Module Training Document (Stage 4)

T.3.3 Training activities for endorsing the EE1st principle in the regional decision support

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PREFACE

Training activities for endorsing the EE1st principle in the regional decision support are based on the materials set out in T2.4. T2.4 provides the framework for REGIO1ST in 8 stages, from Stage 1: Preparation through to Stage 8: Implementation, Monitoring and Review. T3.3 will provide a coherent training and guidance package for assisting the six Regio1st regional authorities (and beyond during the exploitation activities in WP6 for 100 regions) in undertaking the steps of T3.2. More specifically, it will provide ad-hoc and upon demand trainings to familiarize the users with the functionalities, components and methodology, to explain and provide information and examples of all the main features of the decision support process, to train the users on how to use the framework and the respective tools. For the data required per region to include in the decision support, the ENERGEEWATCH will be used as a benchmark through the data from the regional observatories.

Module	Partner Responsible
Stage 1. Preparation	SEEA
Stage 2. Engaging Stakeholders & building partnerships	LEASP/ Menea / Faen
Stage 3. Reviewing energy objectives and targets	Clube / Faen
Stage 4: Exploring the current regional energy system	ICCS/ Clube / Faen/ MENEA
Stage 5: Cost benefit analysis	Fraunhofer / IEECP
Stage 6: Assessing the practical feasibility of least cost energy solutions	Fraunhofer / IEECP / ICCS
Stage 7: Defining actions and developing the regional energy plan	IEECP / ICCS
Stage 8: Implementation, monitoring and review	IEECP (Lead) / Clube / SEEA

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Introduction

The following report outlines a comprehensive training session on energy inventory and data collection. Through this written document, we aim to provide a detailed overview of the training's purpose, objectives, expected outcomes, and the outline of its modules.

Energy inventories serve as vital tools for assessing energy consumption patterns, pinpointing areas ripe for improvement, and laying the groundwork for energy strategies. Through meticulous data collection and analysis, organizations can identify opportunities to enhance energy efficiency and transition towards greener energy sources.

Through this training, we seek to empower Regions with the necessary expertise to develop comprehensive and efficient energy inventories. By aligning practices with this principle, participants will be better equipped to drive positive change, optimize energy usage, and apply the Energy Efficiency First principle in a coherent planning strategy.

By the conclusion of this training, trainees will:

- Grasp the importance of energy inventories in the context of energy efficiency planning.
- Acquire solid notions in various data collection methods and analysis techniques.
- Learn from examples strategies to overcome usual challenges encountered during data collection and analysis processes.
- Be capable of assisting Local Authorities of their regions to develop actionable energy inventories that support the Energy Efficiency First principle.

The training session delineates two distinct modules, each offering valuable insights and practical examples:

- Module 1: Data Collection: This section provides foundational knowledge on data collection methodologies, with a focus on effective management strategies inspired by the experience of the Principality of Asturias.
- Module 2: Developing the Energy Inventory: Readers will gain insights into transforming collected data into actionable intelligence, supplemented by lessons learned from the experience of Medjimurje county in Croatia.

Throughout this training, we emphasize practical techniques and real-world examples to enhance comprehension and applicability. We invite trainees to explore each module thoroughly and leverage the insights gained to contribute to a better implementation of the Energy Efficiency First principle in the future.

1. The Regio1st Framework outline

Stage 4 of the REGIO1st Planning Framework is fundamental as it sets the foundation for understanding the current regional energy system comprehensively. As discussed in the training session, this stage encompasses four key steps, each aimed at ensuring that data collection, analysis, and evaluation areconducted thoroughly and transparently. These steps are crucial for gaining in-depth insights into the regional energy system, enabling stakeholders to give their feedback on the findings to ensure all aspects have been considered.

The process involves gathering and analyzing data on the existing energy system, which includes studying energy consumption patterns, infrastructure, and other critical aspects. By meticulously examining these elements, stakeholders can identify inefficiencies, potential areas for improvement, and opportunities for innovation. This comprehensive approach ensures that the planning framework is built on a solid understanding of the current energy landscape, paving the way for more effective and sustainable energy strategies.

Collate data to understand the current energy system

In this first step of Stage 4, planners should gather data to understand the current regional energy system. This includes quantitative information on regional energy production, renewable energy production, energy consumption per sector and energy source. Data sources may include regional and national statistical institutes/offices, utilities, industry reports, technical reports and academic publications.

Accurate and comprehensive data are essential for developing a baseline energy inventory, understanding the current regional energy system and setting realistic targets in the regional energy plan.

Analyse energy consumption patterns by sector

Once the necessary data has been collected, planners should analyse the energy consumption data by sector, in order to derive consumption patterns in different sectors, especially the residential, commercial, and transport sector. The analysis should

consider factors such as energy demand, energy intensity, and the types of energy sources used in each sector.

Understanding sector-specific energy consumption patterns will help planners identify opportunities to improve energy efficiency, switch fuels, and implement other demand-side interventions.

Evaluate existing energy infrastructure

In addition to analysing energy consumption, planners should evaluate the existing energy infrastructure in the region. This should consider the age, condition, capacity, and efficiency of energy production, distribution, and storage facilities, as well as the availability and accessibility of renewable energy resources.

This assessment will help planners identify infrastructure-related constraints and opportunities to include in the regional energy plan, such as the development of new renewable energy projects.

Review the current system with stakeholders

Once a thorough understanding of the current regional energy system has been established, planners should discuss the findings with stakeholders. This may involve organizing workshops, meetings, or other engagement activities to present the data and analysis, as well as to gather feedback and insight from stakeholders.

This step is important for validating the information, ensuring that all relevant aspects have been considered, and building consensus on the key challenges and opportunities of the regional energy system.

2. Data collection

Setting up an Energy Management System

Defining an Energy Manager

The energy manager is crucial in ensuring efficient energy management within any regions or local authorities. Their responsibilities span across various activities essential for maintaining energy stability and promoting sustainability.

Firstly, the energy manager analyses energy supply, consumption, and costs to ensure a secure, stable, and high-quality energy supply. This analysis identifies inefficiencies and areas for potential savings. Regular energy audits are to be conducted by the wider team to understand how energy is used and to pinpoint areas for improvement.

Preparing Renewable Energy Sources (RES) and Rational Use of Energy (RUE) measures is another critical task. These measures form part of the Energy Action Plan aimed at increasing energy efficiency and renewable energy use. Effective communication between decision-makers, maintainers, accountants, and other stakeholders ensures alignment on energy management goals.

Even though the primary focus is Energy Efficiency, the energy manager is also in charge of monitoring wider environmental impacts, such as greenhouse gas emissions, as it is vital for understanding and reducing the organization's environmental footprint. The energy manager develops and implements a long-term strategy for energy management, ensuring ongoing improvements in energy efficiency and sustainability.

Energy bookkeeping involves systematically tracking energy usage and costs. This ongoing monitoring helps maintain control over energy consumption and identify trends. Educating and motivating employees about energy management raises awareness and promotes energy-saving behaviours throughout the organization.

Set up the frame of the Energy Management system

Step 1: Organizing the systematic Acquisition of Energy Data

Systematic acquisition of energy data is the foundation of an effective energy management system. Creating an inventory of all buildings owned by the municipality forms the basis for understanding energy use. Energy data should be collected at regular intervals, preferably using energy bookkeeping software, providing a comprehensive view of energy consumption patterns over time. Preliminary analysis and energy audits establish a baseline of current energy use, essential for all subsequent energy efficiency (EE) and renewable energy sources (RES) implementation.

The energy data collection template tool of the regio1st framework streamlines the data collection process, ensuring consistency and accuracy.

Step 2: Processing and Analysing Energy Data

Once collected, energy data must be processed and analysed to uncover opportunities for improvement. This analysis identifies patterns in energy use and reveals areas where energy efficiency can be enhanced in buildings. Detailed reports, templates, and calculations are used in this analysis, with the CBA (Cost-Benefit Analysis) Tool aiding in evaluating the financial and economic viability of potential energy-saving measures.

Step 3: Implementation of Energy Efficiency Actions

Implementing energy efficiency actions involves several critical steps. Selection of specific energy efficiency measures is based on the analysis, considering feasibility, cost-effectiveness, and potential impact. Detailed feasibility studies and financial analyses ensure the chosen measures are practical and economically viable. Implementation of these measures is followed by ongoing monitoring and verification to track their effectiveness.

Regio1st's framework and its tools such as the Technology Catalogue, CBA Tool, MCDA (Multi-Criteria Decision Analysis) Tool, and Monitoring Tool should support the implementation process.

Energy Data Collection

Defining a Baseline Year

Establishing a baseline year is crucial for tracking progress and setting targets. The recommended baseline year is 1990, although organizations are free to choose the year for which they can obtain the most comprehensive and reliable energy data. It is essential to use the same baseline year consistently for meaningful comparisons over time, even if targets change.

Identifying Key Gatekeepers of Energy Data

Identifying key gatekeepers of energy data is essential for effective data collection. Public authorities, as major consumers of energy, hold valuable data on energy consumption. Energy data providers, including major energy producers, consumers, Transmission System Operators (TSOs), and Distribution System Operators (DSOs), can

provide detailed energy data. Regional Energy Observatories and academic institutions play a crucial role in energy planning and provide valuable data and insights.

Identifying the right Data Sources and Collection

Data collection involves gathering information from various sources and ensuring its reliability. Data exchange between TSOs/DSOs and public authorities is typically voluntary, as there are no mandatory requirements in most EU and national legislative frameworks.

Data sources include government departments, national GHG inventory reports, universities, research institutes, scientific articles, and sector experts. An initial screening of available data sources helps identify accessible data and additional data needs. Whenever possible, local and national data should be used over international data, ensuring reliability and robustness. Missing data can be addressed through surveys of energy providers, extrapolation and scaling methods, or generating new data through direct measurement.

Data Sources

Building, Equipment, and Facilities

Estimating energy consumption in buildings requires a multifaceted approach. Combining different methods provides an overall picture of energy consumption within the local territory. This involves collecting data from municipal/institutional buildings, regional/national sources, market operators, and consumer surveys.

A systematic process is followed to collect and manage energy data. This includes identifying all buildings and facilities owned/managed by the local authority, all energy delivery points, and the person/department receiving invoices and energy data. Centralized collection of these documents/data is organized, and an appropriate system to store and manage the data is selected, which could be a simple spreadsheet or more elaborate software. Data is collected and entered into the system regularly, at least annually, and tele measurement is used, if possible, to ease the data collection process.

Fuel and energy management involves tracking and reporting all energy carriers and sources. For heating oil and other energy carriers, installing measurement devices (e.g., gauges, meters) determines energy consumption accurately. Alternatively, the fuel purchased annually can be assumed to equal the fuel consumed if deliveries are consistent.

Fuel for electricity and district heating/cooling is tracked and reported separately. For renewable electricity, the quantity and guarantee of origin can be obtained from the supplier, and this is accounted for as a bonus to improve the CO2 emission factor.

Public lighting data collection involves collecting all data regarding public lighting. Additional meters may be necessary for supply points serving both public lighting and buildings/facilities.

National central databases and tools provide local-specific data to local authorities. Check for available data at regional or national levels from statistical, energy, environmental, or economic ministries/agencies. Some EU Member States have central databases or tools providing local-specific data to local authorities.

Local Production

Local Production of Electricity

Gathering data on local electricity production from various sources is essential. Information can be obtained from local electricity providers, plant managers, or through questionnaires/statistics. For large plants (e.g., CHPs), direct contact with plant managers or distribution network operators can provide detailed data.

Local Production of Heat/Cold

Collect and manage data on local heat/cold production, imports, and exports. This involves gathering data on the amount of heat/cold produced, energy inputs, and associated emissions. Only the portion of heat/cold produced and consumed within the local territory should be included. Use questionnaires or direct contact with plant managers to obtain necessary data.

Transport sector

Collecting Data

I Data collection in the transport sector involves identifying and categorizing emission sources by transit mode, including on-road transportation, railway, water-borne transportation, aviation, and off-road transportation. It is crucial to establish reliable data sources and methodologies for accurately capturing energy consumption and associated emissions.

To begin, categorize transportation modes and identify key data points for each. This includes fuel consumption, energy use, and emissions data. Ensure that data is specific to the local territory and covers all relevant transit modes.

Road transportation

Road transportation includes various vehicles such as cars, taxis, buses, trucks, motorcycles, and waste collection vehicles. These vehicles primarily use liquid or gaseous fuels in internal combustion engines, producing CO2, CH4, and N2O emissions.

Emission Sources

- On-road vehicles: Includes private and commercial cars, buses, and taxis.
- Municipal fleet: Public transport and service vehicles operated by the local authority.
- Public lighting: Ensure accurate data collection for public lighting, including potential need for additional meters.

Data Collection Methods

- Fuel Sales Method: Tracks fuel sales within the local territory to estimate consumption and emissions.
- Territorial Method: Accounts for fuel consumed within the geographical boundary of the local authority.
- Residential Method: Considers fuel consumed by residents of the local authority, regardless of where the fuel was purchased.
- City-Induced Method: Focuses on fuel consumption influenced by city policies and infrastructure.

Electric and Hybrid Vehicles

Electric or hybrid vehicles add complexity to data collection due to charging stations located both within and outside the city. Ensure energy used for charging is not double-counted and is separated from other stationary energy categories.

Rail Transportation

Rail transportation within the local territory can be divided into urban rail transportation and other rail transportation. The inclusion of these categories in the Baseline Emissions Inventory (BEI) depends on the local authority's measures to reduce emissions.

Emission Sources

- Urban Rail Transportation: Includes trams, metro, and local trains serving the local area.
- Other Rail Transportation: Long-distance, intercity, regional rail, and freight transport that pass through the local territory but serve a broader area.

Data Collection Methods

- Urban Rail Transportation: Strongly recommended for inclusion in the BEI due to its direct impact on the local territory. Typically involves electric trains and trams.
- Other Rail Transportation: Includes diesel locomotives for long-distance and freight transport. Inclusion depends on the local authority's measures in the Sustainable Energy and Climate Action Plan (SECAP).

Key Data Points

- Electricity Consumption: Request annual electricity use data from service providers, categorized by fuel types and applications.
- Fuel Use: Track fuel consumption in diesel locomotives, particularly for non-electric rail services.

How to make data collection manageable – The experience of the Principality of Asturias

The Principality of Asturias has successfully developed a structured yet flexible approach to managing data collection, particularly focusing on the energy sector. This section will explore their experience, highlighting key activities, methodologies, and the valuable lessons learned along the way.

In Asturias, the energy sector is closely monitored through a series of comprehensive reports that are produced annually and quarterly. These reports include the Energy Report of Asturias, the Electricity Report of Asturias, and the Solar Report of Asturias. Each report serves a distinct purpose but collectively they provide a holistic view of the region's energy landscape.

Activities in Data Collection

The Energy Report of Asturias is an annual publication that captures a wide array of data related to energy production, consumption, and the overall energy balance within the region. This report requires meticulous planning and coordination. Surveys are crafted and distributed to various entities, including public departments and private companies. These surveys, typically in Word or Excel formats, are sent out via email to collect the necessary data. The choice of data providers is strategic, ensuring that the most relevant and comprehensive information is gathered.

On a quarterly basis, the Electricity Report of Asturias delves into the specifics of electricity production, examining the different types and sources. This report is crucial for tracking the region's progress towards self-sufficiency and its efforts in reducing CO_2 emissions. It also provides insights into the efficiency of the electrical system. By breaking down the data by source type, the report offers a clear picture of how renewable and non-renewable energy sources are being utilized.

Meanwhile, the Solar Report of Asturias focuses on continuous data collection regarding solar radiation. This is achieved through a network of measurement stations strategically placed across the region. The data collected helps in zoning different areas based on their solar potential, which is invaluable for planning and promoting solar energy projects. The network's maintenance is key to ensuring that the data remains accurate and reliable. This involves regular checks and updates to the equipment to prevent obsolescence.

A significant initiative within Asturias' data collection framework is the Just Transition Observatory of Asturias. This observatory is dedicated to overseeing the region's energy transition from a socially just and sustainable perspective. It monitors and assesses various energy and climate strategies, ensuring that the transition benefits all sectors of society. Moreover, it provides a platform for citizen participation, allowing the public to engage with and contribute to the transition process.

Its mission balances environmental goals with social and economic needs, ensuring that the transition supports jobs and communities. The observatory monitors and assesses energy and climate strategies, providing data-driven insights for effective policy-making. It is committed to social inclusion, advocating for worker retraining and upskilling to facilitate their move into green jobs, and promotes citizen participation through public engagement activities. The observatory has significantly enhanced the regional policy framework, supporting sustainable economic growth and fostering a collaborative environment for the energy transition. By mitigating the negative impacts of moving away from traditional energy sources and creating green job opportunities, it ensures a socially equitable transition. Its continuous monitoring and evaluation of policies enable responsive and effective adaptations. Overall, the Just Transition Observatory of Asturias serves as a catalyst for inclusive and fair sustainability, setting a model for other regions.

Other examples of reports done by FAEN in the same way by data collection are:

The Strategy for a Just Energy Transition in Asturias sets the overarching goals, emphasizing social equity and economic growth alongside environmental sustainability. Complementing this, the Final Document Joint Commission consolidates the agreements and collaborative efforts of all stakeholders involved, ensuring a unified approach.

FAEN's practical guides like the **Professional Guide for Self-Consumption Procedures** and the **Municipal Energy Management Guide** provide essential steps and best practices for professionals and municipalities to efficiently manage energy resources and adopt self-consumption solutions. The **Pellets Guide** promotes the use of biomass energy, offering insights into the production and utilization of pellets, which supports local economies and reduces carbon emissions.

For broader energy efficiency, FAEN's **Energy Savings Guide** offers actionable strategies for households, businesses, and public institutions to reduce their energy consumption. Additionally, the **Strategy for Energy Rehabilitation of Buildings in Asturias** focuses on enhancing the energy performance of buildings through renovations and upgrades, aiming to cut down energy use and emissions.

Methodology

The data collection methodology in Asturias is both systematic and adaptive. Surveys are designed to be comprehensive yet user-friendly, ensuring that data providers can easily understand and respond. To maintain the flow of data, periodic reminders are sent out, ensuring timely submissions. The collected data is then meticulously compiled analyzed and validated. This allows for a thorough assessment and the generation of detailed reports that inform policy and decision-making.

Continuous improvement is a cornerstone of Asturias' approach. After each data collection cycle, evaluations are conducted to identify areas for improvement. Feedback is actively sought and incorporated into subsequent cycles, making the process increasingly efficient and comprehensive over time. This iterative approach helps in addressing any gaps or inefficiencies, ensuring that the data collection framework remains robust and effective.

Goals and maintenance

The goals and outcomes of Asturias' data collection efforts are multifaceted. One of the primary objectives is to provide a clear vision for regional authorities. The baseline emission/energy inventory offers a detailed overview of priorities, helping policymakers evaluate the impact of their measures and track progress towards energy and emission reduction goals. This clarity allows for strategic planning and informed decision-making, directing efforts towards the most critical areas.

Another significant outcome is the motivation and engagement of stakeholders. By regularly sharing the results and demonstrating the impact of collective efforts, Asturias keeps all parties involved and committed to the region's energy goals. Transparent communication and regular updates help maintain momentum and foster a collaborative environment.

The comprehensive energy overview provided by combining data from various sources, including municipal services, regional resources, and market operators, enables better policy-making and strategy development. This holistic view captures the full spectrum of energy dynamics within the region, facilitating informed decisions that support sustainable development.

Asturias' experience underscores the importance of a structured yet flexible approach to data collection, continuous improvement, and stakeholder engagement. Their methodology serves as a valuable model for other regions aiming to make their data collection processes more manageable and impactful. By following these practices, regions can enhance their decision-making capabilities and drive sustainable energy transitions.

3. Developing the energy inventory

This module explores the key steps involved, in creating a comprehensive energy inventory. It includes a short demonstration of the Regio1st tool - ***Energy Inventory & Advanced Inventory tool***, methodology and calculations for each energy sector and last but not least, some ideas of how to conduct an energy consumption analysis. The respective presentation provides also practical examples aiming on deeper understanding of the methods and tools deployed in developing an energy inventory. The main goal is to empower the audience with the necessary knowledge and skills to face the complexities of energy inventory development effectively.

Regio1st tool - Energy Inventory & "Advanced Inventory tool" (Data types)

The data collection tool helps the user identify and collect the data required to build an energy inventory, both from the supply and demand side, in order to analyse the current situation and conduct the energy regional planning in line with the Energy Efficiency First (EE1st) principle.

The table enables the categorization of energy consumptions per sector and per fuel. The three main sectors are Buildings, Equipment/Facilities and Industries, Transport and Other. The fuels are divided into fossil fuels and renewable energy sources.

The "Advanced Inventory tool" indicates relevant disaggregated data that can be collected to help the user estimate energy consumption/production.

Methodology- Calculations

This section, apart from some introductory horizontal considerations, is divided into the following 9 sectors, which are further analysed based on their energy activities:

1. Residential
   a. Electricity
   b. Heating
   c. Hot water
2. Tertiary
   a. Electricity
   b. Heating
3. Municipal Sector
   a. Electricity
   b. Heating

4. Public Lighting	a. Electricity
5. Municipal Fleet	a. Gasoline and Diesel
6. Public Transport	a. Diesel
7. Private Transport	a. Gasoline and Diesel
8. Agriculture Sector	a. Electricity b. Diesel
9. Renewable Energy Sources	

Horizontal Considerations

These slides draw the attention of the audience on what measurement units could be used while gathering data or calculating energy consumptions. They also provide basic guidelines on how to make conversions between units and how to use the prefixes efficiently.

Methodology per sector

The sectors and fuels provided above are indicative. The user has first to explore the region's energy systems and activities, and then decide, along with the stakeholders, what consumptions will be included in the inventory (already discussed in Stage 1 of the framework).

As soon as the sectors to be examined are selected, there are two basic steps that the user should follow (which are similar for each sector).

- Firstly, in the buildings sector for instance, the activities within buildings as well as the deployed energy sources should be identified.
  For example, given a specific region, the user could notice that lighting, cooking, and cooling use electricity, heating uses heating oil and solar water heaters are used for domestic hot water.
- The second step is to explore the key question *"What is available?"*. This involves determining the type and the level (national, regional, local) of available data. There is a variety of data types regarding the energy consumption, however we can observe 4 representative categories between them.
  - Energy consumptions which are ready to use: E.g. sales data of the examined sector and on the desired level (regional)

- Energy consumptions in other upper/lower level: E.g. national consumptions from which regional data can be estimated through extrapolation.
- Per capita energy consumptions: E.g. some multiplications would be sufficient to calculate the total consumption.
- A variety of other data types: Data obtained from literature, reports or statistics could be effectively combined to determine the energy consumption of a sector at a specific level.

These categories can apply more or less to all the sectors. As such, further combinations of the above could cover all the cases.

Subsequently, after thorough research the user could be able to choose the most suitable methodology based on the availability of information in order to estimate the energy consumptions.

Indicative examples with specific calculations could be found in the relevant part of the presentation, aiming to illustrate the proposed methodologies.

Energy consumption analysis

Once the energy inventory has been completed, the user is encouraged to conduct an analysis in order to gain fruitful insights for the energy situation within the region and/or in comparison with other regions/administrative levels. The analysis could also support the stakeholders in selecting mitigation actions as well as in developing energy strategies. Three indicative types of values are proposed in the presentation. that could be transformed into figures for more efficient comparability:

- Consumption shares per sector
- Consumption allocation per sector and per source
- Consumption allocation per source

Moreover, a variety of indicators are also proposed to further assist the decision makers:

- Energy consumption/capita (e.g. Heating Oil in Residential/capita)
- Total energy consumption/capita (e.g. Regional Electricity/capita)
- Energy consumption/household (e.g. Electricity in Residential/residence)
- Energy consumption/car (e.g. Gasoline/private car)
- Energy consumption/area (e.g. Electricity in Street Lighting/km2)

It is strongly recommended to adapt the indicators based on region's needs (extend the list by adding more or combine them).

4. Overcoming problems in data collection and analysis – The experience of the Medjimurje county in Croatia

Medjimurje County is located in the far North of the Republic of Croatia and it is the smallest county by size in the country. It is bordered by two rivers – Mura and Drava and this is the place where the Pannonian plain ends and the Alps begin. It shares a state border with the countries Slovenia (on the Northwest) and Hungary (on the Northeast).

MEĐIMURSKA ŽUPANIJA

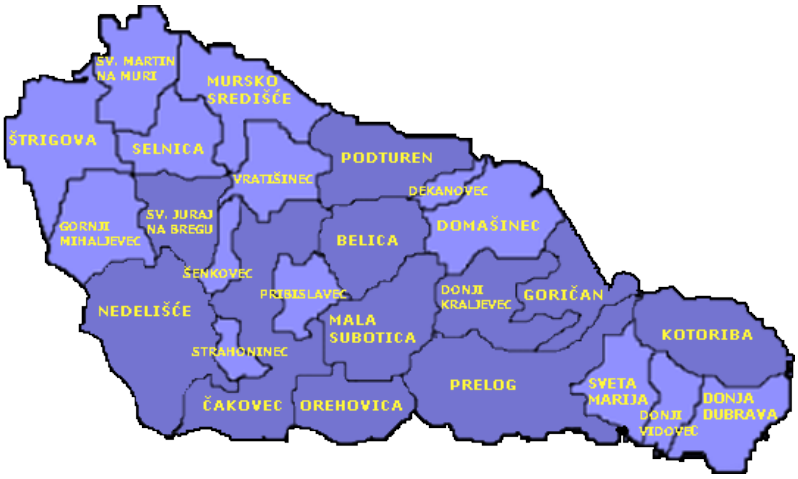
Thanks to its geographical location and very well build transport infrastructure, Medjimurje County is often referred to as "the Croatian gates" to other Central and Eastern countries. Several transport and traffic corridors pass through this part of the country, out of which the most important are: the highway that connects the cities Rijeka and Zagreb with Budapest, as well as the European corridor V that connects Venice with Lavov (it passes on the Slovenian side of the river Mura). In the year 1850 the first Croatian railroad was built and it connected Budapest with Trieste, as well as the Town of Varaždin and the City of Zagreb. Also, Zagreb, Maribor, Graz, and Heviz international airports are just an hour and a half car ride away.

Finally, near this part of Croatia, and within a radius of 300 kilometers, lie the great European cities Bratislava, Budapest, Graz, Ljubljana, Trieste, Vienna, and Zagreb.

Figure 1.The geographic location of Medjimurje County

Medjimurje County is the smallest regional authority in the Republic of Croatia. It has a total area of 729,58 km^2, 3 small and medium size towns, and 22 municipalities which

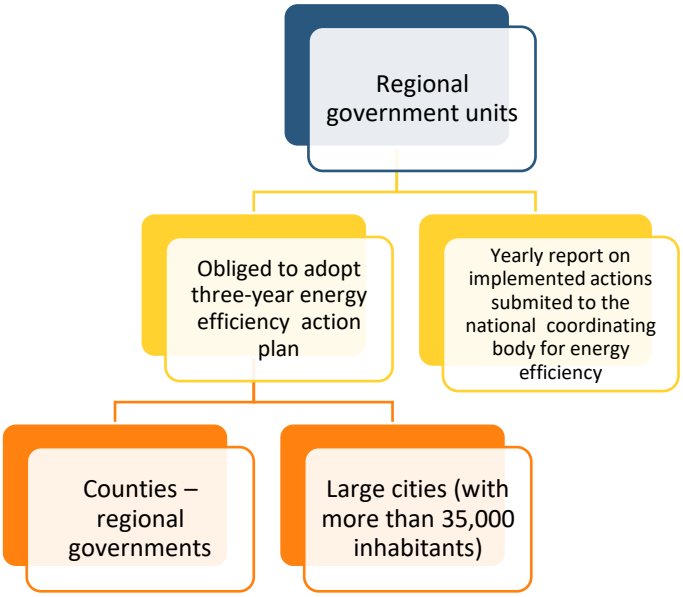
together count 131 settlements. The regional interests are represented by regional representative bodies.



Population of region (2021)	105.250	Cap
Area of region	729,58	km²
Population density	144,26	cap/km²
Average age of population	42,9	Years
Administrative division	25	(3 towns + 22 municipalities)

Planning context

Medjimurje County, as the regional government in Medjimurje region, has an active role in energy planning at the regional level. Mandated by Croatian Energy Efficiency Act (OG 127/14, 116/18, 25/20, 32/21, 41/21), regional government units (counties – regional governments) and large cities (with more than 35 000 inhabitants) are obliged to adopt energy efficiency action plans (EEAPs) for a three-year period for their regions. These regional EEAPs must be approved by the national coordinating body for energy efficiency, i.e. the Ministry of Economy and Sustainable Development. After the national coordinating body accepts Medjimurje County's EEAP, the Medjimurje County Assembly must accept the EEAP at the assembly session.



When developing regional energy and climate plans (such as EEAPs), national planning framework is considered and taken into account. Most important regulatory framework refers to National energy efficiency action plan valid at the time of developing the regional energy and climate plans, Energy Strategy of the Republic of Croatia until 2030 with a preview until 2050, Integrated National Energy and Climate Plan (NECP) for the period 2021-2030 as well as national laws and corresponding bylaws, such as Energy Efficiency Act, Renewable Energy Sources and High Efficiency Cogeneration Act (OG 127/14, 116/18, 25/20, 32/21, 41/21) and Regulation on system for monitoring, measurement and verification of energy savings (OG 98/21).

Energy Efficiency Action Plan (EEAP)

Through EEAPs, regional governments determine the implementation of policies for improving energy efficiency in their regions. To evaluate the expected effects of individual measures defined in EEAPs, a methodology for evaluating energy savings is being used - bottom-up approach. It is a method for calculating energy savings at the level of implementation of each measure for improving energy efficiency based on mathematical formulas and reference values defined by by-laws for individual measures.

The Medjimurje County's EEAP covers building and transport sectors, since those are the sectors where Medjimurje County has authority and can influence and make decisions about measures and investments.

In order to develop Medjimurje County's EEAP, data about building sector within the jurisdiction of Medjimurje County and transport sector were collected, from the Energy

Management Information System and directly from institutions founded by Medjimurje County, respectively. Collected data is referring to energy and fuel consumption as well as CO_2 emissions. After the data analysis, suitable measures are defined in cooperation with Medjimurje County and they are aligned with the County's budget. Energy consumption of other sectors, such as industry, agriculture and public lightning was not used in the development of this action plan since Medjimurje County, as regional government, has no direct influence on consumption, planning and implementation of energy efficiency measures in mentioned sectors. Public lightning sector is not covered because Medjimurje County, as regional government, does not have jurisdiction over the public lightning management system; according to Protection from Light Pollution Act (OG 14/19), the public lightning is in jurisdiction of 25 local governments in Medjimurje region.

Energy and climate action plan (ECAP+)

The LIFE project CEESEU-DIGIT (Central and Eastern Europe Sustainable Energy Union's Design and Implementation of regional Government Initiatives for a just energy Transition), aims to support local and regional authorities in the preparation of a new type of regional Energy and Climate Plans (ECAP+) in six Central and Eastern European carbon-intensive target areas (regions within CEE countries: Croatia, Czech, Estonia, Latvia, Poland, Slovenia) and with the cooperation of the Hungarian partner. This project builds capacity of local and regional authorities in all the aspects covered in ECAP+, provides the documents' alignment with national and European Union 2050 goals related to carbon neutrality, creates a methodology whereby climate adaptation, social and landscape use aspects are equally valid in these documents in addition to mitigation measures.

ECAP+ is a new approach to the regional-level Energy and Climate Plan document.

Main goals of the development of a new type of uniform, holistic, cross-sector Energy and Climate Plans (ECAP+) for regional implementation are:

- promoting a just energy transition,
- placing great emphasis on adaptation and landscape-level planning compared to the already existing energy and climate plans with particular regard to vulnerable/marginalized social groups and energy poverty, as well as the social aspects of climate sensitivity and climate protection goals,
- ensuring alignment with EU 2050 goals related to carbon neutrality,
- preparing these documents in coordination with the goals set in the National Energy and Climate Plans at the national level,
- increasing financial support and planning for just energy transition.

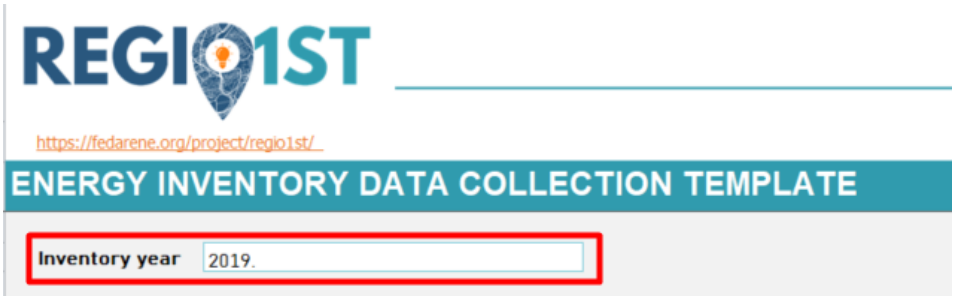
Data collection

The energy inventory data collection template consists of two tabs related to energy data: the energy supply inventory and the energy production inventory. These two tabs are built on the format of the Covenant of Mayors energy inventory, to help authorities accelerate the data gathering, in case they have already prepared an energy and climate plan. Here, the baseline of information needed is about the energy consumed and produced, per fuel type and production technology/consumption category.

Inventory year

When determining the base year, the factors of data availability and the impact of the COVID-19 pandemic were taken into account.

- ➔ for the years 2022 and 2023 not all data is available
- ➔ The year 2021 is post COVID year so consumption data are still not real
- ➔ The year 2020 is the year when the COVID pandemic hit the world and consumption data are not real
- ➔ The year 2019 is the year with real and available data



Sources

The following is an overview of the main sources used for filling out the energy inventory data collection template:

1. Energy efficiency action plan of Medjimurje County
   The action plan is a planning document which determines the implementation of policies to improve energy efficiency in the region. Data on energy consumption in public buildings (within the jurisdiction of the regional authority) and transport sector are collected, analysed and used as a base for calculating energy savings at the level of implementation of each measure planned in the document.
2. Medjmurje County in numbers – statistic yearbook
   The publication presents important numerical data about the region of Medjimurje county and compares them with the data of the Republic of Croatia and other counties. The yearbook contains data about energy, employment, economy, industry, agriculture, education system and much more. The publication uses sources from various institutions such as the State Bureau of Statistics, relevant ministries, energy distributers, etc.
3. Energy Management Information System – EMIS
   EMIS is a web application for monitoring and analysing energy and water consumption in public sector buildings. EMIS greatly facilitates the process of systematic energy management in public buildings as it enables easy access to data on energy consumption and costs, with easy graphical and tabular presentation of data and analysed results.
4. Energy in Croatia – Annual energy report
   Issued by the Croatian ministry of economy and sustainable development, the report presents commonly and recognizably numerous information and characteristic values of the Croatian energy system related to energy production and consumption at all levels. Diverse information on capacities, stocks, prices, and individual energy balances of crude oil, petroleum products, natural gas, electricity, heat, coal, and renewable energy sources is presented.

5. Annual report of the national electricity distributor
   Issued by the national DSO for electricity, it reports about the consumption, production, distribution and procurement of electricity, energy sources, sale of electricity and category of buyers, amongst others.
6. Register of renewable energy sources and cogeneration and eligible producers – a unique registry of RES and high-efficiency cogeneration projects, production facilities using RES, i.e. high-efficiency cogeneration plants and eligible producers in the territory of the Republic of Croatia. The register is set up by the ministry responsible for energy in electronic form, for monitoring and supervising the implementation of projects and RES plants and cogeneration, and for the purpose of, amongst other things, collection and analysis of data on production plants that use RES and high-efficient cogeneration.

Data that was not available in the above mentioned sources was extrapolated using various methods, which are described in details in the text below.

Energy Demand Inventory

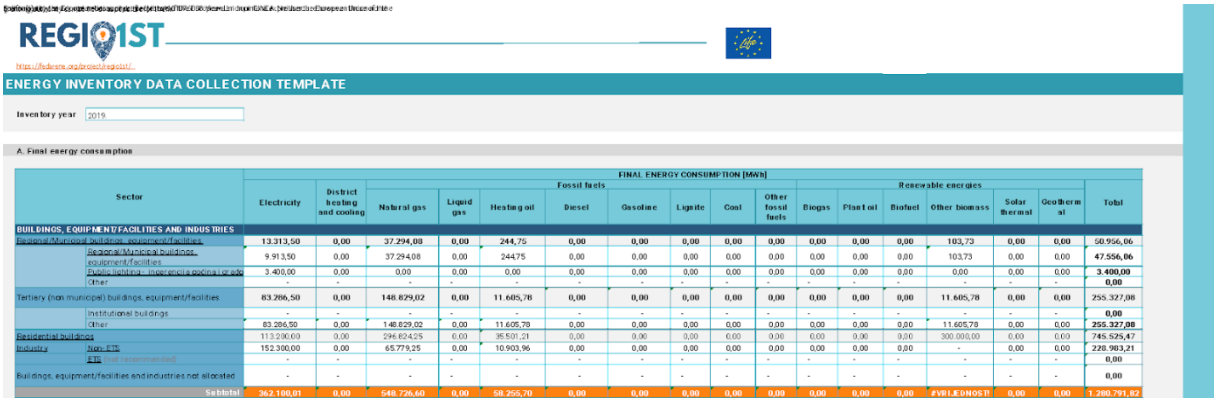
Energy demand data is included in this part of data collection and analysis.

An Energy Demand Inventory is a comprehensive assessment of the energy needs and consumption patterns within a specific area, such as a city, region, or country.

The purpose of an Energy Demand Inventory is to provide policymakers, energy planners, and stakeholders with detailed information about how energy is being used within the target area. This information can then be used to develop strategies for energy efficiency improvements, demand management initiatives, infrastructure investments, and sustainable energy transitions.

By analyzing energy demand patterns and identifying opportunities for optimization, decision-makers can make more informed choices about energy policies, investments, and technologies to meet current and future energy needs while minimizing environmental impacts and enhancing energy security.

Buildings, equipment/facilities and industries



ENERGY INVENTORY DATA COLLECTION TEMPLATE

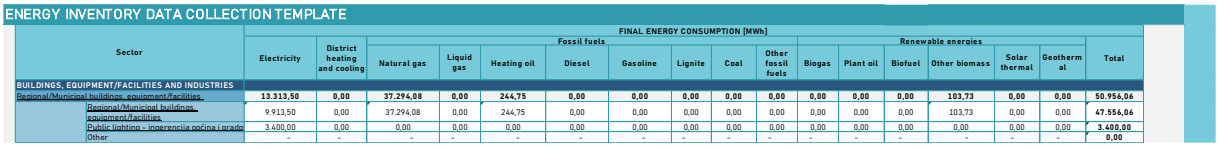
Inventory year: 2019

A. Final energy consumption

Sector	FINAL ENERGY CONSUMPTION [MWh]																
			Fossil fuels								Renewable energies						
	Electricity	District heating and cooling	Natural gas	Liquid gas	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Biogas	Plant oil	Biofuel	Other biomass	Solar thermal	Geotherm al	Total
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES																	
Regional/Municipal buildings, equipment/facilities	13.313,50	0,00	37.294,08	0,00	244,75	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	103,73	0,00	0,00	50.956,06
Regional/Municipal buildings, equipment/facilities	9.913,50	0,00	37.294,08	0,00	244,75	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	103,73	0,00	0,00	47.556,06
Public lighting - inoprencija općina i gradc	3.400,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	3.400,00
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
Tertiary (non municipal) buildings, equipment/facilities	83.286,50	0,00	148.829,02	0,00	11.605,78	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	11.605,78	0,00	0,00	255.327,08
Institutional buildings	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
Other	83.286,50	0,00	148.829,02	0,00	11.605,78	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	11.605,78	0,00	0,00	255.327,08
Residential buildings	113.200,00	0,00	296.624,25	0,00	35.501,21	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	300.000,00	0,00	0,00	745.525,47
Industry Non-ETS	152.300,00	0,00	65.779,25	0,00	10.903,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-	0,00	0,00	228.983,21
ETS (if one recommended)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
Buildings, equipment/facilities and industries not allocated	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
Subtotal	362.100,01	0,00	548.726,60	0,00	58.255,70	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	#VRIJEDNOST!	0,00	0,00	1.280.791,82

Regional/Municipal buildings, equipment/facilities

Regional/Municipal buildings, equipment/facilities refer to buildings and facilities owned by regional and local authority. In the case of Medjimurje County, regional and municipal buildings include buildings owned by Medjimurje County and other municipalities and towns within the region,.



ENERGY INVENTORY DATA COLLECTION TEMPLATE

Sector	FINAL ENERGY CONSUMPTION [MWh]																
			Fossil fuels								Renewable energies						
	Electricity	District heating and cooling	Natural gas	Liquid gas	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Biogas	Plant oil	Biofuel	Other biomass	Solar thermal	Geotherm al	Total
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES																	
Regional/Municipal buildings, equipment/facilities	13.313,50	0,00	37.294,08	0,00	244,75	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	103,73	0,00	0,00	50.956,06
Regional/Municipal buildings, equipment/facilities	9.913,50	0,00	37.294,08	0,00	244,75	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	103,73	0,00	0,00	47.556,06
Public lighting - inoprencija općina i gradc	3.400,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	3.400,00
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00

Electricity

Publicly available data is available only for buildings owned by Medjimurje County and are included in the energy efficiency action plan.

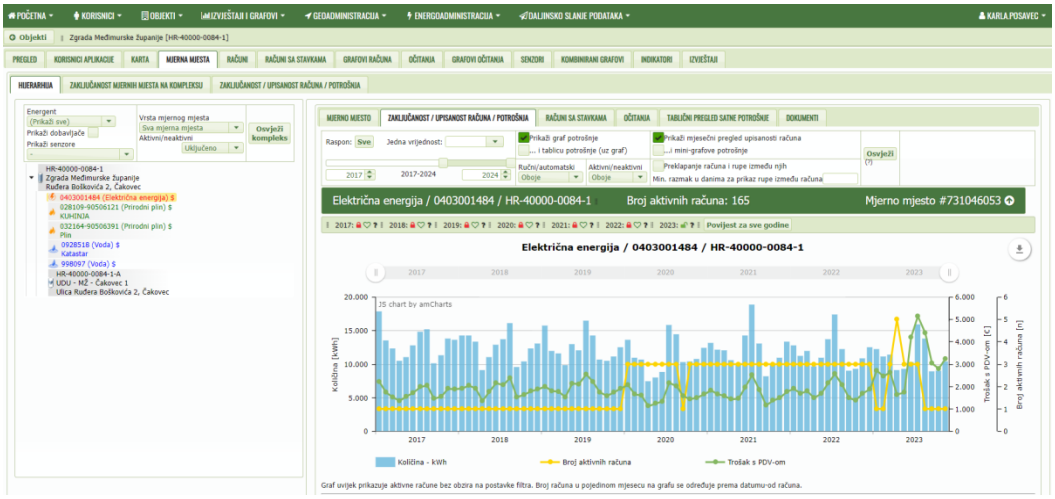
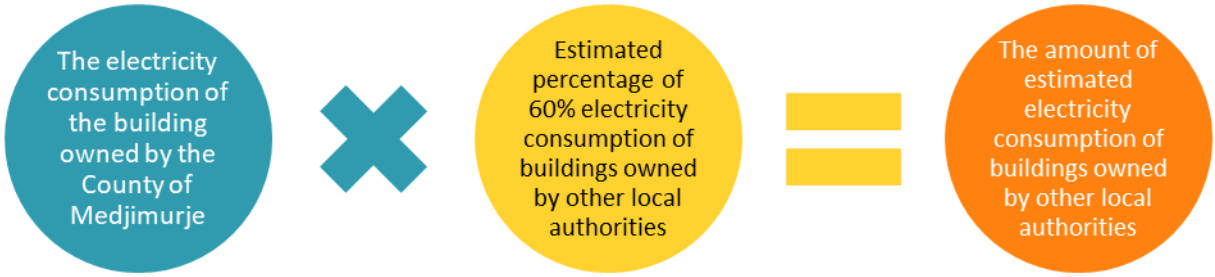


Figure: Electricity consumption (Source: Energy Management Information System - EMIS)

Medjimurje County or institutions founded by Medjimurje County own 135 public buildings at 2019.

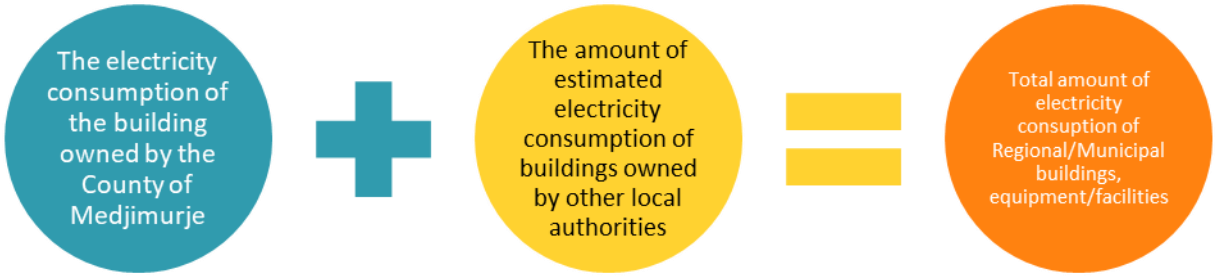
The electricity consumption of the building owned by the County of Medjimurje is 6,195.937 MWh. It is estimated that the electricity consumption of buildings owned by the other local authorities amounts to 60% of the consumption of buildings owned by Medjimurje County.

Therefore, the amount of electricity consumption of buildings owned by the County of Medjimurje was multiplied by 60% in order to obtain the share of consumption buildings of other local authorities. According to the estimate, the electricity consumption of buildings owned by other local authorities amounts to 3,717.562 MWh.



6,195,937 MWh 60% 3,717.562 MWh

The obtained estimated amount of electricity consumption of buildings owned by other local authorities is added to the consumption of buildings owned by Medjimurje County, and the total electricity consumption of Regional/Municipal buildings, equipment/facilities amounts to 9913.50 MWh.



6195,937 MWh 3717,562 MWh 9913,502 MWh

Natural gas

The consumption of natural gas in the County of Medjimurje is 37,294.08 MWh. This is an estimated amount based on the actual consumption of natural gas in buildings owned by the County of Medjimurje.

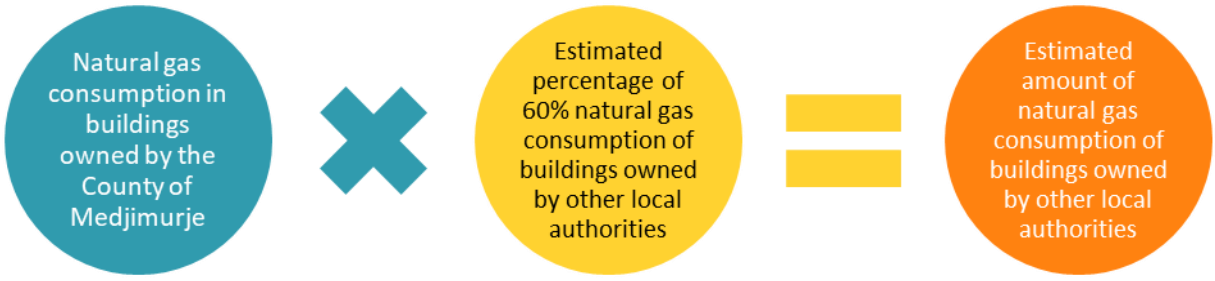
The actual data on the consumption of natural gas in the buildings of Medjimurje County is available in the Energy Efficiency Action Plan of Medjimurje County, shown according to the specific consumption of individual sub-sectors of the building industry: educational institutions, health institutions, and other institutions.

Tablica 2.6 Prikaz specifične potrošnje pojedinih podsektora zgradarstva u neposrednoj potrošnji prirodnog plina

Naziv objekta	Godina	Ukupna potrošnja energije (kWh)	Specifična potrošnja **prirodnog plina** (kWh/m²)
Obrazovne ustanove	2019.	9.833.322,01	82,14
	2020.	8.803.967,01	73,54
Zdravstvene ustanove	2019.	12.117.493,01	228,98
	2020.	12.795.829,01	241,80
Ostale ustanove	2019.	1.357.984,41	57,81
	2020.	1.276.567,59	54,34

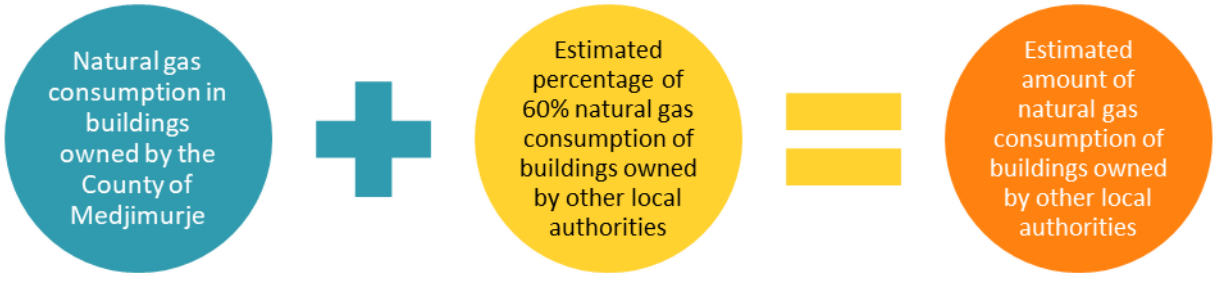
Figure: Natural gas consumption of certain sub-sectors of building construction (educational institutions, health institutions, other institutions) in Medjimurje County in 2019 and 2020 (Source: Medjimurje County Energy Efficiency Action Plan for the period from 2022 to 2024)

Therefore, the actual consumption of natural gas in the buildings of Medjimurje County, which is 23308.79942 MWh, is increased by 60% of the estimated amount of natural gas consumption owned by other local authorities.



23308,79942 MWh 60% 13985,2797 MWh

The estimated amount of natural gas consumption in the buildings of other local authorities of 13985.2797 MWh was added to the actual consumption of natural gas in the buildings of Medjimurje County.



23308,79942 MWh 13985,2797 MWh 37294,08 MWh

Heating oil

The estimated heating oil consumption in buildings in Medjimurje County is 244.75 MWh.

Actual heating oil consumption in buildings owned by the County of Medjimurje is 152.96633. The information is available in the Energy Efficiency Action Plan of the County of Medjimurje County.

Tablica 2.5 Prikaz specifične potrošnje pojedinih podsektora zgradarstva u neposrednoj potrošnji ekstra lakog loživog ulja

Naziv objekta	Godina	Ukupna potrošnja energije (kWh)	Specifična potrošnja **ekstra lakog loživog ulja** (kWh/m^2)
Obrazovne ustanove	2019.	152.966,33	1,28
	2020.	173.431,21	1,45
Zdravstvene ustanove	2019.	0,00	0,00
	2020.	0,00	0,00
Ostale ustanove	2019.	0,00	0,00
	2020.	0,00	0,00

Figure: Heating oil consumption in the building sub-sector (educational institutions, health institutions, other institutions) in Medjimurje County in 2019 and 2020 (Source: Medjimurje County Energy Efficiency Action Plan for the period from 2022 to 2024)

The total consumption of heating oil in the area of Medjimurje County was obtained by estimating the actual consumption of heating oil in the buildings of Medjimurje County in the amount of 152.96633 MWh multiplied by the estimated percentage of 60% of heating oil consumption in buildings owned by other local authorities.

152,96633 MWh 60% 91,7798 MWh

The estimated amount of heating oil consumption in the buildings of other local authorities was added to the actual amount of heating oil consumption in buildings owned by the County of Medjimurje.

152,96633 MWh 91,7798 MWh 244,75 MWh

Other biomass

The consumption of other biomass in the area of Medjimurje County is 103.73 MWh.

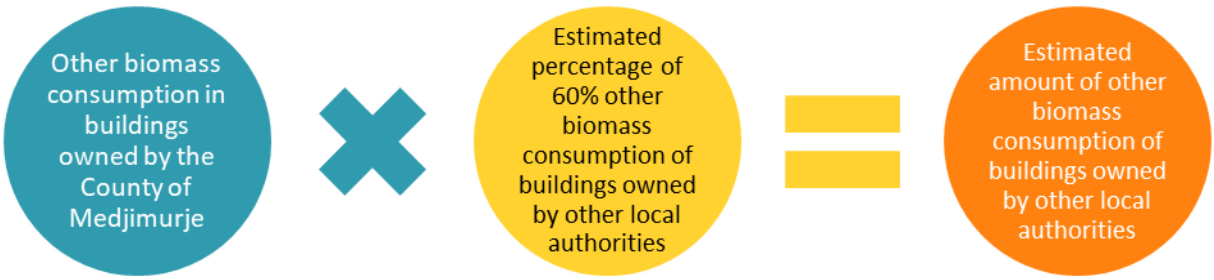
This is the estimated consumption of other biomass based on the actual consumption of the building that is owned by the County of Medjimurje. The consumption of other biomass in the building owned by the County of Medjimurje is 64.83240 MWh and refers to the consumption of firewood in the administrative building of the Knowledge Center of Medjimurje County.

Tablica 2.7 Prikaz specifične potrošnje pojedinih podsektora zgradarstva u neposrednoj potrošnji drva za ogrjev

Naziv objekta	Godina	Ukupna potrošnja energije (kWh)	Specifična potrošnja **drva za ogrjev** (kWh/m^2)
Obrazovne ustanove	2019.	-	-
	2020.	-	-
Zdravstvene ustanove	2019.	-	-
	2020.	-	-
Ostale ustanove	2019.	64.832,40	2,76
	2020.	56.728,35	2,41

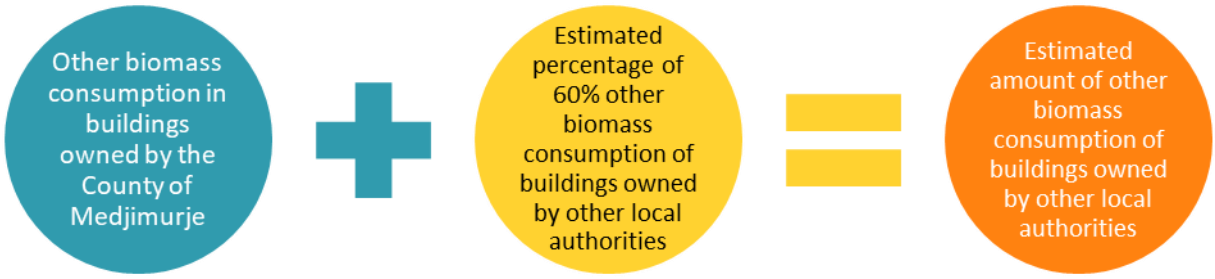
Figure: Consumption of other biomass (firewood) in the sub-sector of building construction (educational institutions, health institutions, other institutions) in Medjimurje County in 2019 and 2020 (Source: Medjimurje County Energy Efficiency Action Plan for the period from 2022 to 2024)

The actual consumption of other biomass of buildings owned by the County of Medjimurje is multiplied by the estimated percentage of 60% of the consumption of buildings owned by the other local authorities.



64,83240 MWh 60% 38,89944 MWh

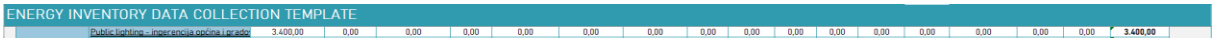
The estimated amount of consumption of buildings owned by other local authorities was added to the consumption of other biomass by buildings owned by the County of Medjimurje, and thus the total consumption of other biomass in the County of Medjimurje was obtained.



64,83240 MWh 38,89944 MWh 103,73 MWh

Public lighting

Public lighting refers to lighting owned or operated by the local authority.



Electricity

Data for electricity used for public lighting are available in the statistical yearbook of Medjimurje in numbers provided by Hrvatska elektroprivreda HEP d.d. – Elektra Čakovec (Local electricity distributor (local DSO)).

The actual consumption of electricity for public lighting in the area of Medjimurje County is 3.400,00 MWh.

Prodaja električne energije

	2016.		2017.		2018.		2019.	
	Broj kupaca	Prodaja kWh	Broj kupaca	Prodaja kWh	Broj kupaca	Prodaja kWh	Broj kupaca	Prodaja kWh
Visoki napon	-	-	-	-	-	-	-	-
Srednji napon	73	127.954.188	73	137.344.990	79	147.370.571	80	152.300.001
Kućanstvo	41.915	114.605.143	42.206	114.952.821	42417	114.501.023	42.687	113.200.003
Poduzetništvo	4.596	91.446.076	4.634	97.317.508	4.723	94.079.228	4.750	93.200.002
Javna rasvjeta	474	5.198.924	484	5.092.656	487	4.437.265	491	3.400.004
Ukupno	47.058	339.204.331	47.397	354.707.975	47.706	360.388.087	48.008	362.100.010

stanje 31. prosinca

Izvor: HEP – DP Elektra Čakovec

Figure: Electricity consumption for public lighting in Medjimurje County (Source: Statistical yearbook Medjimurje in numbers)

Tertiary (non municipal) buildings, equipment/facilities

Tertiary (non municipal) buildings, equipment/facilities refers to buildings and facilities of the tertiary sector (services), for example offices of private companies, banks, commercial and retail activities.

Other

ENERGY INVENTORY DATA COLLECTION TEMPLATE

Sector	FINAL ENERGY CONSUMPTION [MWh]																
			Fossil fuels								Renewable energies						
	Electricity	District heating and cooling	Natural gas	Liquid gas	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Biogas	Plant oil	Biofuel	Other biomass	Solar thermal	Geotherm al	Total
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES																	
Tertiary (non municipal) buildings, equipment/facilities	83.286,50	0,00	148.829,02	0,00	11.605,78	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	11.605,78	0,00	0,00	255.327,08
Institutional buildings	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
Other	83.286,50	0,00	148.829,02	0,00	11.605,78	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	11.605,78	0,00	0,00	255.327,08

Electricity

Electricity consumption in the tertiary sector of Medjimurje County is 83.286,50 MWh. This data was estimated by subtracting the data from the statistical yearbook of Medjimurje in the figures for the entrepreneurship sector 93200,00 MWh with the amount of electricity consumption in regional/municipal buildings 9913,50 MWh.

The reason for this is to avoid double recording of consumption.

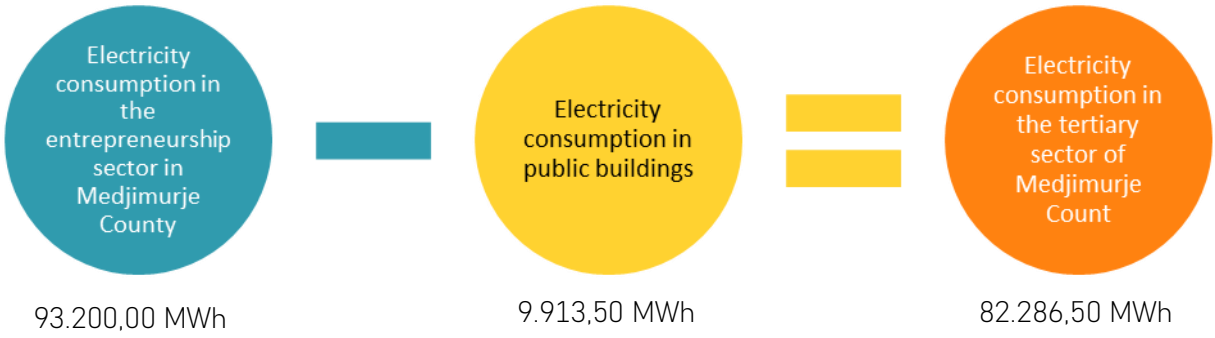
Prodaja električne energije

	2016.		2017.		2018.		2019.	
	Broj kupaca	Prodaja kWh	Broj kupaca	Prodaja kWh	Broj kupaca	Prodaja kWh	Broj kupaca	Prodaja kWh
Visoki napon	-	-	-	-	-	-	-	-
Srednji napon	73	127.954.188	73	137.344.990	79	147.370.571	80	152.300.001
Kućanstvo	41.915	114.605.143	42.206	114.952.821	42417	114.501.023	42.687	113.200.003
Poduzetništvo	4.596	91.446.076	4.634	97.317.508	4.723	94.079.228	4.750	93.200.002
Javna rasvjeta	474	5.198.924	484	5.092.656	487	4.437.265	491	3.400.004
Ukupno	47.058	339.204.331	47.397	354.707.975	47.706	360.388.087	48.008	362.100.010

stanje 31. prosinca

Izvor: HEP – DP Elektra Čakovec

Figure: Consumption of electricity in the tertiary sector in Medjimurje County in 2019 (Source: Statistical yearbook Medjimurje in numbers)

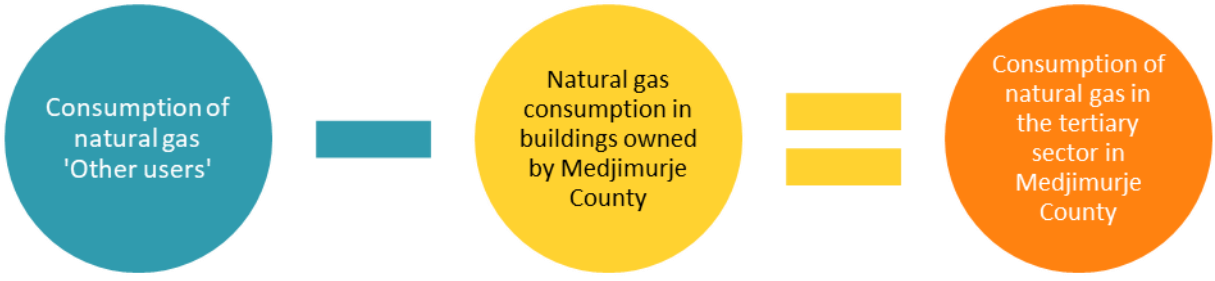


93.200,00 MWh 9.913,50 MWh 82.286,50 MWh

Natural gas

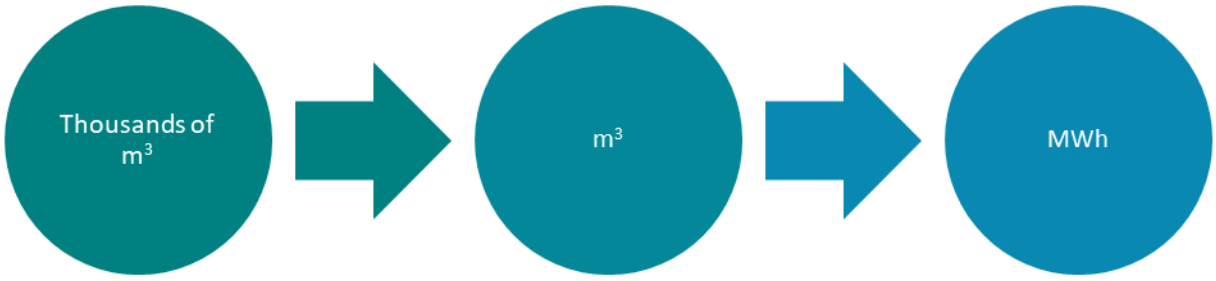
The consumption of natural gas in the territory of Medjimurje County in the tertiary sector amounts to 148.829,02 MWh.

This is accurate information based on the statistical yearbook of Medjimurje in numbers. The amount of consumption of public buildings in the area of Medjimurje County was subtracted from the exact data for the total gas consumption of "other consumers" in order to avoid double recording of consumption monitoring data. The source of the data is the local gas distributor - Medjimurje plin Ltd..



186.123,10 MWh 37.294,08 MWh 148.829,02 MWh

Data on natural gas consumption in the statistical yearbook is expressed in thousands of cubic meters. Therefore, it was first necessary to convert this data into cubic meters, and then from cubic meters into MWh.



Opskrba plinom

	2015.	2016.	2017.	2018.	2019.
Plinski cjevovodi - ukupno km	10.32,79	1.034,07	1.037,9	1.044,8	1.053,3
Od čeličnih cijevi	179,71	171,36	175	168,5	166,7
Od plastičnih cijevi	847,13	854,36	862,9	876,3	886,6
Ukupna potrošnja u tisućama m^3	47126	49.366	52.678	54.291	52.012
Domaćinstva	26.741	27.366	28.915	29.793	28.135
Rudarstvo i prerađivačka industrija	3.102	5.472	5.991	6.298	6.235
Ostali potrošači	17.145	16.432	17.772	18.091	17.642
Broj mjerno redukcijskih stanica na mreži	4	4	4	4	4

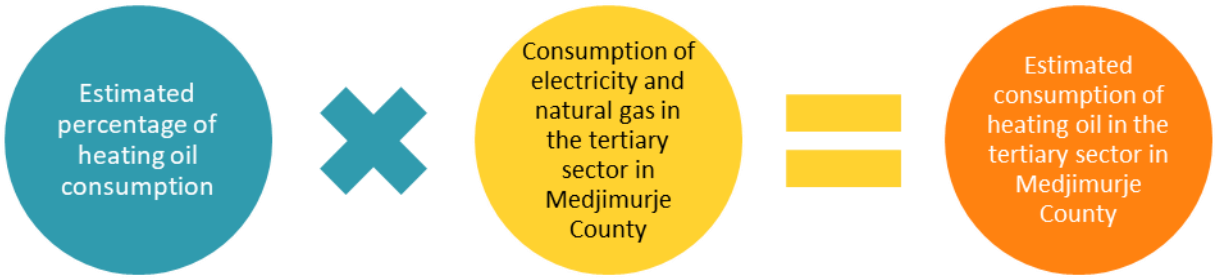
Izvor: Međimurje-plin

Figure: Consumption of natural gas in the tertiary sector in Medjimurje County in 2019 (Source: Statistical yearbook Medjimurje in numbers)

Heating oil

Heating oil consumption in Medjimurje County is 11.605,78 MWh. This is estimated data based on the consumption of electricity and natural gas in the tertiary sector.

It is estimated that heating oil consumption in Medjimurje County is 5% of the total consumption of electricity and natural gas in the tertiary sector in Medjimurje County.

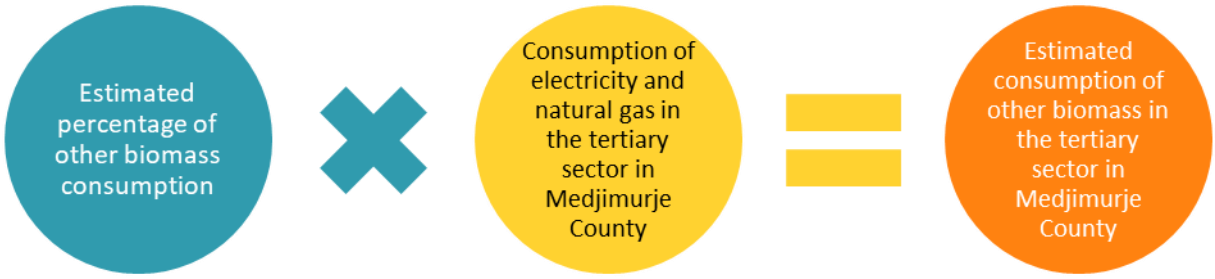


5% (83.286,50 MWh + 148.829,02 MWh) 11.605,78 MWh

Other biomass

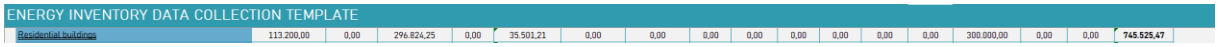
Other biomass consumption in Medjimurje County is 11.605,78 MWh. This is estimated data as well as for heating oil based on the consumption of electricity and natural gas in the tertiary sector.

It is estimated that other biomass consumption in Medjimurje County is 5% of the total consumption of electricity and natural gas in the tertiary sector in Medjimurje County.



Residential buildings

Residential buildings refer to buildings that are primarily used as residential buildings.



Electricity

Electricity consumption for residential buildings in Medjimurje County is 113.200,00 MWh.

This is the exact data available in the statistical yearbook Medjimurje in numbers, while the source of this data is the Local electricity distributor (DSO) – Elektra Čakovec.

Prodaja električne energije

	2016.		2017.		2018.		2019.	
	Broj kupaca	Prodaja kWh	Broj kupaca	Prodaja kWh	Broj kupaca	Prodaja kWh	Broj kupaca	Prodaja kWh
Visoki napon	-	-	-	-	-	-	-	-
Srednji napon	73	127.954.188	73	137.344.990	79	147.370.571	80	152.300.001
Kućanstvo	41.915	114.605.143	42.206	114.952.821	42417	114.501.023	42.687	113.200.003
Poduzetništvo	4.596	91.446.076	4.634	97.317.508	4.723	94.079.228	4.750	93.200.002
Javna rasvjeta	474	5.198.924	484	5.092.656	487	4.437.265	491	3.400.004
Ukupno	47.058	339.204.331	47.397	354.707.975	47.706	360.388.087	48.008	362.100.010

stanje 31. prosinca

Izvor: HEP – DP Elektra Čakovec

Figure: Consumption of electricity in the residential buildings in Medjimurje County in 2019 (Source: Statistical yearbook Medjimurje in numbers)

Natural gas

The consumption of natural gas in residential buildings in the area of electricity amounts to 296.824,25 MWh.

This is the exact data for the "household" consumer category available in the statistical yearbook Medjimurje County in numbers sourced from the local gas distributor Medjimurje-plin Ltd.

Opskrba plinom

	2015.	2016.	2017.	2018.	2019.
Plinski cjevovodi - ukupno km	10.32,79	1.034,07	1.037,9	1.044,8	1.053,3
Od čeličnih cijevi	179,71	171,36	175	168,5	166,7
Od plastičnih cijevi	847,13	854,36	862,9	876,3	886,6
Ukupna potrošnja u tisućama m^3	47126	49.366	52.678	54.291	52.012
Domaćinstva	26.741	27.366	28.915	29.793	28.135
Rudarstvo i prerađivačka industrija	3.102	5.472	5.991	6.298	6.235
Ostali potrošači	17.145	16.432	17.772	18.091	17.642
Broj mjerno redukcijskih stanica na mreži	4	4	4	4	4

Izvor: Međimurje-plin

Figure: Consumption of natural gas in the residential buildings in Medjimurje County in 2019 (Source: Statistical yearbook Medjimurje in numbers)

Data for natural gas consumption in the statistical yearbook are expressed in thousands of cubic meters. First, it is necessary to convert thousands of cubic meters into cubic meters, and then into MWh.

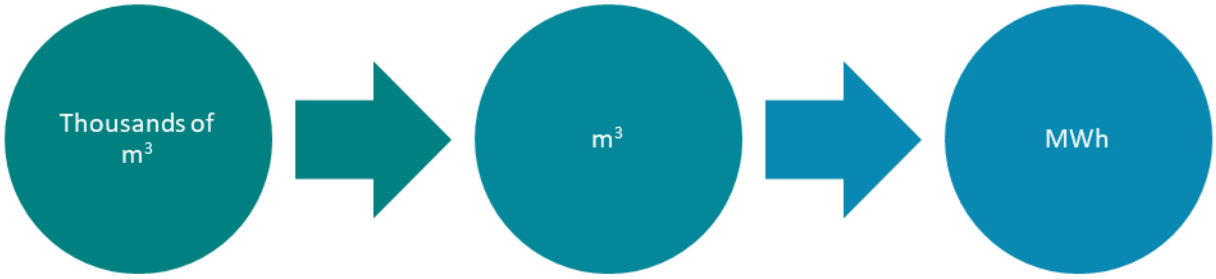


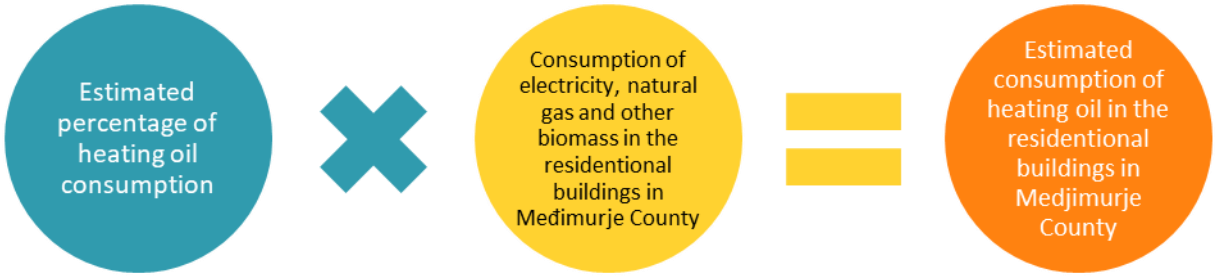
Figure: Conversion of cubic meters to MWh (Source: Calculat.org)

Heating oil

The consumption of heating oil in residential buildings in Medjimurje County is 35.501,21 MWh.

This is estimated data based on the consumption of electricity, natural gas and other biomass in residential buildings in the Medjimurje County area.

It is estimated that the consumption of heating oil in residential buildings in Medjimurje County is 5% of the total consumption of electricity, natural gas and other biomass in residential buildings in Medjimurje County.



5% (113.200,00 MWh + 296.824,25 MWh + 300.000,00 MWh) 35.501,21 MWh

Other biomass

The consumption of other biomass, i.e. firewood in residential buildings in Medjimurje County is 300,000.00 MWh.

It is estimated that the consumption of other biomass, i.e. firewood, is roughly equal to the consumption of natural gas in residential buildings in Medjimurje County.

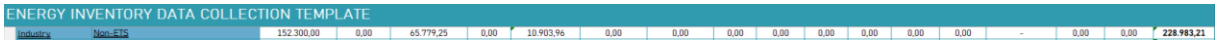
Consumption of other biomass for the residentional buildings in Međimurje County	Estimated consumption of other biomass in the residentional buildings in Međimurje County
296,824,25	300,000,00 MWh

Industry

Industry refers to manufacturing and construction industries.

Non-ETS

Industries not involved in the EU Emissions Trading Scheme (EU-ETS).



Electricity

Electricity consumption in the Industry sector in Medjimurje County is 152,300.00 MWh. This is the exact data of electricity sales for medium voltage available in the statistical yearbook Medjimurje in numbers, and the source of this data is the Local electricity distributor (DSO).

Prodaja električne energije

	2016.		2017.		2018.		2019.	
	Broj kupaca	Prodaja kWh	Broj kupaca	Prodaja kWh	Broj kupaca	Prodaja kWh	Broj kupaca	Prodaja kWh
Visoki napon	-	-	-	-	-	-	-	-
Srednji napon	73	127.954.188	73	137.344.990	79	147.370.571	80	152.300.001
Kućanstvo	41.915	114.605.143	42.206	114.952.821	42417	114.501.023	42.687	113.200.003
Poduzetništvo	4.596	91.446.076	4.634	97.317.508	4.723	94.079.228	4.750	93.200.002
Javna rasvjeta	474	5.198.924	484	5.092.656	487	4.437.265	491	3.400.004
Ukupno	47.058	339.204.331	47.397	354.707.975	47.706	360.388.087	48.008	362.100.010

stanje 31. prosinca

Izvor: HEP – DP Elektra Čakovec

Figure: Consumption of electricity in the Industry sector in Medjimurje County in 2019 (Source: Statistical yearbook Medjimurje in numbers)

Natural gas

The consumption of natural gas in the industry sector in Medjimurje County is 65.779,25 MWh.

This is the exact data available in the statistical yearbook Medjimurje in numbers for the sector 'mining and processing industry', the source of which is the local gas distributor.

Opskrba plinom

	2015.	2016.	2017.	2018.	2019.
Plinski cjevovodi - ukupno km	10.32,79	1.034,07	1.037,9	1.044,8	1.053,3
Od čeličnih cijevi	179,71	171,36	175	168,5	166,7
Od plastičnih cijevi	847,13	854,36	862,9	876,3	886,6
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Ostali potrošači	17.145	16.432	17.772	18.091	17.642
Broj mjerno redukcijskih stanica na mreži	4	4	4	4	4

Izvor: Međimurje-plin

Figure: Consumption of natural gas in the Industry sector in Medjimurje County in 2019 (Source: Statistical yearbook Medjimurje in numbers)

Data for natural gas consumption in the statistical yearbook are expressed in thousands of cubic meters. First, it is necessary to convert thousands of cubic meters into cubic meters, and then into MWh.

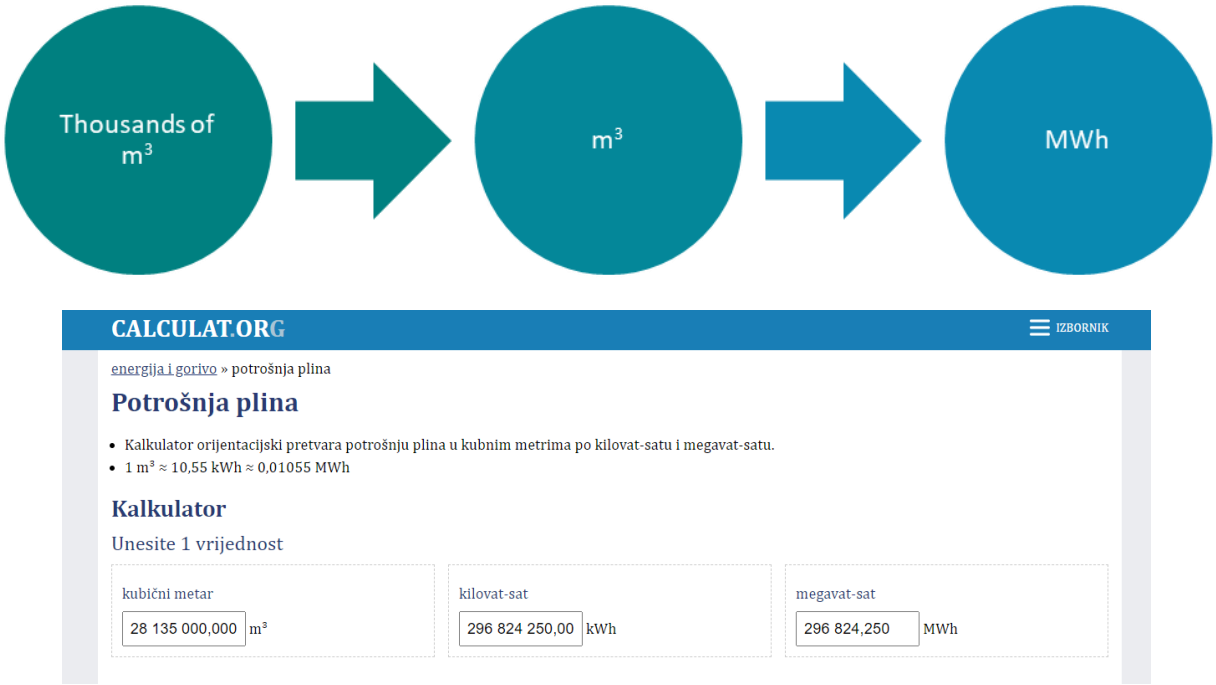


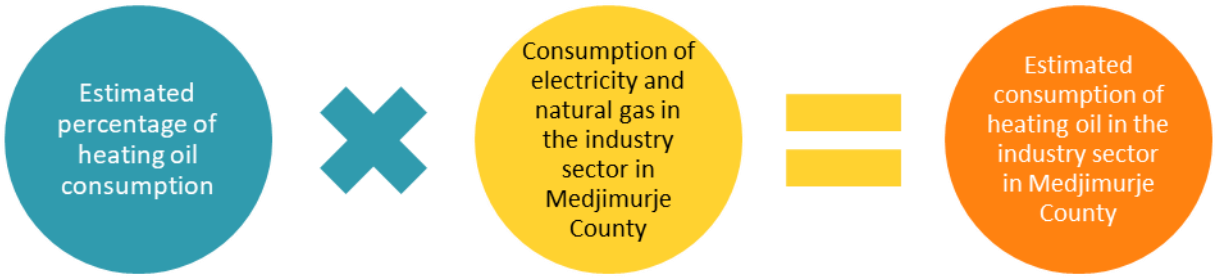
Figure: Conversion of cubic meters to MWh (Source: Calculat.org)

Figure: Conversion of cubic meters to MWh (Source: Calculat.org)

Heating oil

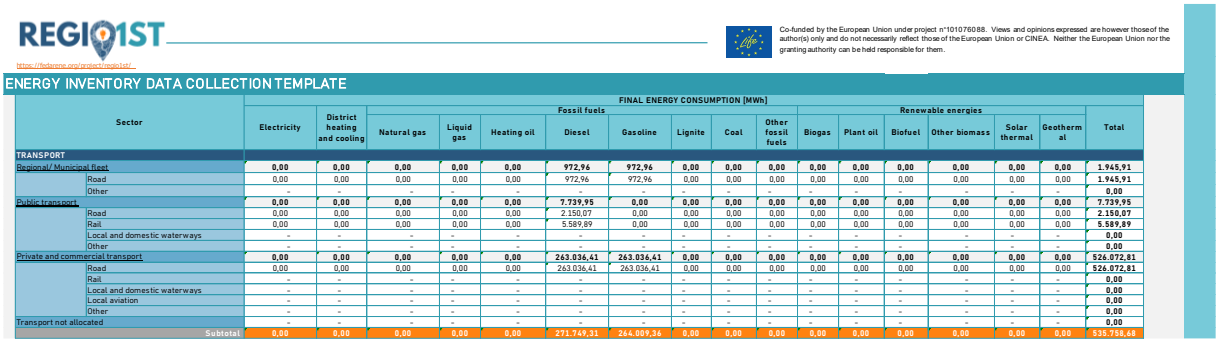
Heating oil consumption for industry sector in Medjimurje County is 11.605,78 MWh. This is an estimated data based on the consumption of electricity and natural gas in the industry sector.

It is estimated that heating oil consumption in Medjimurje County is 5% of the total consumption of electricity and natural gas in the industry sector in Medjimurje County.



5% (152.300,00 MWh + 65.779,25 MWh) 10.903,96 MWh

Transport



REGIO1ST

https://fedarene.org/project/regio1st/

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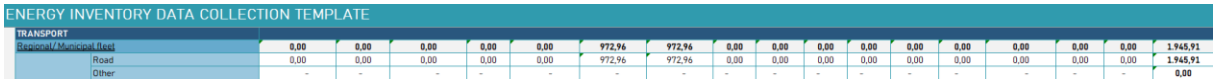
ENERGY INVENTORY DATA COLLECTION TEMPLATE

Sector		FINAL ENERGY CONSUMPTION [MWh]																
				Fossil fuels								Renewable energies						
		Electricity	District heating and cooling	Natural gas	Liquid gas	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Biogas	Plant oil	Biofuel	Other biomass	Solar thermal	Geotherm al	Total
TRANSPORT																		
Regional/ Municipal fleet		0,00	0,00	0,00	0,00	0,00	972,96	972,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1.945,91
	Road	0,00	0,00	0,00	0,00	0,00	972,96	972,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1.945,91
	Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
Public transport		0,00	0,00	0,00	0,00	0,00	7.739,95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	7.739,95
	Road	0,00	0,00	0,00	0,00	0,00	2.150,07	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2.150,07
	Rail	0,00	0,00	0,00	0,00	0,00	5.589,89	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	5.589,89
	Local and domestic waterways	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
	Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
Private and commercial transport		0,00	0,00	0,00	0,00	0,00	263.036,41	263.036,41	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	526.072,81
	Road	0,00	0,00	0,00	0,00	0,00	263.036,41	263.036,41	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	526.072,81
	Rail	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
	Local and domestic waterways	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
	Local aviation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
	Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
Transport not allocated		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
	Subtotal	0,00	0,00	0,00	0,00	0,00	271.749,31	264.009,36	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	535.758,68

Regional/Municipal fleet

Regional/Municipal fleet refers to vehicles owned and used by the local and regional authority.



ENERGY INVENTORY DATA COLLECTION TEMPLATE																	
TRANSPORT																	
Regional/Municipal fleet		0,00	0,00	0,00	0,00	0,00	972,96	972,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1.945,91
	Road	0,00	0,00	0,00	0,00	0,00	972,96	972,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1.945,91
	Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00

Road

There are no public data for energy consumption in road vehicle traffic for regional/municipal vehicles in Medjimurje County.

The procedure for estimating road transport energy consumption was as follows:

- In the statistical yearbook Medjimurje in numbers is available data for numbers of vehicles owned by the County of Medjimurje = 105 vehicles
- The number of vehicles owned by the Medjimurje County is multiplied by the estimated average kilometers traveled by vehicles owned by the County of Medjimurje for the year is 12,500 kilometers/per year
- Estimated fuel consumption is 7 liters per 100 kilometers. The vehicle's fuel consumption has been reduced to consumption per 1 kilometer. The number of vehicles and kilometers traveled is multiplied by the average consumption of 0.07 liters of fuel per 1 kilometer
- The obtained consumption of the vehicle in liters is multiplied by 0.01059 - the factor by which the fuel is converted into MWh (1 liter of diesel = 0.0159 MWh)
    - Method of calculation which is obtained factor:
        - Energy content (MWh) of diesel fuel = Volume (L) x Density (kg/L) x Calorific value (MJ/kg) x (1000)/(3600 x 1000)

          Average density of diesel fuel = 0.84 kg/L (Regulation on SMIV)

          Calorific value = 45.4 (MJ/kg)
        - The conversion factor (1000)/(3600 x 1000) for calculating from MJ/L to MWh/L is obtained based on the following calculation:

          1 J = 1 Ws

          1 MJ = 1 000 000 Ws

          = 1 000 kWs

          = 1000/3600 kWh

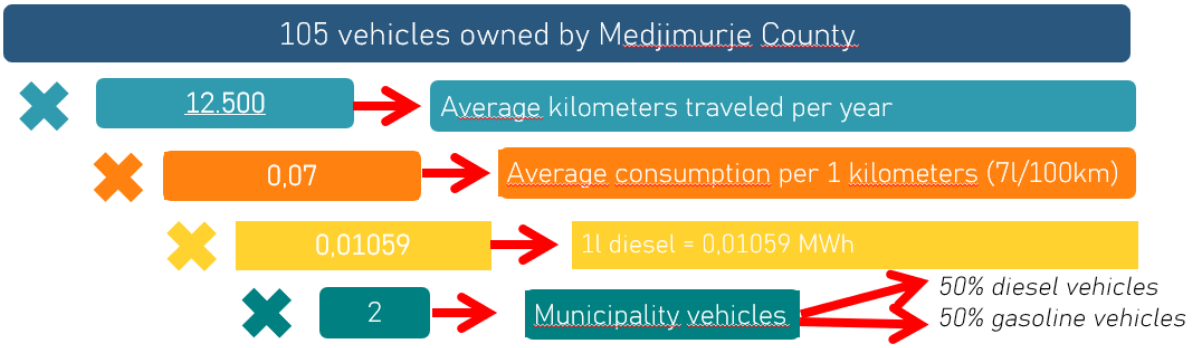
= 1000/(3600 x 1000) MWh

So, 1 L of diesel = 0,84 x 45,4 x (1000)/(3600 x 1000) = 0,01059 MWh

or

= 0,84 x 45,4 x (1000)/(3600) = 10,59 kWh

- The obtained result is multiplied by 2 in order to include the estimated number of vehicles owned by towns and municipalities
- The obtained result of the total fuel consumption refers to both vehicles using diesel and vehicles using gasoline
    - The consumption result is divided by 2 to obtain separate consumption for vehicles owned by the County of Medjimurje and for vehicles owned by towns and municipalities



Calculation:

105 x 12.500 km = 1.312,500 km

1.312.500 km x 0,07 l/km = 91.875 l

91.875 l x 0,01059 = 972,96 MWh

972,96 MWh x 2 = 1.945,91 MWh

1.945,91 MWh / 2 = **972,96 MWh**

Diesel

The estimated consumption of diesel for regional/municipal vehicles based on the previously explained procedure is 972,96 MWh

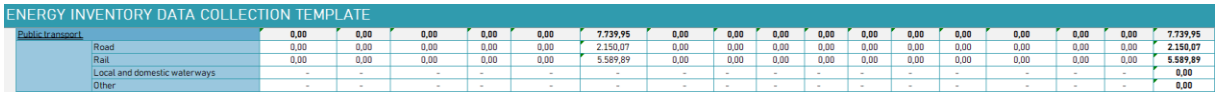
Gasoline

The estimated gasoline consumption for regional/municipal vehicles based on the previously explained procedure is 972,96 MWh.

Public transport

Public transport refers to bus, tramway, metro, urban rail transportation, and local ferries used for passenger transport.

In Medjimurje County, public transport refers to buses and trains.



ENERGY INVENTORY DATA COLLECTION TEMPLATE																	
Public transport		0,00	0,00	0,00	0,00	0,00	7.739,95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	7.739,95
	Road	0,00	0,00	0,00	0,00	0,00	2.150,07	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2.150,07
	Rail	0,00	0,00	0,00	0,00	0,00	5.589,89	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	5.589,89
	Local and domestic waterways	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
	Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00

Road

There are no public data for energy consumption of public road transport in Medjimurje County.

The estimate of the consumption of public road transport was made on the basis of available data on bus lines in Medjimurje County and the average fuel consumption of buses.

On the website of the association of bus operators in Medjimurje, the timetable of bus lines is different. The timetable includes the frequency of driving and the length of the route. Kilometers of all bus lines on all routes in Medjimurje County are added up on a weekly basis. The weekly number of kilometers of bus lines is multiplied by the average number of weeks 40, taking into account school holidays when buses operate in reduced volume.

Figure: Bus line in Medjimurje County (Source: M-Grupa)

Figure: Bus line in Medjimurje County (Source: M-Grupa)

VOZNI RED ZA ŽUPANIJSKU AUTOBUSNU LINIJU

stalna linija — VOZNI RED — R.BROJ:66

Vrsta linije

ČAKOVEC — GORIČAN

Mjesto polaska — Mjesto dolaska

Vrijeme u polasku 1 Prometuje 12345	Vrijeme u polasku 2 Prometuje 12345	km	STAJALIŠTA	Vrijeme u povratku 3 Prometuje 123456	Vrijeme u povratku 4 Prometuje 12345	Vrijeme u povratku 5 Prometuje 12345
10:35	19:40	0	ČAKOVEC	06:40	09:25	12:30
10:41	19:46	4	PRIBISLAVEC	06:34	09:19	12:24
10:47	19:52	8	BELICA	06:28	09:13	12:18
10:53	19:58	12	GARDINOVEC	06:22	09:07	12:12
*	*	16	DEKANOVEC	06:19	*	*
*	*	18	NOVAKOVEC	06:17	*	*
11:00	20:05	20	DEKANOVEC	06:15	09:00	12:05
11:03	20:08	23	DOMAŠINEC	06:12	08:57	12:02
11:07	20:12	25	TURČIŠĆE	06:08	08:53	11:58
11:12	*	28	D.HRAŠĆAN	06:03	08:48	11:53
11:15	*	32	HODOŠAN	06:00	08:45	11:50
11:20	*	35	D.KRALJEVEC	05:55	08:40	11:45
11:25	*	38	GORIČAN	05:50	08:35	11:40

Napomena : Polasci pod rednim brojevima 3, prometuju tokom cijele godine
Polasci pod rednim brojevima 1,2,4,5,prometuju za vrijeme trajanja školske nastave
Na polasku pod r. br. 3 mjesto Novakovec prometuje se za vrijeme trajanja školskih praznika,linija subotom ne prometuje za vrijeme trajanja školskih praznika

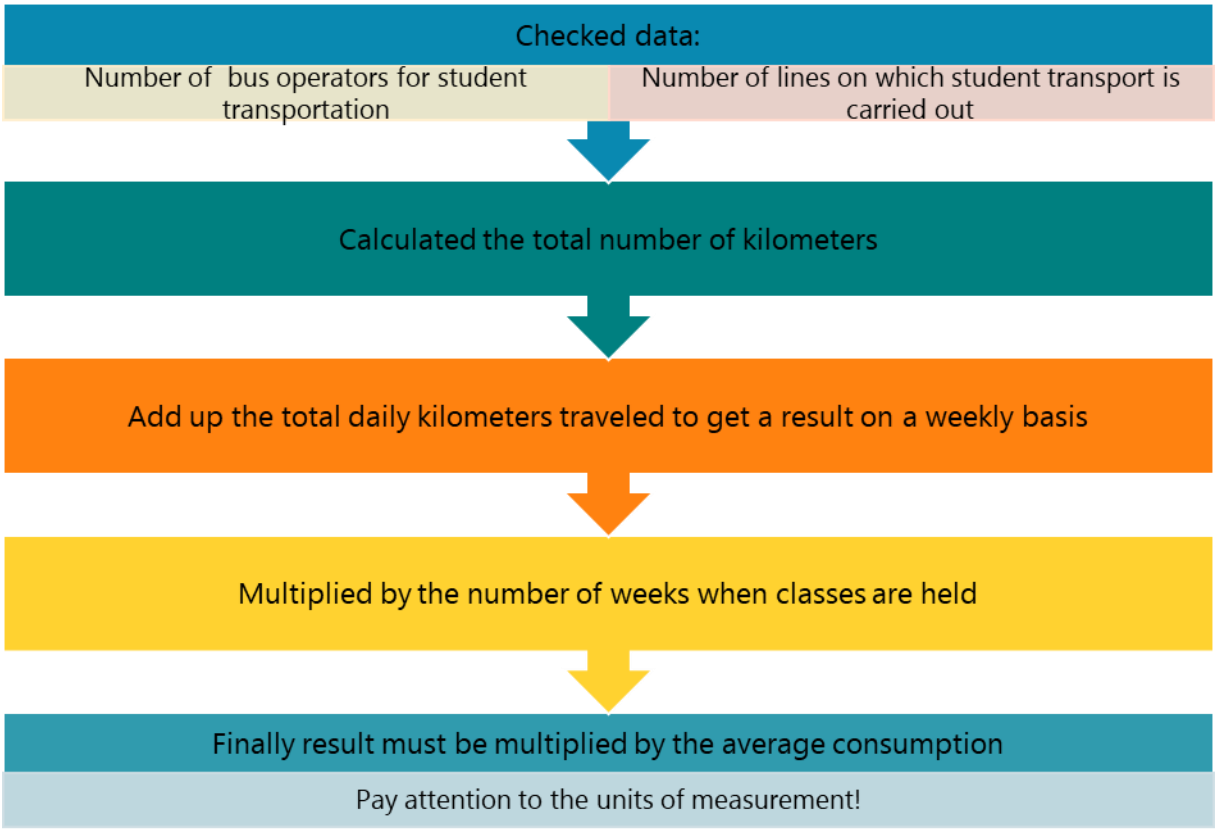
RUDI EXPRESS

Figure: Bus timetable in Medjimurje County (Source: M-Grupa)

The annual number of kilometers traveled in Medjimurje county in public bus transport is 676,760 km multiplied by the average fuel consumption of 0.3 liters per 1 kilometer (that is, 30 liters per 100 kilometers).

The obtained fuel consumption of 527,845.76 liters is multiplied by 0.01059 – the factor by which the fuel is converted into MWh (1 liter of diesel = 0.0159 MWh).

The consumption of fuel – diesel in public bus transport in 2019 in the area of Medjimurje County is 2,150.07 MWh.



Diesel

The consumption of diesel in public bus transport in 2019 in the area of Medjimurje County is 2.150,07 MWh according to previous estimation method.

Rail

ENERGY INVENTORY DATA COLLECTION TEMPLATE

Sector	FINAL ENERGY CONSUMPTION [MWh]																
			Fossil fuels								Renewable energies						
	Electricity	District heating and cooling	Natural gas	Liquid gas	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Biogas	Plant oil	Biofuel	Other biomass	Solar thermal	Geotherm al	Total
TRANSPORT																	
Public transport	0,00	0,00	0,00	0,00	0,00	7.739,95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	7.739,95
Road	0,00	0,00	0,00	0,00	0,00	2.150,07	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2.150,07
Rail	0,00	0,00	0,00	0,00	0,00	5.589,89	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	5.589,89

Diesel

There is no publicly available data for railway energy consumption in the area of Medjimurje County. In 2019, the consumption of diesel in the area of the Medjimurje County amounted to 5,589.89 MWh. This is an estimated data considering the length of the routes, the timetable used by trains in the Medjimurje County and the average consumption of a diesel locomotive.

The calculation procedure is as follows:

The train timetable is published on the website of the public railway carrier "Hrvatske željeznice". The timetable shows the traffic of trains on a daily basis. Therefore, the number of times a day trains run on a particular route on weekdays, weekends and holidays has been summed up.

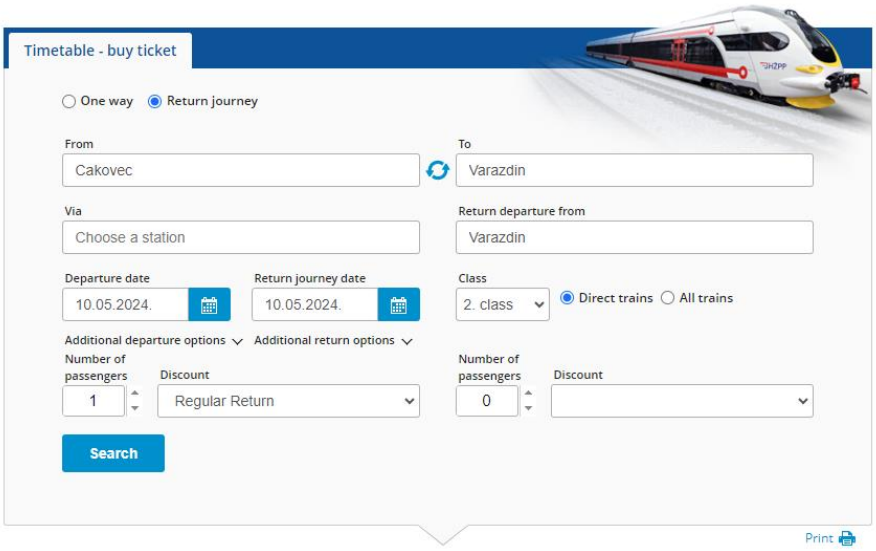
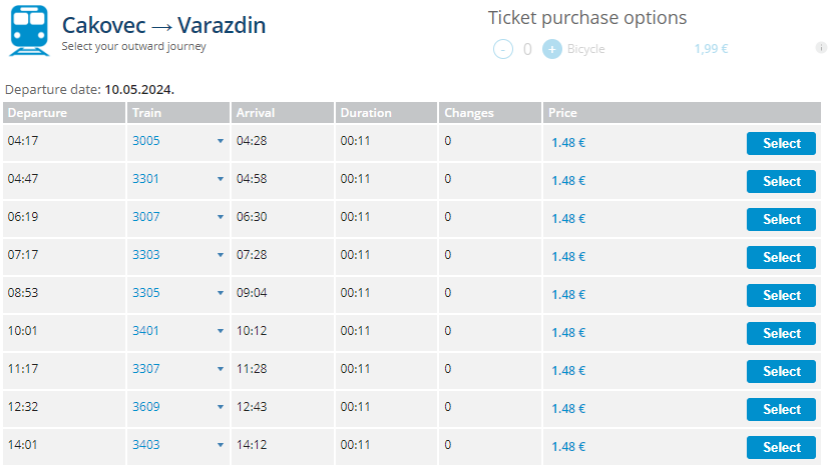


Figure: Train schedule in Medjimurje County (Source: HŽ Passenger Transport)



Departure	Train	Arrival	Duration	Changes	Price	
04:17	3005	04:28	00:11	0	1.48 €	Select
04:47	3301	04:58	00:11	0	1.48 €	Select
06:19	3007	06:30	00:11	0	1.48 €	Select
07:17	3303	07:28	00:11	0	1.48 €	Select
08:53	3305	09:04	00:11	0	1.48 €	Select
10:01	3401	10:12	00:11	0	1.48 €	Select
11:17	3307	11:28	00:11	0	1.48 €	Select
12:32	3609	12:43	00:11	0	1.48 €	Select
14:01	3403	14:12	00:11	0	1.48 €	Select

Figure: Train schedule in Medjimurje County (Source: HŽ Passenger Transport)

There are a total of 4 train routes in Medjimurje County. These are:

1. Čakovec Varaždin,
2. Čakovec – Macinec,
3. Čakovec – Kotoriba
4. Čakovec – Mursko Središće.

Figure: Railway tracks (routes) in Medjimurje County (Source: Report on the network - HŽ Infrastruktura)

Data on the length of each railway line are available in the network report of the company "HŽ Infrastruktura", which is the manager of the railway infrastructure in Croatia.

***Prilog 2.13.** Udaljenost između službenih mjesta, dopuštene/ograničene brzine i slobodni profili*

Naziv kolodvora / dionice	Šifra	KM položaj	Status	Duljina dionice [m]	Međukolodvorski razmak [m]	Brzina (dopuštena ili ograničena)								Slobodni profili	
						Vozni smjer A → B (smjer prema nazivu pruge)				Vozni smjer B → A (smjer suprotan od naziva pruge)					
						Dionica		Brzina (km/h)		Dionica		Brzina (km/h)			
						Od km	Do km	Vlakovi bez nagibne tehnike	Vlakovi s nagibnom tehnikom	Od km	Do km	Vlakovi bez nagibne tehnike	Vlakovi s nagibnom tehnikom	Profil	Napomena
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
23. M501 DG - Čakovec - Kotoriba - DG															
Čakovec DG	74861	51+894	10			51+894	51+944	100/35	-	51+944	51+894	100/35	-	GC	
Čakovec DG - Macinec				1598		51+944			-		51+944		-	GC	
Macinec	74801	53+492	03						-				-	GC	
Macinec - Dunjkovec				3573	8961*			40	-			40	-	GC	
Dunjkovec	74802	57+065	03						-				-	GC	
Dunjkovec - Čakovec				3790*			60+200		-	60+200			-	GC	
ČAKOVEC	74860	60+846	01			60+200	61+394	35	-	61+394	60+200	35	-	GC	
Čakovec - Čakovec-Buzovec				1945		61+394			-		61+394		-	GC	
Čakovec-Buzovec	74803	62+791	03		8836*				-				-	GC	
Čakovec-Buzovec - Mala Subotica				6891*					-				-	GC	
MALA SUBOTICA	74804	69+680	01					100	-			100	-	GC	
Mala Subotica - Čehovec				6326					-				-	GC	
Čehovec	74805	76+006	03		8548				-				-	GC	
Čehovec - Donji Kraljevec				2222					-				-	GC	
DONJI KRALJEVEC	74806	78+228	01				78+228		-	78+228			-	GC	
						78+228			-		78+228		-	GC	
Donji Kraljevec - Goričan				3122					-				-	GC	
Goričan **	94807	81+350	03					60	-			60	-	GC	
Goričan - Donji Mihaljevec				2986					-				-	GC	
Donji Mihaljevec	74807	84+336	03		12666				-				-	GC	
Donji Mihaljevec - Kotoriba				6558			86+300		-	86+300			-	GC	
						86+300	87+700	50	-	87+700	86+300	50	-	GC	
						87+700	90+163	60	-	90+163	87+700	60	-	GC	
KOTORIBA	74808	90+894	01			90+163	91+254	50	-	91+254	90+163	50	-	GC	
Kotoriba - Kotoriba DG				3377*	3377*	91+254	94+050	60	-	94+050	91+254	60	-	GB	
						94+050	94+100	55	-	94+100	94+050	55	-	GB	
						94+100		80	-		94+100	80	-	GB	
Kotoriba DG	74809	94+204	10				94+204		-	94+204			-	GB	Most Mura

Figure: Distance between train stations (Source: Report on the network - HŽ Infrastruktura)

The daily lines for each of the routes have been added up, taking into account the reduced volume of the timetable during school holidays.

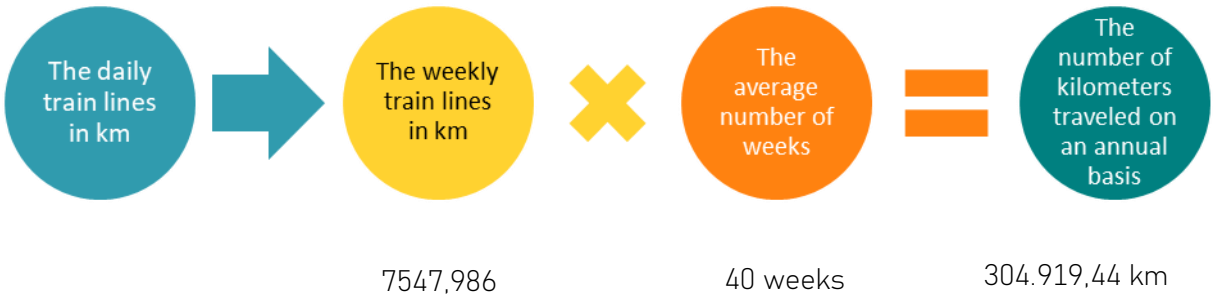
The daily train lines were first multiplied by the length of the routes in kilometers and then added together to obtain the number of kilometers traveled on a weekly basis.

The weekly number of kilometers traveled is multiplied by the average number of 40 weeks because trains run in smaller volumes during the summer and winter months due to school holidays.

The obtained annual number of kilometers traveled by trains in Medjimurje County was multiplied by the average diesel locomotive consumption of 1,7483 liter per kilometer (174,83 liter per 100).

The obtained result of the total annual consumption of public rail transport of 52.784.575,7 liters of diesel is multiplied by 0,0159 the factor by which the fuel is converted into MWh (1 liter of diesel = 0,0159 MWh).

Relacija		Kilometar pruge Od	Do	Udaljenost u km	Dnevni promet (radni dan)	Dnevni promet (subota)	Dnevni promet (nedjelja i blagdan)	Ukupno km dnevno u 1 smjeru (radni dan)	Ukupno km dnevno u 1 smjeru (subota)	Ukupno km dnevno u 1 smjeru (nedjelja)
Varaždin	Čakovec	88	99	10,867	16	12	8	173,872	130,404	86,936
Čakovec	Varaždin			10,867	18	10	8	195,606	108,67	86,936
Čakovec	Kotoriba	60	90	30,050	11	8	5	330,55	240,4	150,25
Kotoriba	Čakovec			30,050	10	9	6	300,5	270,45	180,3
Čakovec	Mursko Središće	0	16	16,608	5	5	0	83,04	83,04	0
Mursko Središće	Čakovec			16,608	5	5	0	83,04	83,04	0
Macinec	Čakovec	53	60	7,363	4	0	0	29,452	0	0
Čakovec	Macinec			7,363	4	0	0	29,452	0	0
			UKUPNO	129,776	73,000	49,000	27,000	1225,512	916,004	504,422
Potrošnja na 100 km (dizel)	174,83									
			UKUPNO na tjedan	7547,986						
	UKUPNO na godišnjoj razini			301919,44						
			u MWh	5589,886566						

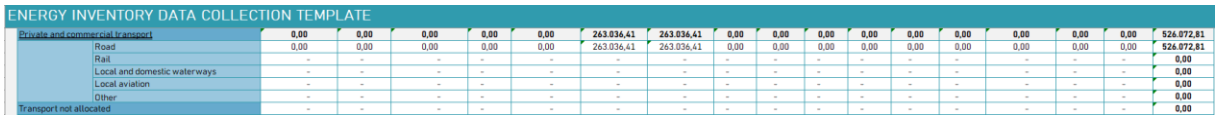


7547,986 40 weeks 304.919,44 km

304.919,44 km 1,7483 l/1 km 0,01059 5.589,89 MWh

Private and commercial transport

Road, rail and boat transport in the territory of the local authority which refer to the transport of persons and goods not specified above.



ENERGY INVENTORY DATA COLLECTION TEMPLATE																		
Private and commercial transport		0,00	0,00	0,00	0,00	0,00	263.036,41	263.036,41	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	526.072,81
	Road	0,00	0,00	0,00	0,00	0,00	263.036,41	263.036,41	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	526.072,81
	Rail	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
	Local and domestic waterways	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
	Local aviation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
	Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00
Transport not allocated		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,00

Road

There is no publicly available data for energy consumption in private and commercial transport. Estimated consumption is made for private cars.

The estimated consumption of private transport in the area of Medjimurje County in 2019 is 527.045.76 MWh. The estimated value was obtained based on the number of registered vehicles in the area of Medjimurje County in 2019, the average fuel consumption and the average number of kilometers traveled.

The consumption estimation procedure is as follows:

In the statistical yearbook Medjimurje County in number, the number of registered vehicles in the area of Medjimurje County in 2019 is available in figures, the source of which is the Police Department of Medjimurje and the Croatian Vehicle Center. It amounts to 57,064. The number of regional and other public vehicles (168) was subtracted from the total number of registered vehicles in order to avoid double registration. The total number of private vehicles is 56.896.

Registrirana cestovna motorna vozila

	Ukupno	Vrsta vozila				
		Mopedi i motocikli	Osobna vozila	Autobusi	Teretna i radna vozila[56]	Ostala vozila[57]
2014.	54.706	2.843	39.621	92	3.916	8.234
2015.	55.883	2.714	40.750	105	4.027	8.287
2016.	57.324	2.609	42.064	114	4.210	8.327
2017.	62.098	3.768	45.672	133	4.970	7.555
2018.	61.194	3.674	45.323	116	4.705	2018.
2019.	57.046	3.180	42.591	90	4.052	7.133

podaci o vozilima registriranim u PU međimurskoj

Izvor: Centar za vozila Hrvatske

Figure: Number of registered road motor vehicles in Medjimurje County (Statistical yearbook Medjimurje in numbers)

The number of vehicles in private transport is multiplied by the average estimated kilometers traveled in a year i.e. 12,500 km.

The total number of kilometers traveled by private vehicles in the area of Medjimurje County in 2019 (719.975.000 km) was multiplied by the average fuel consumption of 0,07 l/km (7l/100 km) in order to obtain the total fuel consumption of all private vehicles on an annual basis.

The obtained result is multiplied by 0,01059, the factor by which the fuel is converted into MWh (1 liter of diesel = 0,01059 MWh).

The obtained result of the total estimated consumption of 527.045,77 MWh was divided by two in order to obtain an estimate separately for diesel consumption and separately for gasoline consumption.

Diesel

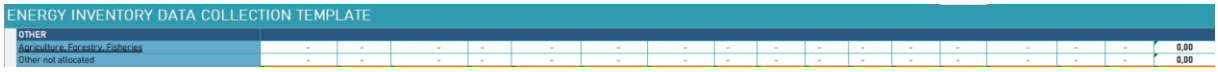
The estimated consumption of diesel for private transport based on the previously explained procedure is 263.522,88 MWh

Gasoline

The estimated consumption of gasoline for private transport based on the previously explained procedure is 263.522,88 MWh

Other

-> Buildings, facilities and machinery of the primary sector (agriculture, foresty, fisheries).



For Agriculture, Foresty, Fisferies/Other not allocated for, there are no publicly available data and therefore this data was not included in the energy inventory.

Data collection – Energy Production Inventory

Local/distributed electricity production (Renewable energy only)

ENERGY INVENTORY DATA COLLECTION TEMPLATE

B1. Local/distributed electricity production (Renewable energy only)

Local renewable electricity plants	Renewable electricity produced [MWh]	Renewable installed capacity [MW]
Wind	-	-
Hydroelectric	779.900,00	157,20
Photovoltaics	13.344,60	11,60
Geothermal	-	-
Sustainable Biomass	-	-
Other	-	-
TOTAL	793244,6	168,804

Local renewable electricity plants

Hydroelectric

There are two hydropower plants operating in Međimurje County. These are the Čakovec hydroelectric plant and the Dubrava hydroelectric plant. These are two of the three hydroelectric power plants located on the Drava River.

The Čakovec hydroelectric power plant with a capacity of 77,44 MW is located in the northwestern part of Croatia, in the Medjimurje and Varaždin counties, on the Drava river, near the towns of Varaždin and Čakovec, and covers the section of the river from Varaždin to Hrženica.

Figure: Hydroelectric power plant Čakovec (Source: Hrvatska elektroprivreda HEP)

The 79,78 MW Dubrava hydropower plant is located in the northwestern part of Croatia, in the area of Medjimurje, Varaždin and Koprivnica-Križevačka counties, and covers the section of the river from Hrženica to Donja Dubrava. HPP Dubrava is the last of the three multi-purpose hydropower plants on the Drava river, which, in addition

Figure: Hydroelectric power plan Dubrava (Source: Hrvatska elektroprivreda HEP)

to producing electricity, participate in water supply, flood protection, soil erosion protection, irrigation, drainage, and traffic. It is also the most downstream of a total of 22 hydropower plants on the Drava River in general. It started producing electricity in 1989.

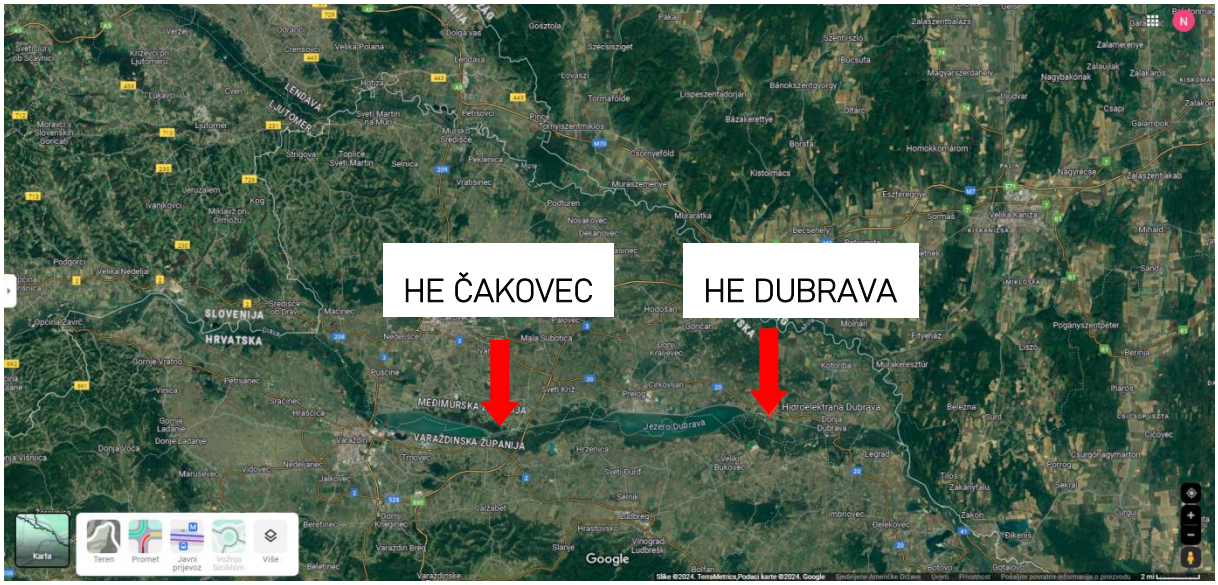


Figure: The location of the Čakovec and Dubrava hydroelectric plant plant (Source: Google Maps)

In 2019, the total electricity produced by hydroelectric power plants in the area of Medjimurje County in 2019 is 779.900,00 MWh, of which HPP Čakovec produces 385,5 MWh, and HPP Dubrava produces 394,4 MWh. The renewable installed capacity of hydropower plants is 157,20 MW. Of this, 77,4 MW is from the Čakovec hydroelectric plant, and 79,8 MW from the Dubrava hydroelectric plant.

These are the exact data available in the annual report of the national electricity distributor.

Tablica 5.1.2. Hidroelektrane u Republici Hrvatskoj — Table 5.1.2 Hydro power plants in the Republic of Croatia

Akumulacijske • Storage plants	Raspoloživa snaga • Available power [MW]	Proizvedena električna energija u 2019. godini (na generatoru) Gross Electricity produced in 2019 [GWh]
HE Zakučac	538	1 665,2
HE Orlovac	237	323,2
HE Senj	216	1 008,6
HE Dubrovnik	235	45,5
HE Vinodol	90	144,2
HE Kraljevac	46,4	54,7
HE PEruća	60	130,9
HE Đale	40,8	129,8
HE Sklope	22,5	82,4
Ukupno akumulacijske • Total storage	**1 485,7**	**3 584,5**
Protočne • Run-of-river		
HE Varaždin	94,6	455,2
HE Čakovec	77,4	385,5
HE Dubrava	79,8	394,4

Figure: Available power and produced electricity of hydropower plants (Source: Annual energy report Energy in Croatia)

Photoelectric

In the County of Medjimurje in 2019 the total installed capacity of photovoltaic power plants was 11,604 kW. This is the exact information available in the annual report of the distribution system operator HEP d.d..

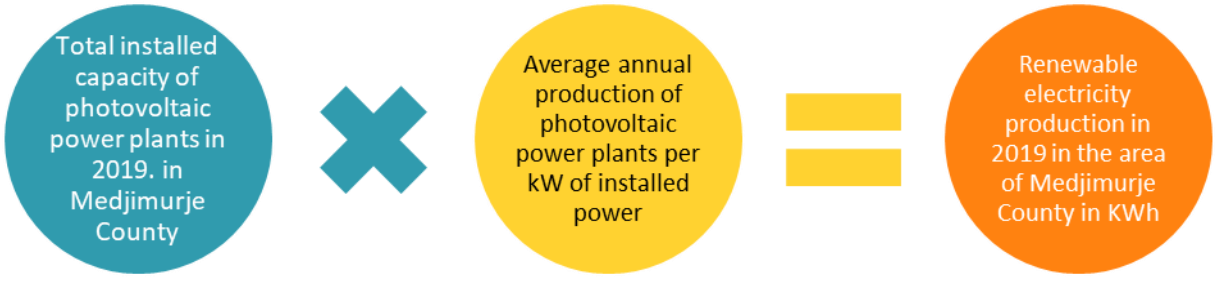
ELEKTRA ČAKOVEC

Broj obračunskih mjernih mjesta: **47.993**
Duljina mreže: **3.112,2 km**
Broj transformatorskih stanica: **541**
Instalirana snaga transformacije: **430,3 MVA**
Broj priključenih distribuiranih izvora: **149**
Priključna snaga distribuiranih izvora: **11.604 kW**
Broj radnika: **117**

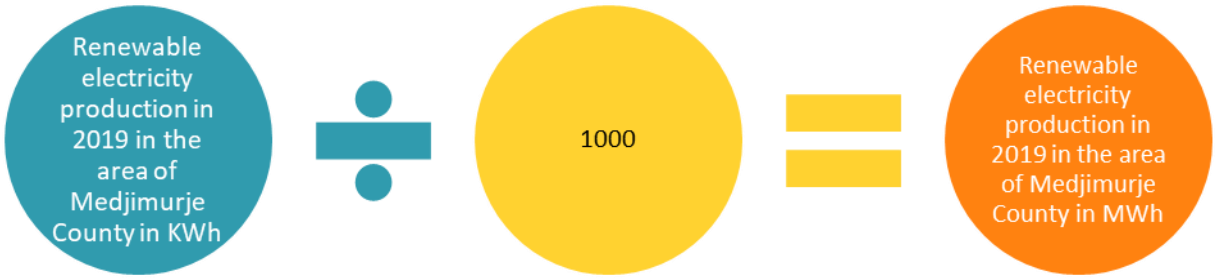
Figure: Information about the distribution area in Medjimurje county (Source: HEP ODS annual report)

The connected power of distributed sources is multiplied by 1.150 KWh, which represents the average annual production of photovoltaic power plants per kW of installed power. The obtained result of 13.344.600 KWh is divided by 1.000 to obtain Renewable electricity production expressed in MWh.

Renewable electricity production in 2019 in the area of Medjimurje County is 13.344,60 MWh. Renewable installed capacity was 11,60 MW.



11.604 kW — 1150 KWh — 13.344.600 KWh



13.344.600 KWh

13.344,60 MWh

Local/distributed electricity production

ENERGY INVENTORY DATA COLLECTION TEMPLATE

B2. Local/distributed electricity production

Local electricity production plants	Electricity produced [MWh]		Energy carrier input [MWh]											CO_2 / CO_2 eq. emissions [t]	
			Fossil fuels					Waste	Plant oil	Other biomass	Biogas	Other renewable	Other		
	from renewable sources	from non-renewable sources	Natural gas	Liquid gas	Heating oil	Lignite	Coal							Fossil sources	Renewable sources
Combined Heat and Power	0	202,2945	-	0	0	0	0	0	0	0	0	0	0	-	0
Other (ETS and large-scale plants > 20 MW not recommended)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	202,2945	0	0	0	0	0	0	0	0	0	0	0	0	0

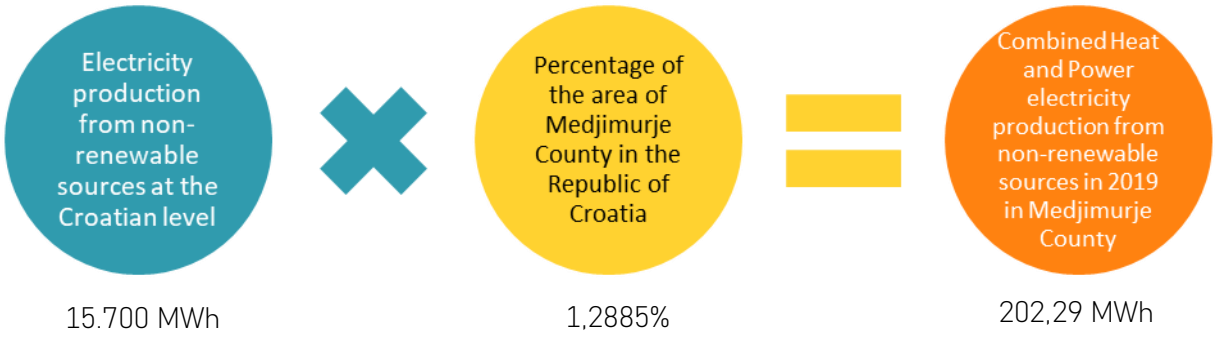
Combined Heat and Power

Combined Heat and Power electricity production from non-renewable sources in 2019 in Medjimurje County is 202,2945 MWh.

This is an estimated data based on the available data for the Republic of Croatia (available in the Energy in Croatia report) in relation to the area of Medjimurje County in the Republic of Croatia.

First, the percentage of the area of Medjimurje County in the Republic of Croatia was calculated. The total area of Medjimurje County of 729 km2 is divided by the area of the Republic of Croatia of 56,594 km2 and multiplied by 100 to get the percentage. The percentage of the area of Medjimurje County in the Republic of Croatia is 1,2885%.

Then the electricity production at the national level of 15,700 MWh was multiplied by the percentage of the area of Medjimurje County (1,2885%) in order to get the estimated production in the area of Medjimurje County.



Tablica 5.1.3. Termoelektrane u Republici Hrvatskoj **Table 5.1.3 Thermal power plants in the Republic of Croatia**

Termoelektrane Thermal power plants	Raspoloživa snaga na pragu Available net capacity MW	Proizvedena električna energija u 2019. (na generatoru) Gross Electricity produced in 2019 GWh	Gorivo Fuel
TE-TO Sisak	229,0	719,9	loživo ulje / prirodni plin uel oil / natural gas
TE-TO Zagreb	420,0	1 339,8	prirodni plin / loživo ulje natural gas / fuel oil
TE Rijeka	303,0	0	loživo ulje fuel oil
TE Plomin (A)	105,0	0	ugljen coal
TE Plomin (B)	210,0	1630,8	ugljen coal
EL-TO Zagreb	50,0	191,1	prirodni plin / loživo ulje natural gas / fuel oil
KTE Jertovec	76,0	1,3	prirodni plin / ekstralako ulje natural gas / extra light oil
TE-TO Osijek	89,0	56,2	loživo ulje / prirodni plin / ekstralako ulje fuel oil / natural gas / extra light oil
Ostale elektrane na bioplin Other biogas plants	51,9	383,9	bioplin/biogas
Ostale elektrane na biomasu Other biomass plants	75,5	477,1	biomasa/biomass
Geotermalne elektrane Geothermal power plants	10,0	91,9	
Industrijske kogeneracije CHP in Industry	157,3	369,5	ugljen/prirodni plin / loživo ulje/drvni otpad coal/natural gas / fuel oil/ wood
Ostale male kogeneracije Other small CHP	4,3	15,7	prirodni plin natural gas
UKUPNO • TOTAL	**1 781,0**	**5 277,2**	

Figure: Combined Heat and Power electricity production from non-renewable sources in 2019 (Source: Annual energy report Energy in Croatia)

Local heat/cold production

ENERGY INVENTORY DATA COLLECTION TEMPLATE

B3. Local heat/cold production

Local heat/cold production plants	Heat/cold produced [MWh]		Energy carrier input [MWh]											CO_2 / CO_2 eq. emissions [t]	
			Fossil fuels					Waste	Plant oil	Other biomass	Biogas	Other renewable	Other		
	from renewable sources	from non-renewable sources	Natural gas	Liquid gas	Heating oil	Lignite	Coal							Fossil sources	Renewable sources
Combined Heat and Power	0	0,78	-	0	0	0	0	0	0	0	0	0	0	-	0
District heating (heat-only)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	0,78	0	0	0	0	0	0	0	0	0	0	0	0	0

Combined Heat and Power

Combined Heat and Power produced from non-renewable sources is 0.78 MWh. This is accurate information available in the Register of renewable energy sources and cogeneration and privileged producers.

Vrsta postrojenja (Plant category)	Registarski broj (Registry number)	Naziv projekta (Project)	Nositelj projekta (Project coordinator)	Grupa (Plant type)	Županija (County)	Lokacija (Location)	Električna snaga (Electrical capacity (MW))	Toplinska snaga (Thermal capacity (MW))	Vrsta rješenja (Type of approval)	Datum izvršnosti (Date of enforceability)
⊟ Kogeneracije - Cogenerations (1)							0,3000	0,7800		
	⊞ 3955637-4647-0704/12	Kogeneracija Gradski bazeni Čakovec	Gradsko poduzeće ERDM d.o.o.	3.a.	Međimurska	ČAKOVEC	0,3000	0,7800		
Ukupno / Total: 1							0,3000	0,7800		

Figure: Combined Heat and Power produced from non-renewable sources (Source: Register of renewable energy sources and cogeneration and privileged producers)

Conclusion

Depending on the sector and the type of data, in most cases the exact data are easily available for Medjimurje region in this chapter. For data that wasn't available for the region, methods of extrapolation were used.

Various ways and methods on how to estimate consumption and production data when (some or all) data are not available, and ways of calculating the estimated energy consumption, are presented in this chapter.

Here are some tips on collecting and analysing data:

- Methods described in this document can help you to estimate data based on already available data
- Brainstorm with your team on methods that suit you (your region) the best regarding the data collecting and analysing
- Pay attention to measurement units and conversion
- Do not let the unavailability of (some or all) energy data discourage you when planning and creating data analyses

5. Take away messages

Exploring the Current Energy System: understanding a region's energy landscape is crucial as it involves gathering comprehensive data from all available sources. The analysis focuses on energy consumption patterns by sector (residential, commercial, transport) and assesses infrastructure. After collecting the data, the results are shared with stakeholders to gather feedback and validate the findings.

Setting up an Energy Management System: it is essential for the success of the process to appoint an Energy Manager to analyze energy consumption, perform audits, and ensure stakeholder communication. Energy data collection includes setting up the system, collecting data from municipal buildings, equipment, and facilities, and implementing actions based on cost-benefit analyses (CBA).

Developing an Energy Inventory: The Regio1st provides a relevant tool that categorizes energy consumption by sector and fuel type, helping regions develop accurate energy usage profiles for efficient strategies.

Challenges in Data Collection: Insightful examples from Asturias and Medjimurje County show how to manage and overcome obstacles like incomplete datasets in data collection.

Website:

https://regio1st-planning-framework.fedarene.org/

Social Media:

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