey as well as the other regional surveys are available for download from the EMILIE project website, www.emilieproject.eu.

Povzetek (Executive Summary in Slovenian language)

Ta raziskava je del projekta EMILIE, ki ga financira "sredozemski" program transnacionalnega sodelovanja MED, s čimer namerava podpreti potencial rasti in inovacijske zmogljivosti majhnih in srednje velikih podjetij na področju energetske učinkovitosti v stavbah storitvenega sektorja na transnacionalni ravni, s čimer bi dejavno prispeval k rasti, konkurenčnosti in zaposlovanju v sredozemskem območju. Dokument vsebuje pregled obstoječih virov podatkov o rabi energije v terciarnem sektorju v Sloveniji, ki je ena od 6 sodelujočih regij v okviru projekta. Poseben poudarek raziskave je na analizah in virih podatkov o rabi energije v zgradbah in s tem povezano zakonodajo, standardi in podpornimi mehanizmi, kot tudi na posodobljenem pregledu energetskih potreb in statusa stavb ter identifikaciji potencialov za energetsko obnovo.

Splošen opis trenutnega stanja stavb v terciarnem sektorju vsebuje podatke o tipičnih strukturi stavb v Sloveniji in njihovih posebnosti glede na tehnologijo in obdobje gradnje. Kvantitativni podatki o rabi različnih virov energije, statusu sistemov, povezanih z energijo, pa tudi ocene potencialov za varčevanje z energijo in uporabo pilotnih tehnologij iz projekta EMILIE so podani za pet najbolj tipičnih vrst objektov v terciarnem sektorju, kot so šole, bolnišnice, javne upravne stavbe, hoteli in nakupovalna središča. Podana je tudi splošna analiza in ocena možnosti za energetsko teh stavb.

Ta raziskava in tudi druge regionalne raziskave, so na voljo za prenos s spletne strani projekta EMILIE, www.emilieproject.eu.

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.

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). 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. 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.

This survey is conducted in the framework of the EMILIE project and is aiming 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. It constitutes data for Slovenia, 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. 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, but could serve as an useful overview of the fields and technologies which offer future business opportunities particularly for local SME's and industry.

In order to clarify the meaning of term 'tertiary' or 'non-residential' buildings the following definitions could be used: '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]' and '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]'.

1. Sources of data

1.1. Published studies on energy consumption

Tertiary sector has been addressed in the following studies related to energy consumption:

- Resolution on the National Energy Programme (*Resolucija o Nacionalnem energetskem programu*, ReNEP) (Ur.l. RS, 57/2004) – the basic strategic document in accordance with the principles set out in the Energy Act, plans and coordinates the activity of actors in the field of energy management in the Republic of Slovenia (stating goals for the use of RES)
- National Energy Programme of Slovenia for the period 2010 to 2030 (*Nacionalni energetski program Slovenije za obdobje 2010 do 2030*, NEP 2010-2030)
- Long-term energy balance of the Republic of Slovenia of NEP by the year 2030 – basis, results (*Dolgoročne energetske bilance RS za NEP do leta 2030 – izhodišča, rezultati*)
- Energy balance of the Republic of Slovenia for 2012 (*Energetska bilanca RS za leto 2012*)
- Action Plan for Renewable energy sources for the period 2010–2020 (AN OVE) (based on Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC)
- First and second national efficiency energy action plan for the periods 2008-2016 and 2011-2016 (AN URE 1 and AN URE 2) (based on Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC)
- Operational programme for limiting greenhouse gas emissions (GHG) until 2012 (*Operativni program zmanjševanja emisij toplogrednih plinov do leta 2012,* OP-TGP)
- Research programme Competitiveness of Slovenia 2006-2013: Project V5-0309: EnGIS - Energy geographic information system for RES (*CRP Konkurenčnost Slovenije 2006-2013: Projekt V5-0309: EnGIS - Energetski geografski informacijski sistem za področje OVE*)

1.2. Available sources of energy data

Basic sources of data on energy in Slovenia are collected, monitored, supervised or provided by:

- Ministrstvo za infrastrukturo in prostor (Ministry for Infrastructure and Spatial Planning), Informacijski portal Energetika (web information portal), http://www.energetika-portal.si
- Javna agencija RS za energijo (Energy Agency of the Republic of Slovenia), http://www.agen-rs.si
- Ministrstvo za kmetijstvo in okolje (Ministry of Agriculture and the Environment), Agencija RS za okolje (Slovenian Environment Agency), http://www.arso.gov.si
- Eko sklad, Slovenski okoljski javni sklad (Eco Fund, Slovenian Environmental Public Fund), http://www.ekosklad.si
- Statistični urad Republike Slovenije (Statistical Office of the Republic of Slovenia), http://www.stat.si; SI-STAT portal (SI-STAT data portal) and http://www.stat.si/tema_okolje_energetika.asp

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

A) national/regional/local legislation, total or partial transposition of EU directives

The main source of data is the web information portal http://www.energetika-portal.si/predpisi/ where all main legislative documents are gathered.

- Energy Act (*Energetski zakon*): This Act lays down the (a) principles of energy policy, (b) electrical and natural gas energy market operation rules, (c) transportation of carbon dioxide through distribution network pipelines, (d) dealing with clients' complaints, (e) manner and form of providing public services in the energy sector, (f) principle of secure supply and efficient use of energy, (g) encouraging the use of renewable energy sources, (h) eco-design requirements for products related to energy, (i) energy efficiency labelling thus indicating energy consumption and other product characteristics which are important for their energy efficiency, (j) conditions for the operation of energy plants, (k) conditions for the performance of energy sector activities as well as (l, m) it regulates the licence and energy permit issue and the bodies performing administrative tasks under this Act. It transposes a number of EC Directives into the law of the Republic of Slovenia, including **Directive 2009/28/EC** (of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC) and **Directive 2010/31/EU** (of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings).

  Note: Energy Act (*Energetski zakon, EZ-1*), which is being under revision (state: Oct 2013), will transpose also **Directive 2012/27/EU** of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending **Directives 2009/125/EC** and **2010/30/EU** and repealing Directives 2004/8/EC and 2006/32/EC.

- Rules on expert training and examination of knowledge for installers of devices using renewable energies (*Pravilnik o strokovnem usposabljanju in preizkusu znanja za inštalaterje naprav na obnovljive vire energije*, Ur. l. RS, 20/2013)
- Regulation on the promotion of efficient energy use and use of renewable energy sources (*Pravilnik o spodbujanju učinkovite rabe energije in rabe obnovljivih virov energije*, Ur.l. RS, 89/2008, 25/2009, 58/2012)
- Rules on feasibility study of alternative energy systems for energy supply in buildings (*Pravilnik o metodologiji izdelave in vsebini študije izvedljivosti alternativnih sistemov za oskrbo stavb z energijo*, Ur.l. RS, 35/2008)
- Rules on efficient use of energy in buildings (*Pravilnik o učinkoviti rabi energije v stavbah*; Ur.l. RS, 93/2008, 47/2009, 52/2010)
- Rules on the methodology of construction and issuance of building energy certificates (*Pravilnik o metodologiji izdelave in izdaji energetskih izkaznic stavb*; Ur.l. RS 77/2009, 93/2012);
- Regulation of methodology and obligatory contents of local energy concepts on the municipality level (*Pravilnik o metodologiji in obveznih vsebinah lokalnih energetskih konceptov*; Ur.l. RS, 74/2009, 3/2011)

- Resolution on the National Energy Programme (*Resolucija o Nacionalnem energetskem programu* /ReNep/), (Ur.l. RS, 57/04)
- Rules on the methods for determination of energy savings at final customers (*Pravilnik o metodah za določanje prihrankov energije pri končnih odjemalcih*; Ur.l. RS, 4/2010, 62/2013)
- Decree on energy savings at end-users (*Uredba o zagotavljanju prihrankov energije pri končnih odjemalcih*, Ur.l. RS, 114/2009, 22/2010-EZ-D, 57/2011)

B) Building standards

- **oSIST prEN 15603:2013** Energy performance of buildings - Overarching standard EPBD (*Energijske lastnosti stavb - Krovni standard za EPBD*) – topics: way of expression Energy Performance and CO2, overall energy use, primary energy, CO2 emissions, Total delivered energy Procedures for calculated and measured energy rating (Note: EPBD - Energy Performance of Buildings Directive 2010/31/EU); **SIST EN 15459:2008** Energy performance of buildings - Economic evaluation procedure for energy systems in buildings (*Grelni sistemi v stavbah - Postopek ekonomskega vrednotenja stavbnih energijskih sistemov*)
- **SIST EN 15217:2007**, Energy performance of buildings - Methods for expressing energy performance and for energy certification of buildings (*Energijske lastnosti stavb - Metode za izražanje lastnosti energije in za certificiranje energije v stavbah*)
- **SIST EN ISO 13790:2008**, Thermal performance of buildings - Calculation of energy use for space heating and cooling (*Energijske lastnosti stavb - Račun rabe energije za ogrevanje in hlajenje prostorov*)
- Standards on heating systems, Heat generation system-Thermal solar system: **SIST EN 15316-4-3:2007** Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-3: Heat generation systems, thermal solar systems (*Grelni sistemi v stavbah - Metoda za preračun energijskih zahtev in učinkovitosti sistema - 4-3. del: Sistemi za ogrevanje prostora, toplotni sončni sistemi*), **SIST EN 15316-4-6:2007** Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-6: Heat generation systems, photovoltaic systems (*Grelni sistemi v stavbah - Metoda za preračun energijskih zahtev in učinkovitosti sistema - 4-6. del: Sistemi za gretje prostora, fotonapetostni sistemi*; (Solar collectors) **oSIST prEN 12975-1:2011** Thermal solar systems and components - Solar collectors - Part 1: General requirements (*Toplotni sončni sistemi in sestavni deli - Sprejemniki sončne energije - 1. del: Splošne zahteve*) SIST EN 12975-2:2006 Thermal solar systems and components - Solar collectors - Part 2: Test methods (*Toplotni sončni sistemi in sestavni deli - Sprejemniki sončne energije - 2. del: Preskusne metode*)
- Standards on AC, ventilation and cooling systems, indoor environment: Air conditioning EN 15240, **SIST EN 15239:2007** Energy performance of buildings - Guidelines for inspection of ventilation systems; Absorption refrigeration and desiccant/evaporative cooling: **SIST EN 15243:2007** Ventilation for buildings - Calculation of room temperatures and of load and energy for buildings with room conditioning systems (*Prezračevanje stavb – Izračun sobne temperature ter obremenitve in energije stavb s sobnim klimatizirnim sistemom*), **SIST EN 13779:2007** Ventilation for non-residential buildings - Performance requirements for ventilation and room-conditioning systems (*Prezračevanje nestanovanjskih stavb - Zahtevane lastnosti za prezračevalne naprave in klimatizirne sisteme*)

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- Standards on lighting (TC169): **SIST EN 15193:2007** Energy performance of buildings - Energy requirements for lighting (*Energijske značilnosti stavb - Energijske zahteve za osvetlitev*)
- Standards on building automation and controls (TC 247): **SIST EN 15232:2012** Energy performance of buildings - Impact of Building Automation, Controls and Building Management (*Energijske lastnosti stavb - Vpliv avtomatizacije stavb in izvršnih elementov ter upravljanja stavb*)
- Standards on inspection (TC 156 & 228) **SIST EN 15378:2007** Heating systems in buildings - Inspection of boilers and heating systems (*Grelni sistemi v stavbah - Nadzor kurilnih naprav in grelnih sistemov*)
- Glass: **SIST EN 410:2011** Glass in building - Determination of luminous and solar characteristics of glazing (*Steklo v gradbeništvu - Določevanje svetlobnih in sončnih karakteristik stekla*)

More detailed list on relevant standards can be found in the Technical Guideline TSG-1-004:2010, TSG-1-004:2010, Efficient Use of Energy (*Učinkovita raba energije*), prepared and issued by the Ministry of Environment and Spatial Planning.

C) Support mechanisms

Public instruments promoting the development of green technologies in SMEs:

- revolving funds providing loans with subsidised interest rate (Eco Fund - Slovenian Environmental Public Fund, Slovenian Regional Development Fund) (general description of the incentive EF-SEPF: soft loans for environmental investments of enterprises to invest in equipment and technology, environmental protection, environmentally friendly technologies and products; general description of the incentive SRDF: soft loans for start-ups in order to promote balanced regional development rural population more uniform, coherent development and increased employment in Slovenia.)
- fund operating as executive agency providing guaranties for SMEs (Slovene Enterprise Fund)
- on-going public calls for investment grants for RES and EE (under the Rural Development Programme of Slovenia for the period 2007 - 2013 and from the sources 'Sustainable Energy' (Trajnostna energija) in the framework of Operational Programme of Environmental and Transport Infrastructure (OP ROPI) /Cohesion/)
- instrument of feed-in tariffs for production of electricity from RES and in high efficient CHP (operated by Borzen)
- national energy efficiency obligation scheme (annual programmes approved by Eco Fund and operated by large scale energy distributors) (General description of incentives: investment subsidy; financial incentives for co-financing specific consultancy services, providing energy savings;

Private instruments promoting the development of green technologies in SMEs:

- several credit lines, programmes of financing of investments and expenditures in the field of innovation activity, green technology and financing of environmental investments developed under the SID (Slovenian Investment and Development) bank in cooperation with private commercial banks
- programmes financed from KfW source and Euro bonds

Other supporting services:

In Slovenia there is a number of companies identified providing supporting services for SMEs in the field of energy efficiency, renewable energy services and innovations (e.g. regional development agencies, Chamber of Commerce and Industry of Slovenia, Chamber of Craft and Small Business of Slovenia, university research centres and national research institutes).

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2. General review of tertiary sector buildings

2.1. General description of the current status of buildings

With an average density of 98 inhabitants per km2 Slovenia ranks amongst the relatively densely populated countries in Central Europe. Slovenia is characterized by moderate urbanization rate (about 65 percent), moderate concentration of population in urban areas (about 50 percent), above-average concentration of population in the suburban areas (12% of the territory is inhabited by 2/3 of the population with over 75% of working places), reflecting the uneven distribution of population throughout the territory of Slovenia. Cities and other urban areas are employment centres, more than 90% of jobs are found in about 500 settlements (about 8% of total).

In Slovenia moderate climate with distinct seasons is dominated. Summer temperatures above 30°C and winter temperatures below -10°C last only a short time. The greatest impact to the favourable environment have moderate latitudes (45°) as well as air currents from the warm Adriatic Sea, large landmasses of North Africa and Euro-Asia in the northeast.

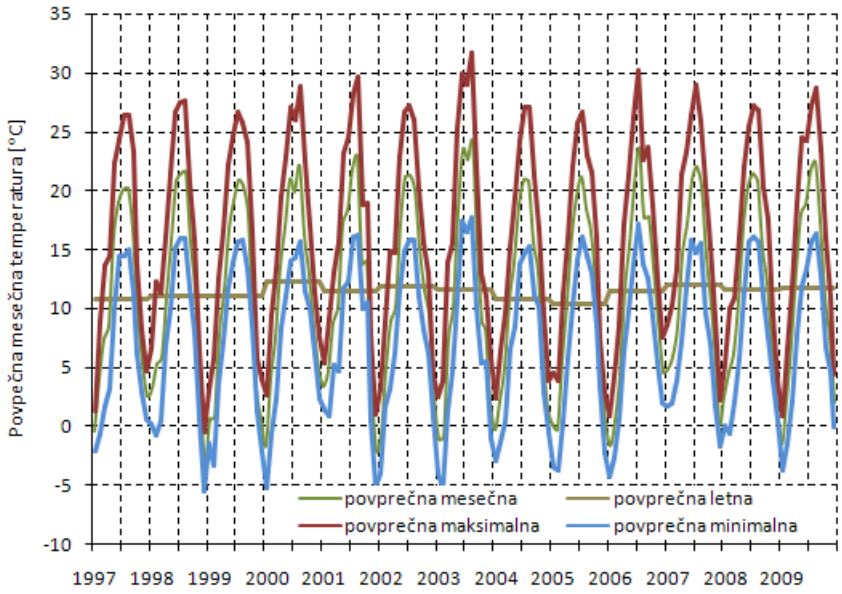

Figure 1: Average monthly air temperature, monthly average daily maximum and monthly average minimum daily air temperatures, meteorological (Source: ARSO, 2010)

Heating/cooling degree days

- Heating degree days, base 18°C (2011): 2638; (average 1996-2000: 2752)
- Heating Degree Days – Monthly (2012) (source Eurostat - data compiled on the basis of DG Energy reports) - see Table 1

Table 1: Heating Degree Days in 2012

	Jan.12	Feb.12	Mar.12	Apr.12	May12	June12	July12	Aug.12	Sep.12	Oct.12	Nov.12	Dec.12	Year 2012
SLO	531.4	592.7	292.9	221.9	90.2	6.0	2.6	1.0	51.1	201.3	297.0	543.7	2.831.8
EU-27	537.5	584.4	367.5	308.3	156.6	86.8	41.5	45.5	118.4	254.7	358.8	560.2	3.420.0

- Long term average degree days, base 18°C: 2839

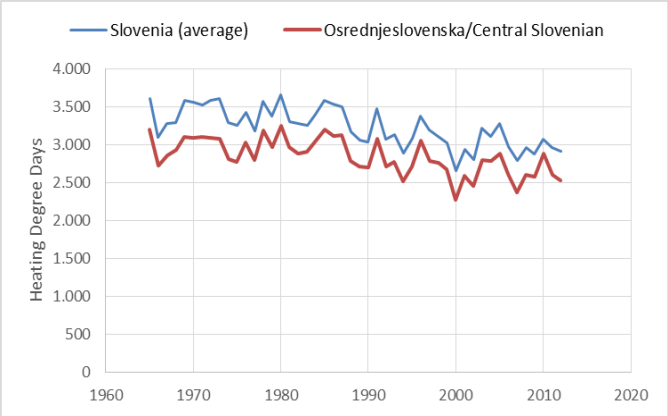

Figure 2: The annual heating degree days – Slovenian average and Central Slovenian (Ljubljana)

Meteorological indicator for the use of heat for buildings degree is a number of annual heating degree days. A number of cooling degree day is a measure of the energy consumption of buildings for cooling. It is the annual sum of the daily differences between the average daily air temperature and the temperature threshold (18°C or 21°C or 23°C) for those days when the average daily air temperature is higher than the temperature threshold.

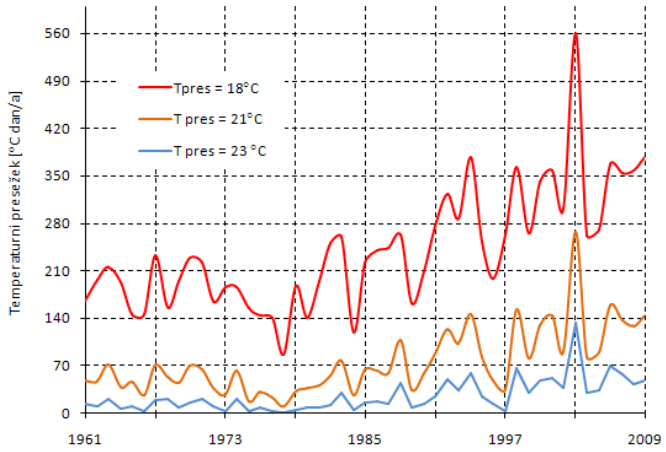

Figure 3: Annual excess temperature set different temperature thresholds (Source: ARSO, 2010)

Values of other influential meteorological parameters - wind speed and precipitation do not show significant deviations from the long-term average.

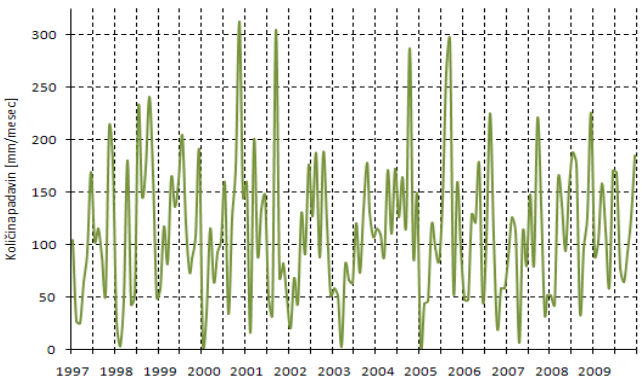

Figure 4: Monthly rainfall (Source: ARSO, 2010)

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The average solar irradiation of horizontal surface in Slovenia is higher than 1000 kWh/m2. The ten-year average of the annual global radiation in the period between 1993 and 2003 ranges between 1053 and 1389 kWh/m2 (Figure), where more than a half of Slovenia receives between 1153 and 1261 kWh/m2. Daily values of global irradiation are much higher in summer (generally about 700 MJ/m2 per month) than in winter (even less than 100 MJ/m2 per month). Geographical differences can be significant: sites with more solar irradiation can be found in Primorska region, a wider range of northern Dolenjska, Posavje and Kozjansko region as well lowlands next to the Drava and in Prekmurje region. In summer, it is systematically less solar energy in mountainous areas, since then, there often appears convective cloudiness. As expected, the lowlands have relatively less sun in the winter, mainly due to increased frequency of fog and low clouds.

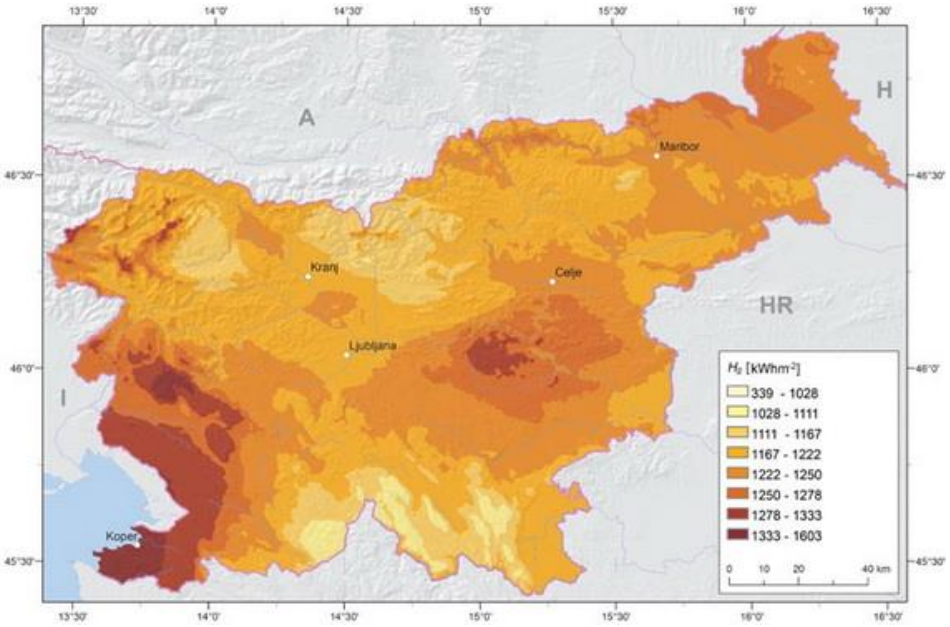

Figure 5: Annual global radiation on a horizontal surface in Slovenia (Source: D. Kastelec, J. Rakovec, K. Zakšek, Sončna energija v Sloveniji, ZRC SAZU, 2007, str. 76)

The use of wind energy in Slovenia is very limited mainly due to small number of days with a sufficiently strong local winds and high local variability of its speed and direction. The maximum wind speed takes place in spring and autumn, for most places in Slovenia wind speeds are between 1 to 3 m/s, which in general is insufficient for the exploitation of wind energy. Only in the higher (mountain) areas and along the coast the average monthly wind speeds are reaching values between 3.5 and 7.5 m/s. The number of days when the wind force exceeds 6 Bf (10.8 to 13.8 m/s) is as well generally low. Slovenia as a whole has an annual average of 43 days when the wind force exceeds 6 Bf and only 10 days exceeding a speed of 8 Bf. So far in Slovenia there has been set up only one wind power plant (in Dolenja vas), a larger wind park is planned nearby, in Senožeška Brda, which belong to the region where the construction of wind power plants is most suitable in Slovenia.

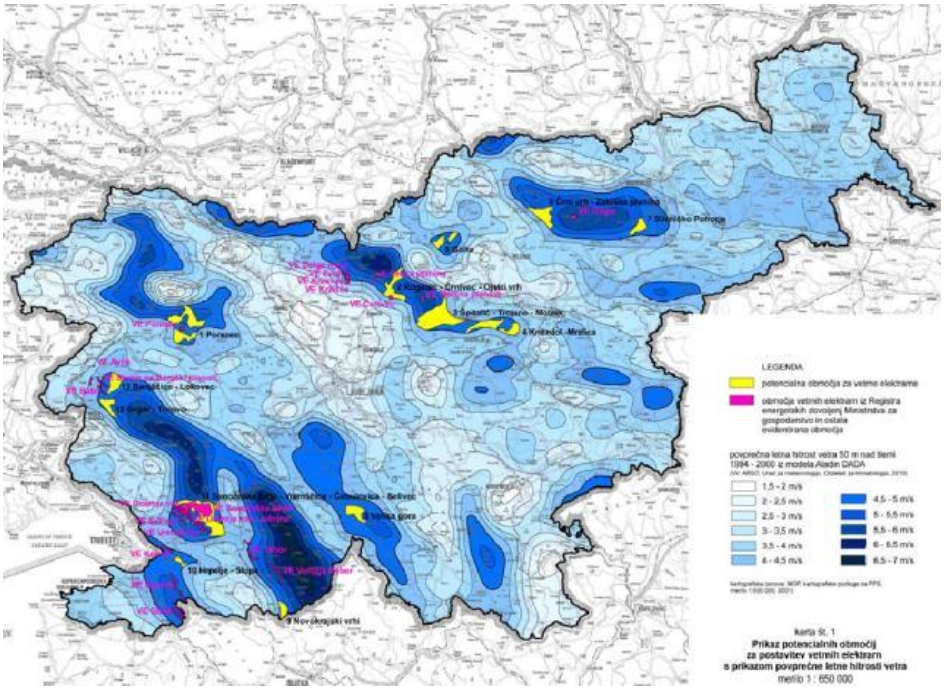

Figure 6: Areas with potential for construction of wind farms and the annual average wind speed

2.1.1. Identification of regional buildings specifics

In Slovenia, in the period between 1955 and 2005 the following building stock has been constructed:

- Residential buildings with an area of approximately 62 million m2
- Business and other buildings with an area of approximately 22 million m2
- Industrial buildings with an area of approximately 10 million m2.

Physical aspects - thermal insulation

Energy consumption in buildings is affected by the size and shape of the building and method of construction. In the absence of statistical data on the actual energy conditions of buildings (building energy card mostly not available) the analysis rely on the period of construction of the building. There is an assumption that the thermal properties of the building are determined by the applicable building standards in a given period.

In the past the legislation regarding thermal insulation was very mild. An important impact had also lack of resources and awareness of payback construction works (related mainly to thermal insulation) and insufficient communication between owners and managers of buildings. Consequently there were many cases where inappropriate decisions and interventions such as replacement of windows with inadequate energy glazing, facade restoration without the installation of thermal insulation could be found.

Buildings in Slovenia built before 1980 are considerable energy consumers because of the poor thermal insulation of the building envelope and therefore offer immense energy saving potential.

The first post-war apartment buildings were erected as clay-brick buildings, built with massive bricks and later with hollow bricks. Buildings from early post war period were built without thermal insulation. The situation was slightly improved after 1967 when new regulations defining minimum requirements of thermal insulation performance of the building envelope came into force. The

performance requirements became harsher in 1970 (outer wall U value 1.2 W/m2K) which had a positive effect upon the thermal insulation installed in the envelopes of the buildings erected after that year.

Table 2: Typical construction technologies

Construction period	Characteristics / standard technology
before the year 1945	Buildings are solid built. The outer walls are solid bricks, thickness >38 cm + plaster layer, often wooden ceilings, wooden windows (mainly casing) with simple glazing. Walls, ceilings, roofs and attics are not insulated or when roofs have been restored they are insulated by insufficient insulation.
post-war period until the seventies (1945 – 1970)	Mostly of poor or at least of the same quality as buildings built before 1945, this is mainly due to a lack of appropriate building materials and its savings. The walls with the implementation of modular bricks or made of cast concrete were thinned down to a thickness of 30 cm, often without or with insufficient insulation. This building stock is essential for energy improvement.
1971 - 1980	Buildings constructed with typically approx. 5 cm insulation of walls, ceilings and roofs. Wooden windows with bound casement and mainly with simple glazing.
1980 - 1990	A period of intensive construction, which involved more supervision regarding the quality. The construction is solid, with an extra layer of insulation (walls - up to 8 cm, roofs - up to 12 cm), either skeletal filled with brick façade, rather common material is concrete. Windows with bound casement.
After 1990	The construction becomes rather diverse, lower growth intensity of concrete construction. Improved materials appear on the market (bricks with higher thicknesses and construction materials with improved insulation). More care is taken to exposition to thermal bridges, the share heat insulated components noticeably increased. Buildings are, on average, solid insulated (by 2000: walls – up to 10 cm, roof ceilings – 12-20 cm, after 2000 the average insulation increased for about 5-7 cm) and the windows (in wooden, plastic or aluminium framing) have a two-layer thermopane glass with k=1.3-1.6 W/m2K.

Table 3: Typical insulation values of main construction parts

	Insulation U-Value in W/(m^{2}K)			
period	wall	floor	roof	window
- 1971	1.4	1.2	1.1	2.4
1971 - 1980	1.4	0.9	0.9	2.1
1981 - 2002	0.9	0.8	0.8	1.6
2003 - 2008	0.6	0.45	0.5	1.6
2008 -	0.3	0.2	0.2	1.3

The first more restrictive thermal insulation regulation (outer wall U value 0.8 W/m2K) was put into force in 1980. Since the current situation in building practice in Slovenia may differ from the ideally expected one, i.e. because of the lack of money for finishing the construction (private investors) or insufficient control of building regulation implementation, some relevant data on building envelope insulation rate were collected with a pole in a relevant statistic sample. In general it can be observed that in 60% of the buildings outer wall U value exceeds 1.0 W/m2K. Following the construction period of the buildings from the random sample in the pole one can conclude that poorly insulated buildings ratio is not considerably reduced until 1980, when implementation of rigorous building insulation regulations should intensively reduce proportion of buildings with U > 1.0 W/m2K and increase the

number of buildings with lower outer wall U value. The obtained results may be discouraging. Nearly one third of buildings erected between 1980 and 1989 still have U value higher than 1.0 W/m2K. Detected energy saving potential is now being realised by raising awareness, state subsidies and by making energy efficiency investments interesting for private investors.

The survey on energy efficiency in Slovenia in tertiary sector, published in November 2013, reveals that 29% of organizations do not have insulated facades, the majority of them (55%) in the sector of public administration. In a quarter of buildings the insulation thickness of the façade is up to 10 cm and in 16% of the sector above 10 cm. The insulation has been installed on a quarter of buildings, about one half of this between 2000 and 2007 and 41% after 2008. Very similar shares apply to renovation of windows: 28% of buildings have restored windows, 46% of them after 2008 and 45% in the period 2000-2007. In 60% of the sector windows have not been changed. Less than a half (46%) of them is under 20 years old, one third (34%) is 20 years or older. Most common are single windows with double-layer energy-efficient glazing (about a third of organizations), followed by casing double-glazed windows (17%) and single glazed windows with double-layer thermopane (16%).

Insulation of lofts/attics with thickness up to 15 cm is installed in one third of buildings and below 15 cm in about 15%, less than a third (28%) of buildings has got uninsulated attics. Where done, renovation of attics mostly took place between years 2000 and 2007 (47%) and after 2008 (38%).

Insulation of roofs has been installed in about one third of buildings. Where done, insulation has been mostly installed after 2008 (47%) and between years 2000 and 2007 (40%).

2.1.2. Quantification of indicators for key types of buildings

Non-residential buildings account for 27.8% of the total building stock of which 9.3% belongs to the public sector and 18.5% to the services. Baseline data on areas intended for tertiary sector (services and public sector) have been prepared on the basis of data from the Real Estate Register (REN), which was designed on the basis of the real estate inventory. Compared to the residential sector, it comprises a more complex and heterogeneous types of buildings such as offices, hospitals, hotels, restaurants, supermarkets and shops, schools, universities and sports centres. In a number of cases multiple functions exist in the same building. By far the most area is used as office and administrative buildings, followed by the shops, primary schools, hotels and restaurants and buildings for culture and entertainment.

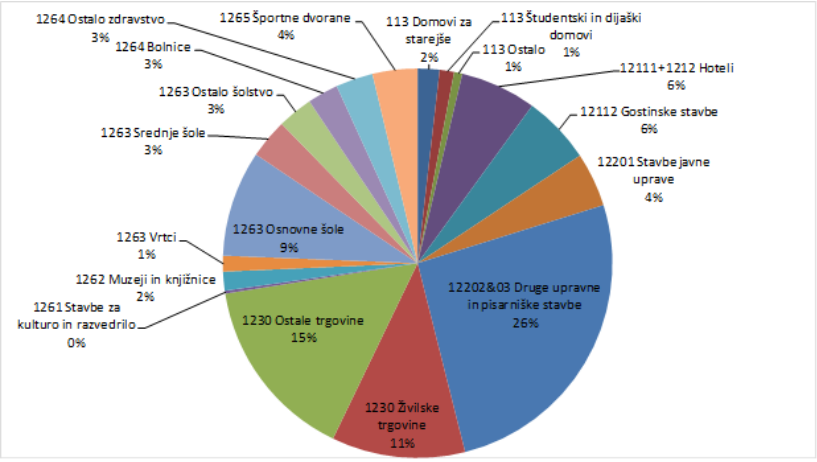

Figure 7: Distribution of areas - services (tertiary) sector by CC-SI classification (2008)

Variations in usage pattern (e.g. warehouses versus schools), energy intensity (e.g. surgery rooms in hospitals versus storage rooms in retail), and construction techniques (e.g. supermarket versus office buildings) are some of the factors adding to the complexity of the sector. The diversity in terms of typology within the non-residential sector is vast. In addition to this, differences are also pronounced within this sector where there is no homogeneity in terms of size, usage pattern (use hours) and construction style. The performance of buildings depends on a number of factors such as the performance of the installed heating system and building envelope, climatic conditions and behaviour characteristics (e.g. typical indoor temperatures).

Table 4: Indicators for key types of buildings (2008)

Type of building	**Indicator**	**Value** [m^2]	**% of total buildings area**
Schools, research, other educational buildings	Area Number of students	3.657.861 343.605	16%
Hospitals, retirement homes other health/social buildings	Area No. of rooms / beds	1.668.740 beds 9586 / patients 367719	7%
Offices, administrative (municipal and other public administrative) buildings	Area	6.813.130	29%
Hotels, restaurants, other tourist buildings	Area No. of rooms / beds	2.685.674 38226 / 97193	11%
Shopping, retail centres	Area	5.923.909	25%
Other			12%

Table 5: Total floor area constructed in various periods (in% of total in 2008)

Period	Schools, educational buildings	Hospitals, retirement homes	Offices, incl. public administrative	Hotels, restaurants	Shopping, retail trade services
-1971	47	40	44	44	20
1971-1980	29	27	26	24	17
1981-2002	19	23	23	25	55
2003-2008	4	10	7	7	8

2.2. Overview of energy consumption

2.2.1. Primary energy sources in Slovenia

Fossil fuels: There were very limited and quantitatively insignificant deposits of natural gas and oil discovered in the northeast (Lendava) of Slovenia, but the sources have been actually depleted. The brown coal mine is located in Trbovlje and the lignite mine in Velenje. Resources are used in local thermal power plants in Trbovlje and Šoštanj (TEŠ). Almost a third of all the electricity produced is obtained from domestic coal.

Hydropower: a quarter of all electricity is obtained from hydropower. Generation of electricity from hydro power plants in Slovenia contributes almost 30% of all the energy produced in Slovenia. Most hydropower plants are positioned on three major Slovenian rivers Sava, Drava, which is most utilized, and Soča. There is more potential available.

Biomass: around 60% of Slovenia is covered by forests. It is considered as underutilized source of energy.

Solar energy: Among the renewable energy sources, solar radiation has a huge potential in Slovenia. Comparing to other European countries, Slovenia ranks among medium-sunny countries. It is estimated that up to 960 GWh of solar potential could be used, whereas less than 5% of this potential is utilized for the production of heat and electricity today.

Wind energy: A large part of Primorska is potentially the most suitable for the utilization of wind energy. More windy areas in our country are normally exposed to higher altitudes, especially mountain ridges. In general this source is untapped but also less important for the region.

Geothermal energy: The total thermal power is about 130 MW. The National Energy Programme of the Republic of Slovenia for the period till 2030 assumes installation of geothermal power plants of 25 MW.

2.2.2. Description of regional specifics of energy use

Electrical energy is most widely used source of energy (89%), followed by the gas, district heating and oil. Compared with the average of the tertiary sector, in hotels and restaurants distribution is slightly different - electricity as the main source is followed by LPG, a significant share is using as well biomass, which is significantly less used in other sectors.

Market analyses show that 6% of consumers would change the supplier should the price of energy products decreased by 5%. Should the price of energy products decreased by 6% to 10% further 23% of organisations would switch the supplier. 17% of organizations would replace the supplier if the price of energy products decreased by 11% to 15% and further 20% of organizations would change the supplier if energy price decreases by more than 15%.

Electrical energy produced from renewable energy sources is purchased by 8% of organizations, further 19% is planning to buy it in the next three years. An annual electricity supply contract is the basis for electricity supply for 18% of organizations, 24% have contracts for a period of two or three years, and 17% for a period longer than three years.

Natural gas is used in 40% of the buildings. Less than one fifth (18%) of organisations has supply contract concluded for a period of one year, 15% for a period of two or three years and 27% for a period longer than three years.

District heating is used in 24% of the buildings. Heating oil is used in 24% of the buildings. LPG is used in 13% of the buildings.

2.2.3. Energy consumption trends in the tertiary sector

In 2010 buildings consumed almost the same amount of total final energy consumption (36%) as transport (38%) and followed by industry (26%).

The average specific energy consumption in the non-residential sector (covering all end-uses) amounts to around 250kWh.

The tertiary sector accounted for 12,5% of total final energy consumption in 2010, which is almost a quarter lower than average of EU-27.

Table 6: Energy consumption share per sector

Sector	2000	2008	2010
Industry	32.1%	28.2%	25.7%
Transport	28.0%	39.2%	36.2%
Residential	25.4%	21.2%	25.5%
Tertiary	14.6%	11.4%	12.5%

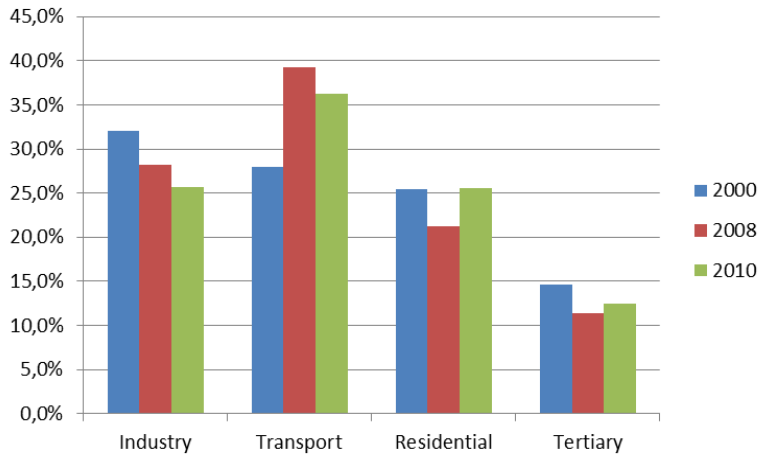

Figure 8: Share of energy consumption by sector

Final energy consumption in the tertiary sector has started to decline during the last years. In 2000 total final energy consumption of the Slovenian tertiary sector was 598 ktoe whereas in 2010 this figure dropped to 545 ktoe and in 2011 slightly increased to 551 ktoe.

Contrary to total final energy consumption or residential energy consumption there is not yet a long term decreasing trend in tertiary energy consumption. The exception was the decrease between 2008 and 2010 which is most likely a result of the financial and economic crisis. Between 1992 and 2011 total energy consumption in the tertiary sector in Slovenia grew by 139% and during the period 2000 to 2011 it decreased by 8%. Energy consumption in the tertiary sector reached its highest level in 2001.

Table 7: Final energy consumption regarding heating types/fuels

[ktoe]	2008	2009	2010	2011	Index 2011/2008
Total final energy consumption	5266	4812	4907	4982	95%
Tertiary sector	516.0	519.3	544.5	550.5	96%
Coal	0	0	0	0	0
Liquid fuels	218.2	211.4	198.5	158.9	73%
Natural gas	11.8	18.1	23.6	39.4	335%
RES (and waste)	1.9	2.1	20.0	19.8	1026%
District heat	16.3	26.9	37.0	42.8	263%
Electricity	267.8	260.8	265.4	289.6	108%

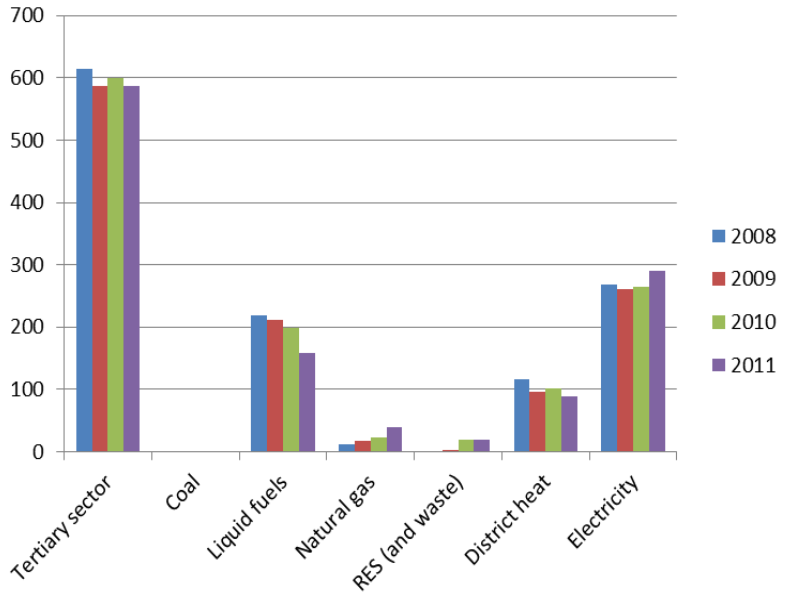

Figure 9: Share of energy consumption regarding heating types/fuels

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

Table 8: Final energy consumption in tertiary sector and share of total energy use per building type (sub sector)

	Total (sub sector) [GWh]	**% (of total sector)**	**Specific energy use [kWh/m^2 a]**
Schools, research, other educational buildings	622	10%	170
Hospitals, retirement homes other health/social buildings	599	10%	359
Offices, administrative (municipal and other public administrative) buildings	1.545	26%	227
Hotels, restaurants, other tourist buildings	655	11%	244
Shopping, retail centres	2.140	36%	361

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3. Energy analysis of building types

3.1. Current energy consumption

General characteristics of use of energy in tertiary sector

The survey of energy use and energy efficiency in the public and service sectors in Slovenia REUS JSS 2013, which was prepared by Informa Echo and published in November 2013 ([A] REUS JSS 2013, *Raziskava energetske učinkovitosti Slovenije v javnem in storitvenem sektorju, Informa Echo, November* 2013; http://www.pozitivnaenergija.si/raziskava), has shown habits of consumption of energy, provided quantified evaluation of certain building energy efficiency indicators and revealed readiness of consumers to introduce measures for increase of energy efficiency.

About 60% of users follow the energy consumption through invoices, only 30% monitor actual energy consumption, the rest is not monitored. In most cases (71%) the consumption is monitored on a monthly basis and in about 13% annually.

Less than 15% of organisations involve external expertise and support for energy management, with exception of schools where this share is doubled.

An operational program for the implementation of measures to reduce energy consumption and /or production of energy from renewable sources has been prepared in about 15% of the tertiary sector.

Less than a half of organizations in the sector are familiar with financial incentives to increase energy efficiency granted by the Eco Fund. This proportion is higher in public administration (59%) and education sector (58%). A quarter of organizations are familiar with financial incentives granted by energy /fuel suppliers. Again this proportion is the highest in public administration (40%).

Opportunities regarding how to reduce energy consumption is communicated to employees through internal courses in about 40%, in about one third of organizations no awareness campaign has been made.

In the next three years about a tenth of organisations in the sector intend to invest in increase of the energy efficiency of commercial premises, in 41% of cases investments are not envisaged.

About two thirds of organisations claim that theyhave a good insight into energy use in their business premises as well as that they are well aware of the energy-saving potential. However, an energy audit that provides a proposal for organizational and investment measures to reduce energy consumption and related costs was carried out in less than a fifth of cases, except in schools where this share reached 37%.

In about 2/3 of cases it is expected that electricity consumption could be reduced between 5% and 15% using organizational and economically viable investment measures. Only 5% of organizations produce electricity by themselves. Among the others there is very limited interest for such supply – only 7% report that it will definitely or very likely be produced in the next three years. Most of them (59%) are considering photovoltaic and 35% are considering cogeneration (CHP).

Heating

The main source of heating is natural gas that is used in one third of organizations, followed by district heating and oil (each about 20%). Heating is mainly central (46%), where heat is generated in one place for the entire building and distributed to heating appliances. Other means are central heating with a connection to the district heating system (18%), storey central heating (12%) and central heating with a connection to a common boiler that supplies heat to several buildings (12%).

Local heating (e.g. electric radiators, gas furnace, air conditioners, solid fuel stove…) applies only to 7% of organizations.

One third of users provide heat (total or main part of it) by a conventional gas boiler, and a quarter by a conventional oil boiler.

Less than half of the users of traditional gas boilers have up to 9 years old boilers, 19% indicate that the age of these boilers ranges from 10 to 14 years, in 16% of cases boilers are aged 15 years or more. One fifth of the traditional oil boilers is aged up to 9 years, age of another fifth ranges from 10 to 14 years, and 40% of boilers are aged 15 years or more.

About 38% of organizations controls heating with thermostatic radiator valves, 29% is using automatic control in dependence on the temperature of the environment air. More than a half (56%) of organizations indicates that the ambient air temperature during the heating period (and working hours) ranges from 21 to 22°C, 17% indicate that the temperature usually ranges from 19 to 20°C and the same ratio (17%) of organizations indicates the temperature of 23°C or more. Outside working hours temperature ranges from 17 to 18°C in about 38% of cases, in 22% of premises the temperature is up to 16°C, the same proportion applies to temperatures of 19 to 20°C, and in 13% of cases temperature is 21°C or more.

Almost a half (48%) of organizations is not planning investments in the heating systems in the next three years, while 30% do not know or is not able to respond. Among the planned investments the most frequent are replacement of heating system (with switching to a different heating source) - reported by 7% of organizations - and the installation of thermostatic valves (6%). The most preferred source of energy (in case of its switching) are natural gas, heat pumps and biomass. The main drivers are fuel prices, simplification of purchase means and environmental awareness.

Ventilation and air-conditioning

Three-quarters of organizations use natural ventilation of the premises (open windows, doors), whereas strictly forced ventilation is used by 22% of the organizations. Of these, in about a half of buildings heat recovery ventilation is installed. In case of forced ventilated spaces, this is mainly carried out according to the set schedule (51%) or at all times equal (28%) and depending on the level of air quality (17%).

About 70% of organisations are air conditioning their premises. In about 63% of these cases a system of local cooling (individual rooms) is installed, a quarter of buildings is covered by a central cooling system for the entire building and in 11% of buildings a central cooling for a part of the building is installed. On average, organizations air condition about 60% of the premises: 7% of them by up to 10% of their premises, a third of them between 10 and 50% of the rooms, almost a third of them 50 to 80% of the space, and a fifth more than 80% of their business premises. More than a half (56%) of those use air conditioners for cooling only and 42% for both cooling as well as heating, 2% use air-conditioning systems for heating only.

Almost a quarter of air conditioners are used when an outdoor temperature is below 25°C, 41% at an outdoor temperature of 25 to 28°C and a third at temperatures above 28°C. The internal ambient

temperature in conditioned rooms is set to 22°C in 23% of cases, while the temperatures between 22 to 25°C are maintained in 61% of premises.

One-tenth of the air conditioners is up to 2 years old, 37% from 3 to 5 years, a third from 6 to 10 years and another tenth more than 10 years. About 14% of organizations intend to install (new) air conditioning in the next three years, while more than a half (58%) most probably not.

External blinds are used in about 60% of the organizations (in the summer), this is mostly used in educational institutions (83%).

Lighting

On average, in 29% of premises energy saving lamps or bulbs are not installed, more than 40% of organizations have less than 10% of area where energy saving lamps are used.

The most common are energy-saving fluorescent lamps (in average they cover 40% of premises), followed by compact fluorescent lamps or energy saving light bulbs (21% of all business premises) and halogen lamps (11% of all business premises), while LED lamps cover only 4% of premises. More than 70% of organizations use manual on/off switching, much more seldom motion sensor or timer switch is installed (in about 15% of cases).

Solutions for natural illumination (e.g. skylights or similar) are implemented solely in about one fifth of premises. Most often this solution is found in educational institutions (34%).

Less than half (47%) of organizations report that they will not invest in measures to increase energy efficiency of lighting over the next three years, almost 30% does not know or is not able to respond. Among the planned measures the most popular is installation of LED light bulbs (12%).

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3.1.1. Primary schools

Short description of the typical primary school building

Age of construction: in average 30-35 years

More than half of schools have specific energy consumption values between 80 and 200 kWh/m2, in a quarter of primary schools this value exceeds 200 kWh/m2.

Share of energy in total costs: 48%

Energy sources used (besides electricity): gas – 39%, district heat – 22%, oil – 39%, LPG – 20%, biomass – 5%, solar – 3%

Main heating sources: gas – 32%, district heat – 21%, oil – 33%, LPG – 4%, biomass – 5%, heat pumps – 2%, electricity – 1%

Picture of typical building

OŠ Slave Klavore, MB

OŠ Franc Rozman Stane, MB

OŠ Milojke Štrukelj, Nova Gorica

Building heating area (m^2)		**4230**			
Energy consumption of the building					
Electricity (MWh)		**97**			
Fuels, district heat, RES (MWh)		**647 (153 kWh/m2)**			
TOTAL (MWh)		**744**			
Specific energy consumption for heating (kWh/m^2)		**137.6**			
Specific electricity consumption (kWh/m^2)		**23**			
	Heating	Cooling (VAC)	Hot water	Lighting	Other
Share in energy consumption [%]	**78.2**	**0.7**	**8.7**	**9.1**	**3.2**

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Remarks on data quality:
Figures on energy consumption are estimated on real sample. The majority of data on energy related systems are provided by extensive survey of energy use and energy efficiency in the public and service sectors in Slovenia REUS JSS 2013 (see 3.1, note A).

Short description of the energy related systems

Envelope

Year of envelope/façades insulation (in case of refurbishment): 2000-2007 – 37%; after 2008 – 60%
Thickness of envelope insulation: uninsulated – 44%, up to 5cm – 12%, 6-10cm – 16%, 11-15cm – 13%, above 15 cm – 9%
Share of replaced windows (reference year - 2013): 33%
Replacement of windows – share of replaced windows per period: 1990-1999 – 5%, 2000-2007 – 26%, after 2008 – 67%
Age of non-replaced windows, in years (reference year - 2013): less than 5 – 14%, 5-19 – 33%, 20-34 – 33%, more than 35 – 26%
Thickness of attics insulation: uninsulated – 28%, up to 5cm – 21%, 6-15cm – 25%, 16-30cm – 20%

HVAC systems

Main heating sources (other than DHC): gas boiler (31%), oil boiler (37%), highly efficient biomass boiler (5%), condensing gas boiler (5%). Average efficiency range: 65-75%
Main means of heating regulation: thermostatic radiator valves (54%), weather compensated hating controls (46%), ambient air temperature regulation with room thermostat (11%), thermostat with the time-preset air temperature regulation (10%)
The share of cooled area (of total): up to 10% (34%), 11-30% (31%), 31-50% (11%), 51-80% (15%), above 80% (7%)
Average age of air conditioning systems: up to 2 years (26%), 3-5 years (49%), 6-10 years (22%), more than 10 years (1%)
External shading: used in 83% of cases
Ventilation installed mainly in kitchens, sport halls and where obligatory - for areas above 1000 m2 (regulated since 2008), AC split systems only in some rooms/areas (e.g. computer room, teacher's staff room)

Energy management status in the buildings

Responsibility of the energy supply and energy management: School management 34%, maintenance service 20%, not dedicated 20%
In the vast majority of cases (66%) energy consumption is monitored for premises as a whole (not per energy consumption sites or users).

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 (2%)	**energy consumption – rarely (37%); cost data – usually (54%)**	**rarely**	**rarely (pilots - only few lately refurbished buildings)**

Potential for energy savings/refurbishment

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other
high	**medium to high (below 30 years old); medium (buildings older than 30 years)**	**high (optimisation, CHP, behaviour…)**	**low (few installations); high potential for initial installation of EE solutions)**	**medium to high**	-

Typical needs for improvement:
- Roof/attics insulation and roofing replacement
- Façade (envelope) insulation
- Central preparation of sanitary hot water
- Replacement of windows
- Installation of thermostatic valves
- Installation of lighting sensors
- Replacement of boilers and heating devices
- Change of the heating source

Potential application of the pilot technologies from EMILIE project

Solar heating & cooling	HVAC optimisation	Energy management	PCM
likely (limited due to seasonal use of building/vacation)	**very applicable**	**very applicable**	**very applicable (large transparent surfaces)**

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Comments: Long list of needs for improvement offers great possibility to use pilot technologies.
Potential introduction of renewable energy sources (RES) in buildings
• **Solar:** likely - thermal (limited due to seasonal use of building/vacation), very applicable – PV • **Biomass:** very applicable (rural area, where no DH/NG network exists) • **Heat pump:** very applicable (rural area, where no DH/NG network exists; linked with building energy retrofit) • **Geothermal:** limited potential (only some specific regions)

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3.1.2. Hospitals

Short description of the typical hospital building	Picture of typical building
Age of construction: in average 30-40 years Size: average 10000 – 40000 m2 Current status: Total number in region: 25 (most important) The most common loss of energy occurrence: insulation of the building envelope and systems for heat transfer, efficiency of facilities for the production of heating and cooling medium and lighting systems. In parts where buildings were not improved specific energy consumption values easily reach values of 550 kWh/m2. Climatic conditions in some regions (e.g. coastal) require air-conditioning of work spaces and patient rooms over a longer time period than in the mainland, hence ratio between costs for cooling, dehumidification and air-conditioning and costs of heating is also much dependent on the region.	 General Hospital, Novo mesto  General Hospital, Celje
Building heating area (m^2)	**27000**
Energy consumption of the building	

Electricity (MWh)		**4266**			
Fuels, district heat, RES (MWh)		**11022 (408 kWh/m2)**			
TOTAL (MWh)		**15288**			
Specific energy consumption for heating (kWh/m^2)		**137.6**			
Specific electricity consumption (kWh/m^2)		**158**			
	Heating	Cooling (VAC)	Hot water	Lighting	Other
Share in energy consumption [%]	**57.7**	**5.7**	**14.4**	**6.1**	**16.1**

Remarks on data quality:
Figures on energy consumption are estimated on real sample. Hospitals were not a part of the survey of energy use and energy efficiency in the public and service sectors in Slovenia REUS JSS 2013 (see 3.1, note A), quantification of data is limited due to small and rather diverse sample.

Short description of the energy related systems

Envelope

Insulation of walls, roof/attics

- before 1975: almost no insulation (by now about 50% refurbished with insulation according to the state of the art standards)
- 1975 – 2000: up to 10 cm on the roof/attics + 5 cm envelope
- from 2000 on: insulation according to EE standards; situation in 2008: 50-60% non-insulated; 12 hospitals refurbished according to EE standards

Example of refurbishment in General Hospital, Novo mesto (envelope before /left/ and after /right/ improvement):


HVAC systems:

- mainly high temperature heating (heating oil), efficiency max. 65-75%
- where refurbished - HVAC systems were improved; in other cases: mainly AC split systems or old central cooling/ventilation (surgery blocks, intensive treatment)

Energy management status in the buildings:
Responsibility of the energy supply and energy management: ???

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)
Rarely	**energy consumption - rarely; cost data - usually**	**rarely**	**rarely (where refurbished, about half of them)**

Potential for energy savings/refurbishment

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other
high	**medium (in older and not refurbished buildings)**	**high (in older and not refurbished buildings)**	**high (in older and not refurbished buildings; high potential for initial installation of EE solutions)**	**high (in buildings which were not refurbished yet)**	-

Typical needs for improvement:

- Insulation of façades and replacement of windows and doors

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- Optimisation of heating/cooling systems (particularly for improvement of living standards in patient rooms) - ceiling radiation cooling instead of convective systems
- Installation of waste heat recovery (e.g. waste heat generated in rooms with large internal gains - spaces with computer servers or major medical devices)
- Modernisation (higher energy efficiency) of HVAC systems
- Installation of an adjustable speed / frequency regulation of ventilation
- Measurement of energy consumption
- Installation of EE lighting systems, lighting sensors / automation and integration with shading systems
- Installation of heat pumps and systems for the utilization of solar energy (RES)
- Establishment of a central supervisory-control system

Potential application of the pilot technologies from EMILIE project
(Rate: very applicable, likely applicable, not applicable)

Solar heating & cooling	HVAC optimisation	Energy management	PCM
very applicable	**very applicable**	**very applicable**	**very applicable (depending on orientation of the building)**

Comments:

Potential introduction of renewable energy sources (RES) in buildings
(Specify: solar, biomass, heat pump…)
(Rate: very applicable, likely applicable, not applicable)

- **Solar:** very applicable (thermal and PV)
- **Biomass:** likely applicable (healthcare in rural area)
- **Heat pump:** likely applicable (particularly for smaller systems); waste heat recovery
- **Geothermal:** limited potential (only some specific regions)

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3.1.3. Public administrative buildings

Short description of the typical public administrative building Age of construction: very diverse About 1/10 of public buildings meets the general criteria of energy efficiency (80 kWh/m2a) and almost half of buildings exceed twice this value. Buildings which meet the latest criteria of energy efficiency (40 kWh/m2a) are very rare. Comparing to other subsectors, there is a small proportion of renewable energy sources. **Share of energy in total costs**: 35% **Energy sources used** (besides electricity): gas – 39%, district heat – 30%, oil – 25%, LPG – 5%, biomass – 3%, solar – 1% **Main heating sources**: gas – 27%, district heat – 30%, oil – 27%, LPG – 6%, biomass – 3%, electricity – 4%	Picture of typical building  Municipality building, Domžale  Ministry of Finance / Durs, Ljubljana
Building heating area (m^2)	**2100**
Energy consumption of the building	

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Electricity (MWh)		**126**			
Fuels, district heat, RES (MWh)		**311 (148 kWh/m2)**			
TOTAL (MWh)		**437**			
Specific energy consumption for heating (kWh/m^2)		**142.3**			
Specific electricity consumption (kWh/m^2)		**60**			
	Heating	Cooling (VAC)	Hot water	Lighting	Other
Share in energy consumption [%]	**68.3**	**7.2**	**2.8**	**10.1**	**11.5**

Remarks on data quality:
Figures on energy consumption are estimated on real sample. The majority of data on energy related systems are provided by extensive survey of energy use and energy efficiency in the public and service sectors in Slovenia REUS JSS 2013 (see 3.1, note A).

Short description of the energy related systems

Envelope

Year of envelope/façades insulation (in case of refurbishment): 1990-1999 – 15%, 2000-2007 – 42%, after 2008 – 26%
Thickness of envelope insulation: uninsulated – 64%, up to 5cm – 12%, 6-10cm –8%, 11-15cm – 12%
Share of replaced windows (reference year - 2013): 28%
Replacement of windows – share of replaced windows per period: 1990-1999 – 9%, 2000-2007 – 46%, after 2008 –47%
Age of non-replaced windows, in years (reference year - 2013): less than 5 – 3%, 5-19 – 23%, 20-34 – 31%, more than 35 – 38%
Thickness of attics insulation: uninsulated – 50%, up to 5cm – 11%, 6-15cm – 21%, 16-30cm – 14%

HVAC systems

Main heating sources (other than DHC): gas boiler (32%), oil boiler (40%), highly efficient biomass boiler (1%), condensing gas boiler (7%). Average efficiency range: 65-75%
Main means of heating regulation: thermostatic radiator valves (40%), weather compensated hating controls (driven according to the atmosphere air temperature)(29%), ambient air temperature regulation with room thermostat (15%), thermostat with the time-preset air temperature regulation (13%)
The share of cooled area (of total): up to 10% (1%), 11-30% (19%), 31-50% (19%), 51-80% (34%), above 80% (18%)
Average age of air conditioning systems: up to 2 years (2%), 3-5 years (42%), 6-10 years (42%), more than 10 years (8%)
External shading: used in 73% of cases
In older non-refurbished buildings usually only some local split systems are installed. Medium age (20-30 years old) buildings have often a combination of central ventilation (usually in bad condition) and split systems. New buildings are usually equipped with complete and modern HVAC solutions.

Energy management status in the buildings

Responsibility of the energy supply and energy management: organization management 25%, maintenance service 16%, not dedicated 30%
In the vast majority of cases (74%) energy consumption is monitored for premises as a whole (not per energy consumption sites or users). Other quantified data are specified in the table below.

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)
Rarely (6%)	energy consumption (23%) - rarely; cost data – usually (68%)	rarely	rarely

Potential for energy savings/refurbishment
(Rate: high, medium, low)

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other
high (medium to low in protected Cultural Heritage buildings)	**high (in older and not refurbished buildings)**	**high (in older and not refurbished buildings)**	**high (in older and not refurbished buildings; high potential for initial installation of EE solutions)**	**high (in buildings which were not refurbished yet)**	

Typical needs for improvement:
- Insulation of façades, replacement of windows (in older buildings also roof/attics insulation)
- Optimisation of heating/cooling systems and installation of thermostatic valves
- Modernisation (higher energy efficiency) of HVAC systems
- Installation of EE lighting systems, lightning sensors / automation and integration with shading systems

- Change of the heating source
- Measurement of energy consumption
- Establish building energy management system
- Awareness campaign among employees

Potential application of the pilot technologies from EMILIE project
(Rate: very applicable, likely applicable, not applicable)

Solar heating & cooling	HVAC optimisation	Energy management	PCM
very applicable	**very applicable**	**very applicable**	**very applicable (depending on orientation of the building)**

Comments:

Potential introduction of renewable energy sources (RES) in buildings
(Specify: solar, biomass, heat pump…)
(Rate: very applicable, likely applicable, not applicable)

- **Solar:** very applicable (PV, thermal mostly for cooling purpose)
- **Biomass:** very applicable (rural area, where no DH/NG network exists)
- **Heat pump:** very applicable (rural area, where no DH/NG network exists; linked with building energy retrofit)
- **Geothermal:** limited potential (only some specific regions)

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3.1.4. Hotels

Short description of the typical hotel building Age of construction: very diverse (from old heritage buildings to modern new constructions) **Share of energy in total costs**: 50% **Energy sources used (besides electricity)**: gas – 30%, district heat – 17%, oil – 32%, LPG – 39%, biomass – 30%, solar – 9% **Main heating sources**: gas – 14%, district heat – 13%, oil – 23%, LPG – 6%, biomass – 25%, heat pumps – 2%, electricity – 14%	Picture of typical building  City hotel, Ljubljana
Building heating area (m^2)	**1800**

Energy consumption of the building					
Electricity (MWh)	**173**				
Fuels, district heat, RES (MWh)	**256 (142 kWh/m2)**				
TOTAL (MWh)	**429**				
Specific energy consumption for heating (kWh/m^2)	**116.7**				
Specific electricity consumption (kWh/m^2)	**96**				
	Heating	Cooling (VAC)	Hot water	Lighting	Other
Share in energy consumption [%]	**48.9**	**7.5**	**10.7**	**18.0**	**14.8**

Remarks on data quality:
Figures on energy consumption are estimated on real sample. The majority of data on energy related systems are provided by extensive survey of energy use and energy efficiency in the public and service sectors in Slovenia REUS JSS 2013 (see 3.1, note A).

Short description of the energy related systems

Envelope

Year of envelope/façades insulation (in case of refurbishment): 1990-1999 – 22%, 2000-2007 – 28%, after 2008 – 40%
Thickness of envelope insulation: uninsulated – 40%, up to 5cm – 18%, 6-10cm – 28%, 11-15cm – 12%, above 15 cm – 5%
Share of replaced windows (reference year - 2013): 35%
Replacement of windows – share of replaced windows per period: 1990-1999 – 16%, 2000-2007 – 35%, after 2008 – 49%
Age of non-replaced windows, in years (reference year - 2013): less than 5 – 6%, 5-19 – 50%, 20-34 – 25%, more than 35 – 12%
Thickness of attics insulation: uninsulated – 30%, up to 5cm – 15%, 6-15cm – 34%, 16-30cm – 21%

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HVAC systems

Main heating sources (other than DHC): gas boiler (19%), oil boiler (25%), highly efficient biomass boiler (10%), heat pumps (6%), condensing gas boiler (1%)

Main means of heating regulation: thermostatic radiator valves (32%), weather compensated hating controls (driven according to the atmosphere air temperature) (23%), ambient air temperature regulation with room thermostat (31%), thermostat with the time-preset air temperature regulation (18%)

Forced ventilation: according to the set schedule (51%), at all times equal (12%), according to the air quality (35%)

The share of cooled area (of total): up to 10% (4%), 11-30% (5%), 31-50% (22%), 51-80% (33%), above 80% (21%)

Average age of air conditioning systems: up to 2 years (15%), 3-5 years (33%), 6-10 years (30%), more than 10 years (17%)

External shading: used in 57% of cases

Energy management status in the buildings

Responsibility of the energy supply and energy management: hotel management 34%, owner of the building 20%, not dedicated 20%

Energy consumption is mainly (69%) monitored for premises as a whole (not per energy consumption sites or users).

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)
Rarely (4%)	**energy consumption – rarely (41%); cost data – usually (55%)**	**rarely (usually in SPA centres)**	**usually (where refurbished or in a new centres)**

Potential for energy savings/refurbishment

(Rate: high, medium, low)

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other
high (medium to low in protected Cultural Heritage buildings)	**high (in older and not refurbished buildings)**	**high (in older and not refurbished buildings)**	**high (in older and not refurbished buildings)**	**high (in buildings which were not refurbished yet)**	

Typical needs for improvement:

- Insulation of façades, fitting secondary glazing, replacement of windows
- Optimisation of heating/cooling systems and installation of thermostatic valves
- Modernisation (higher energy efficiency) of HVAC systems
- Installation of efficient heat exchangers and heat recovery systems
- Use of low-carbon electricity and thermal energy supply (e.g. heat-pump system and gas-fired CHP) for water, pool and space heating
- Installation of EE lighting systems in guest rooms, lighting sensors / automation / control system of corridor and hallways lights
- Maximise use of natural daylight and zoned, daylight controlled, low energy lighting
- Measurement of energy consumption
- Establishment of a central building energy management system

Potential application of the pilot technologies from EMILIE project

(Rate: very applicable, likely applicable, not applicable)

Solar heating & cooling	HVAC optimisation	Energy management	PCM
very applicable	**very applicable**	**very applicable**	**very applicable (depending on orientation of the building)**

Comments:

Potential introduction of renewable energy sources (RES) in buildings

(Specify: solar, biomass, heat pump…)

(Rate: very applicable, likely applicable, not applicable)

- **Solar:** very applicable
- **Biomass:** very applicable (rural area, where no DH/NG network exists)
- **Heat pump:** very applicable (rural area, where no DH/NG network exists; linked with building energy retrofit)
- **Geothermal:** limited potential (only some specific regions)

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3.1.5. Retail (shopping) centres

Short description of the typical shopping centre building

Most shopping centres in Slovenia have between 7 – 10 thousand m2 of shopping area, in small and medium size cities the area varies between 3 and 5 thousand m2. There are 10 shopping centres with area above 20 thousand m2. Typical shopping centre area is dedicated 25-35% to food/household and the rest to other sales program.

Share of energy in total costs: 36%

Energy sources used (besides electricity): gas – 41%, district heat – 23%, oil – 18%, LPG – 6%, biomass – 8%, solar – 5%

Main heating sources: gas – 36%, district heat – 17%, oil – 17%, LPG – 3%, biomass – 8%, heat pumps – 3%, electricity – 11%

Picture of typical building

City Center, Celje

Shopping centre, Velenje

Shopping centre, Ptuj

Building heating area (m^2)		**9500**			
Energy consumption of the building					
Electricity (MWh)		**2255**			
Fuels, district heat, RES (MWh)		**1048 (110 kWh/m2)**			
TOTAL (MWh)		**3303**			
Specific energy consumption for heating (kWh/m^2)		**104.8**			
Specific electricity consumption (kWh/m^2)		**237**			
	Heating	Cooling (VAC)	Hot water	Lighting	Other
Share in energy consumption [%]	**30.2**	**11.5**	**1.6**	**36.0**	**20.8**

Remarks on data quality:
Figures on energy consumption are estimated on real sample. The majority of data on energy related systems are provided by extensive survey of energy use and energy efficiency in the public and service sectors in Slovenia REUS JSS 2013 (see 3.1, note A).

Short description of the energy related systems

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Envelope

Year of envelope/façades insulation (in case of refurbishment): 1990-1999 – 10%, 2000-2007 – 39%, after 2008 – 45%
Thickness of envelope insulation: uninsulated – 30%, up to 5cm – 11%, 6-10cm – 25%, 11-15cm – 18%, above 15 cm – 4%
Share of replaced windows (reference year - 2013): 30%
Replacement of windows – share of replaced windows per period: 1990-1999 – 8%, 2000-2007 – 50%, after 2008 – 42%
Age of non-replaced windows, in years (reference year - 2013): less than 5 – 13%, 5-19 – 45%, 20-34 – 20%, more than 35 - 14
Thickness of attics insulation: uninsulated – 25%, up to 5cm – 18%, 6-15cm – 31%, 16-30cm – 18%

HVAC systems

Main heating sources (other than DHC): gas boiler (41%), oil boiler (21%), highly efficient biomass boiler (10%), condensing gas boiler (2%)
Main means of heating regulation: thermostatic radiator valves (30%), weather compensated hating controls (driven according to the atmosphere air temperature) (26%), ambient air temperature regulation with room thermostat (17%), thermostat with the time-preset air temperature regulation (22%)
Forced ventilation: according to the set schedule (53%), at all times equal (28%), according to the air quality (12%)
The share cooled area (of total): up to 10% (5%), 11-30% (14%), 31-50% (19%), 51-80% (30%), above 80% (20%)
Average age of air conditioning systems: up to 2 years (7%), 3-5 years (44%), 6-10 years (29%), more than 10 years (10%)
External shading: used in 41% of cases

Energy management status in the buildings

Responsibility of energy supply and energy management: centre management 36%, owner of the building 17%, maintenance service 17%, not dedicated 12%
Energy consumption is in the majority of cases (72%) monitored for premises as a whole (not per energy consumption sites or users).

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)
Rarely (9%)	**energy consumption – rarely (27%); cost data – usually (60%)**	**rarely**	**rarely (where refurbished or in a new centres)**

Potential for energy savings/refurbishment
(Rate: high, medium, low)

Envelope insulation	Windows replacement	Heating	Cooling (VAC)	Lighting	Other
high (in buildings which were not refurbished yet)	**high (in older and not refurbished buildings)**	**high (in older and not refurbished buildings)**	**high (in older and not refurbished buildings)**	**high (in buildings which were not refurbished yet)**	**-**

Typical needs for improvement:

- Installation of EE lighting systems and maximise use of natural daylight
- Optimisation of heating/cooling (matching HVAC system operating hours with the times when heating, ventilation and cooling are required; a gap or 'dead-band' between heating and air conditioning control temperatures is set to avoid them operating at the same time)
- Modernisation of air handling and chiller systems combining natural ventilation and free cooling
- Insulation of roof (and façades)
- Installation of heat recovery systems
- Installation of low-carbon electricity and thermal energy supply for space heating (e.g. heat-pump system, gas-fired CHP, solar thermal)
- Maintaining correct refrigeration temperatures and avoiding over-cooling (food retail)
- Measurement of energy consumption
- Establishment of a building energy management-controlling system

Potential application of the pilot technologies from EMILIE project
(Rate: very applicable, likely applicable, not applicable)

Solar heating & cooling	HVAC optimisation	Energy management	PCM
very applicable	**very applicable**	**very applicable**	**very applicable (depending on orientation of the building)**

Comments:

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Potential introduction of renewable energy sources (RES) in buildings *(Specify: solar, biomass, heat pump…)* *(Rate: very applicable, likely applicable, not applicable)*
• **Solar:** very applicable • **Biomass:** very applicable (rural area, where no DH/NG network exists) • **Heat pump:** very applicable (rural area, where no DH/NG network exists; linked with building energy retrofit) • **Geothermal:** limited potential (only some specific regions)

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3.2. Assessment of diverse technologies effects on the supply chain

The development and use of energy-efficient systems and technologies for air conditioning is inextricably linked to the construction sector, which is increasingly focused on ensuring sustainable development. Exploitation of solar energy - both for heating purposes, as well as producing electricity - as well as innovative solutions for ventilation and air conditioning are getting more and more attractive. Certain potential represent air conditioners with heat recovery, as well as solutions that make use of solar energy for space cooling.

Technologies with potential of production and installation in the local market:

- photovoltaic modules,
- solar thermal modules,
- air conduit (ventilation) systems,
- highly efficient water heating,
- thermal energy storage buffers with regulation,
- air filtration,
- ventilation with heat recovery.

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

The basic framework of the promotion of environmentally friendly ('green') technologies for Slovenia is given in strategic documents such as the National Environment Protection Action Programme (Nacionalni program varstva okolja), Operational programme of environmental and transport infrastructure development (Operativni program razvoja okoljske in prometne infrastructure), National efficiency energy action plan for the period 2008-2016 (Nacionalni akcijski načrt za energetsko učinkovitost za obdobje 2008-2016) and Resolution on the National Energy Programme (Resolucija o nacionalnem energetskem programu).

The main areas of promotion of sustainable use of energy and increased use of renewable energy sources are:

- energy improvement and sustainable construction of buildings: energy-efficient remediation of existing buildings (energy-saving building restoration) in the public sector, the construction of low-energy and passive buildings in the public sector, the use of modern technologies for heating, ventilation and air conditioning of buildings and eco-friendly decentralized energy supply systems with a focus on renewable energy sources and cogeneration;
- efficient use of electricity: implementation of measures in the industry, public and service sectors;
- innovative systems for local energy supply: greater individual systems and remote and joint systems for the production of heat and electricity with an emphasis on renewable energy sources and cogeneration;
- demonstration and pilot projects and programs of energy advisory, information and training of energy consumers, potential investors, energy service providers and other target groups.

Energy restoration and sustainable construction of buildings

The best time to introduce energy and carbon dioxide saving measures is when specifying, designing and/ or constructing a new building. This phase provides the opportunity to:

- optimise the location and orientation within a site;
- make use of the layout, form and fabric to moderate energy needs;
- reduce heat demand by using insulation and air-tight construction;
- meet the remaining heat demand with efficient plant and controls;
- minimise cooling needs through the use of fabric (envelope, construction);
- maximise the use of natural ventilation;
- consider the use of renewable energy sources;
- meet residual cooling needs with innovative plant and controls.

In existing buildings the scope for improvements in efficiency is more limited, but there are many opportunities for cost-effective investment, either as stand-alone measures or as part of other replacement or refurbishment plans. Energy remediation of buildings and their sustainable construction covers various aspects of improving the performance of buildings and its integrated systems to reduce energy consumption and increase renewable energy use in buildings in the public sector.

The area of energy restoration and sustainable construction of buildings in the public sector includes indicative:

- energy restoration of building structures (thermal insulation of facades, thermal insulation of attics, window replacement);
- restoration of heating systems (installation of condensation and modular boilers, installation of biomass boilers, installation of thermostatic valves, inspection and hydraulic balancing of heating systems, metering and billing of energy costs according to actual consumption, replacement of heating substations in district heating systems);
- more innovative approaches such as installation of solar systems and heat pumps for heating and hot water preparation, installation of systems for cogeneration of electricity and heat (CHP), installation of PV systems;
- Installation or upgrade of lighting systems with more efficient lamps, luminaires and controls;
- properly designed controls for building services;
- construction of new low-energy buildings;
- construction of passive buildings.

Efficient use of electricity

The priority in the efficient use of electricity includes a variety of activities aimed at reducing electricity consumption in industry (manufacturing) and other general use. It is aimed to slow down the growth trends in the use of electricity in Slovenia, which goes beyond the expected growth thus not allowing the sustainable development of economy and society. Activities for reduction of electricity consumption are considered mainly in the following sectors:

- industry (target technologies: energy efficient electric motors, frequency inverters for speed control of motors, energy-efficient pumps and fans, systems for the preparation of compressed air, energy-saving lighting);
- general use (energy efficient ventilation, air conditioning and lighting);
- public lighting (installation of energy saving light bulbs and regulation).

Innovative measures for local energy supply

The priority is aimed at modern systems for energy supply, which will considerably improve the efficiency of use of fossil fuels and increase the use of renewable energy sources for production of electricity and heat. The focus will be put on larger individual local and regional energy systems.

The following technologies are primarily considered:

- remote (district heating) biomass (wood) systems, including cogeneration of heat and electricity using biomass;
- modern biomass and natural gas boilers and systems combining heat and power;
- biogas systems for the production of heat and electricity;
- production of electricity and heat from geothermal energy.

Eco-technologies include:

- technologies for efficient use of energy and raw materials (e.g. insulation of buildings, vehicle fleet with fuel-efficient engines and less energy consumption);
- technologies for the production of energy from renewable sources (e.g. solar cells, solar collectors, own small hydroelectric power plants, equipment for the production of energy from biomass…);
- technologies enabling reduction of emissions and pollution prevention and climate change (e.g., filters, equipment for waste water treatment, pumps, dampers, ...).

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