ANALYSIS OF HOUSEHOLDS’ ENERGY NEEDS IN THE 4 PILOT AREAS

Task 4.2 Mapping Households’ energy needs
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1. INTRODUCTION

Cities play an important role in addressing global climate change and in mitigating the risk of more frequent and extreme weather events and their impact on the cities’ residents. The energy used in cities’ buildings accounts for approximately 40% of the city’s total emission of carbon dioxide in the atmosphere, therefore addressing building energy performance becomes fundamental to encourage the energy transition process and, at the same time, to improve the comfort of the residents.

PadovaFIT EXPANDED brings together a strong consortium of 8 partners coming from four EU Member States. The Municipality of Padova (Italy) coordinates the consortium supported by Università Commerciale Luigi Bocconi (Italy), SINLOC (Italy), SOGESCA (Italy), Forum per la Finanza Sostenibile (Italy), Climate Alliance (Germany) and Energy Agency of Plodviv (Bulgaria), a European network of local authorities for sustainability. PadovaFIT EXPANDED starts from the knowledge and experience produced in the Padova area and aims at creating and piloting a One-Stop-Shop (OSS) dedicated to supporting citizens in the energy renovation of private residential buildings - not only condominiums but also private residential buildings.

Another goal for the project is to expand the business model to the city of Timisoara (Romania), who will benefit from the work done in Italy and will adapt it to the Romanian conditions, launching and managing a OSS itself. Finally, the Energy Agency of Plovdiv will support the metropolitan area of Vidin and Smolyan (Bulgaria) to take the example coming from Padova to prepare the conditions for the launching of a OSS in Bulgaria.

One of the actions to be undertaken, in order to prepare the ground for a sound conceptualization of the OSS in the four pilot areas, is the analysis of the state of conservation of the local building stock and its need for energy renovation.

According to the availability of data and the different timeline for the setting up of the OSSs in the 4 pilot sectors (Padova first, then Timisoara and finally Vidin and Smolyan with an action plan), the content of this deliverable includes a common methodological approach. Data availability for the municipality of Padova allowed a more in depth analysis of the territory and the subsequent selection of the intervention areas was based on data comparison that allowed a precise choice of buildings needing renovation based on accurate data on energy consumption. The data availability for the Romanian and Bulgarian pilot areas is less comprehensive therefore the methodology for the selection of the areas of intervention is not as punctual as the one for Padova. However, the areas of intervention for the municipality of Timisoara and the two municipalities of Vidin and Smolyan were selected and will be illustrated below in chapter 5 and 6.

Coherently with the work done in parallel by SINLOC on the available economic and financial information about households in the pilot areas and the analysis of all possible risks and barriers that could undermine the deployment of energy solutions and sustainable and bankable interventions, the purpose of the work carried out in this report is mapping of the energy needs of the families living in the city of Padova, Timisoara, Vidin and Smolyan. For the municipality of Padova, given the abundance of available information, a methodology was developed to elaborate all the information related to the area: data concerning the energy consumption and the performance of the building envelope and on the thermal and cooling plants and the plants for the production of energy from renewable sources.
2. METHODOLOGICAL APPROACH FOR DATA COLLECTION

The purpose of the work in this report concerns the mapping of the families’ energy needs and building energy performance in the cities of Padova, Timisoara, Vidin and Smolyan.

To start collecting information, a data request list was formulated in collaboration with SINLOC, the project partner responsible for mapping families’ financial capacity, to better understand which data the interested municipalities would be able to provide.

The data sought were the following:

- Building type
  - condominium
  - terraced house
  - single house
- Average age of buildings
- State of conservation of buildings
- Energy class of buildings
- Type and average age of the technological plants
- Possible energy requalification interventions already carried out
- Average annual electricity consumption
- Average annual consumption of natural gas
- Subdivision of energy consumption within the typical dwelling (data from energy diagnosis)
- Purchase price of energy carriers
- Price for carrying out efficiency improvement measures
- Number of apartments on the same condominium
- Number of residents
- Type of occupants
  - Single
  - Singles with one or more young children
  - Singles with one or more older children
  - Couple with children
  - Couple without children
  - Elderly (> 65 years)
- Average age of occupants

We tried to immediately highlight the need to have consistent data (with the same reference) so that the data could be linked and cross-referenced to correlate them, whenever possible. To carry out a more precise mapping, it would be necessary to have the data of each building, but this is nearly impossible due to the extreme detail required and possible privacy issues. A good compromise between having punctual data and respect for privacy is represented by requesting data divided by the census sections.
The census section is the minimum unit of the survey of the municipality based on which the census survey is organized. It consists of a single body bounded by a closed broken line. Starting from the census sections, it is possible to reconstruct, by summing them, the upper geographical and administrative levels (inhabited areas, sub-municipal areas, etc.). Each census section must be completely contained within one and only one municipality. The municipal territory must be exhaustively divided into census sections and its subdivision allows us to allocate all the information surveyed, also relating to the population and buildings. This level of information was only available for the municipality of Padova in Italy.
3. MAPPING HOUSEHOLDS’ ENERGY NEEDS IN THE CITY OF PADOVA (ITALY)

In this phase of the project, data collection was carried out concerning the current state of the building stock and the mapping of the financial capacity of the families residing in the Municipality of Padova using all available resources to obtain the most up-to-date and punctual values. Some indicators that may be relevant to quantify the energy demand are listed below: consumption of electricity and natural gas, information on the structure of the building, number of components for each resident family, indicators of energy poverty, map of energy consumption.

An analysis of the information collected led to identify which areas of the city have the greatest potential to be chosen as a starting point for the application of the measures developed by the PadovaFIT EXPANDED One Stop Shop, once operational. In other words, it is necessary to identify a certain number of buildings located on the municipal territory that can be chosen as "pilot buildings" (PadovaFIT Pioneers) and become a sort of showcase of all the services that the One-Stop-Shop can provide to citizens wishing to carry out energy efficiency measures in their homes, with the dual objective of reducing consumption (and costs) and increasing comfort.

Residential buildings, especially condominiums, are complex entities whose management can be complicated; the technical and non-technical variables may change depending on the time, place and type of residents; it is therefore essential to focus on a precise target of buildings to measure the potential and the aspects to be improved of the selected approach. The choice of pilot buildings has the function of testing all the steps of the process of energy renovation offered by the OSS to fine-tune the service and deliver quality measures with consequent satisfaction of the owners. They can take on the role of promoters of the initiative, positively publicizing the OSS to their contacts and neighbors and, consequently, increasing the number of citizens interested in exploiting the services offered.

Data collection was carried out by consulting the S.I.T. (Territorial Information System), which is the operating unit of the municipality responsible for the acquisition, control, and organization of spatial, cartographic and related data. To protect privacy, we have chosen to request data aggregated by section of census, allowing us to work with values with a good degree of detail, always guaranteeing the anonymity of the individual citizens. In the Municipality of Padua, there are 1,760 different sections of census due to a surface extension of the municipal area of just over 93 km²; the ratio between the two values results in an average surface of 0.053 km² per section of census, ensuring the possibility to look down for details to try and identify the areas of the municipal territory that have the greatest potential for energy efficiency interventions.

The municipality of Padua is divided in 1,760 census sections: this means that it is possible to have precise data to describe the energy situation. However, it has not been possible to recover the data concerning the subdivision of energy consumption within the typical house (lighting, cooling, walls, windows, ...), the energy upgrading works carried out in the past and the price paid for such interventions. On the other hand, the remaining data were recovered and made available by census section.
The elaboration by S.I.T. allowed us to obtain the following data that have been organized in tables to be able to have a general overview and proceed with further considerations:

- Housing occupied by residents and non-residents (or empty);
- Surface of houses occupied by at least one resident person;
- Number of families living in rented / owned households;
- Total resident families and number of members of resident families;
- Classification of the number of families by number of members in the household;
- For each section of census: number of buildings, number of buildings used and the distinction between buildings for residential or other uses;
- Distribution of buildings by construction technology;
- Subdivision of residential buildings by construction period;
- Subdivision of residential buildings by number of floors above ground;
- Subdivision of residential buildings by number of internals;
- Subdivision of residential buildings based on conservation status;
- Consumption and expenditure for electricity in kWh for residential buildings of a given section in 2017;
- Consumption and expenditure for natural gas in Sm$^3$ for residential buildings of a given section in 2017;
- Consumption and expenditure for electricity in kWh for residential buildings of a given section in 2018;
- Consumption and expenditure for natural gas in Sm$^3$ for residential buildings of a given section in 2018;
- Data relating to the payment of the TARI (rubbish) tax.

Regarding electricity consumption, it is important to make a clarification: the consumption data on which the analyses will be made are not global, but only include contracts related to the safeguarded category regime (consumers that have chosen not to buy electricity on the liberalized market); results for this sector are therefore impacted by data availability . Consumption data on natural gas are available in their entirety resulting in more precise conclusions.

Padova is a city with just over 210,000 inhabitants and with a density of 2,263.64 inhabitants / km$^2$ (2017). It is the most densely populated city in Veneto Region: counting the entire metropolitan area, the population rises to more than four hundred thousand inhabitants. From the analysis of the distribution of the population by section of census, we noticed how some areas are much more inhabited than others. This is reflected by the number of houses present and occupied by at least one resident person. A further consideration is that when the number of residents in a given section of census increases, the number of buildings with more than one or two floors increases; the most obvious repercussion is the increase in building density, passing from having a landscape with mostly single and two-family houses to one where the majority of buildings are condominiums. Therefore, if we want to focus the attention on this type of buildings, the focus should be on the most densely populated areas of the city.

Padova is characterized by a negative demographic trend with a tendency to a progressive aging of the population, a phenomenon that characterizes Italy as a whole. The average age is, in fact, equal to 46.8 years (up 1.4 years in the 2009-2019 period) and more than a quarter of the residents are over 65 years old. The increase in the average age of the population can lead to a consideration: an older person is generally less
inclined to invest than the average, especially if the return on investment is rather long term, as may occur in the event of the most expensive efficiency improvements such as the insulation of the external walls through a coat or the installation of solar panels. Therefore, there can be resistance to change the status quo and difficulty in accepting to change habits just for the advent of new technology.

Load-bearing masonry is the prevailing construction technology of the building stock, accounting for 63% of the buildings in the city. Another 30% was built using reinforced concrete and the remaining buildings using alternative materials. The sections of census characterized by a high number of buildings in reinforced concrete have an equally high value of buildings with two or more floors as this type of technological solution is rarely used for the construction of single houses. Reinforced concrete has several advantages: good resistance to various types of structural stresses (compression, traction, flexural and torsional resistance), easy availability and cheapness of elementary components (concrete, sand, gravel, steel rods), relative ease and speed of execution. Among the advantages the excellent durability of the structures can be included. However, an essential condition is that the concrete mixture completely covers the reinforcement bars; otherwise, the process of oxidation of the metal reinforcement will start with a consequent increase in its volume, which induces tensions over the whole structure causing their progressive disintegration. By crossing the data that indicate the classification of the state of the building, from optimal to very bad, it is possible to understand where critical situations exist where it is most necessary to intervene. In principle, the greater the need for renovation of the building, the greater the propensity of those who live there to accept a renovation proposal: therefore, this should have the dual effect of increasing the value of the property and increasing its comfort for those living there.

Out of 30,886 residential buildings located in the municipal area, 7% are single-storey buildings, 52% have two floors, 23% three floors and, finally, 17% have four or more floors. As already mentioned, we observe that in general the majority of the building stock is composed of semi-detached houses and small apartment buildings, although there are sections of census where the weight of condominiums is preponderant, generally characterized by having a high population and building construction years between the 60s and 80s. Many condominiums dating back to that period of the last century have modest energy performances, falling into class G and with an average annual energy requirement of 180 kWh / m².

The choice to focus the OSS activities also on apartment buildings presents several difficulties: firstly, it is usually the type of building where energy efficiency measures are less likely to be carried out, especially compared to single-family homes. Furthermore, the main problem affecting the implementation of large-scale energy efficiency measures in apartment buildings is the difficulty residents face in finding a common agreement. This is also because of the lack of knowledge and the difficulty in grasping the economic benefits that this type of intervention entails. Furthermore, we are witnessing a worrying increase in energy poverty: by definition, a family is in energy poverty if it has difficulty in purchasing a minimum basket of energy goods and services, or when accessing the energy services involves having to commit a share of its income above a "normal value". The impact of energy consumption (and related costs) on the total household expenditure is a key indicator to measure energy poverty. Among the types of intervention to be implemented to resolve energy poverty contained in the "2019 Energy Poverty Report" drawn up by the Italian Observatory on Energy Poverty, the main one is to undertake actions for the energy efficiency of homes.

The scarce energy competences also registered among those who have roles of management in condominiums represents a further issue. Therefore, the OSS will need to support the building managers in every step concerning the renovation process: from the initial involvement of citizens up to monitoring actions.
after work is completed. It is necessary to overcome the fear of collectively borrowing as a condominium by providing a solution tailored to the needs of the individual units, selecting the financing options among the many already existing possibilities (EPC through ESCO, credit transfer, ad hoc financial products, etc.). An additional challenge in operating on condominiums is the high incidence of rented houses, also due to the university presence in the city of Padova where a large number of students (out of a total of ca. 60,000) find themselves in need of renting accommodation for the duration of their studies. Also, in this circumstance, it is necessary to elaborate a strategy to overcome the resistance of the owners of the house and push them to invest in the presence of tenants or as an investment in anticipation of a future sale to see the value of their property increased.

Further considerations can be made by analyzing the consumption of electricity and natural gas for each section of census. In particular, to have values that can be coherently compared, we proceeded by comparing consumption, in kWh and Sm$^3$ respectively, with the data relating to the surface area of the houses occupied by at least one resident person: specific consumption was therefore obtained for each section of census. A further refinement was to transform everything into toe using the following conversion coefficients:

- Electricity: 1.87E-04 toe/kWh
- Natural gas: 8.36E-04 toe/Sm$^3$

Summing up the two distinct consumption values, the total specific consumption for the year 2018 was obtained, this made it possible to identify the sections of Padova with the highest energy consumption. In fact, after ordering the sections of census from the one with the highest energy demand up to those in which there is no consumption, it is possible to select the areas with the greatest potential, that is, in which areas we could obtain the greatest savings for the same building intervention, increasing the effectiveness of the action itself.

Similarly it is possible to study consumption by relating it to the number of components that reside in the particular section of census: in general, there is a correlation between this value and that previous one referred to the surface. The third and final elaboration was relating the expenditure of electricity and natural gas to the number of components of the census section to obtain how much on average a resident spends in a year to satisfy his/her energy demand. There is a trend that is consistent with what was observed in the previous cases: the greater the specific consumption, the higher the expenditure to be incurred. An aspect to be emphasized is the presence of sections of census with high electricity consumption and almost zero natural gas consumption, a sign that needs such as space heating and cooking are satisfied in an alternative way to the use of boilers and gas stove.

Once we concluded this first analytical phase, it was possible to translate the data collected into maps produced using G.I.S (Geographical Information System), to have a smoother and more immediate visualization. In particular, the maps produced will be used for further processing that will be carried out during the subsequent phases of the project.

Through the G.I.S. elaboration, it was possible to represent the data provided by the Municipal S.I.T. on the map of the city of Padova divided by sections of census, obtaining a distinct graphical representation. It was
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possible to obtain 24 different cartograms that can be used to better analyze the current state of the building stock, having an overview of the city allowed by the display of the map of the entire municipality. The way the data is represented on the graphic representation differs depending on the type of data:

- Representation by applying the min-max normalization technique: this method requires that the type of data selected undergoes a process of resizing on a fixed interval, generally from 0 to 1. It is a good technique when the data distribution is unknown. The formula used is the following:

  \[ Z = \frac{x - \min(x)}{\max(x) - \min(x)} \]

  With this method we were able to represent: the surface of the houses, property, number of families, number of residents, number of family members, number of residential buildings, construction period, number of floors above ground, number of interiors per household, total number of interiors, state of conservation.

  Advantages: the possibility of having comparable data without taking care of the unit of measurement.

  Disadvantages: if one or more values are significantly different from the average of the values of the selected class of data, the result is a general flattening of the representation, making the majority of the sections of census fall within the same interval, decreasing the representativeness of the map.

  From the analysis of the maps, we obtain a very similar trend between the surface of the section of census destined to residential buildings and number of families; the trend is consistent since the denser a population, the greater the housing need; therefore there is a significant number of residential buildings out of the total number of buildings in the census section.

  Regarding the construction period, there is a higher presence of buildings of more recent construction as we move towards peripheral areas of the city, with only a few isolated exceptions. In general, however, only 4% of the residential buildings were built after 2000: therefore, we start from a generalized situation of old to very old buildings. The vertical development of the city that is the greater concentration of condominiums can be found in the semi-central areas of the city and the densely populated area located just north of the railway station. The high number of condominiums can also be found in the representation that illustrates the number of dwellings per household.

  The state of conservation of the buildings is generally good even if critical issues characterize some sections of the city, and buildings are semi-abandoned.

- Representation by application of Jenks natural breaks classification: this method requires that the type of data selected is grouped in such a way as to determine the best arrangement of values in
different classes. This is done by trying to minimize the average deviation of each class from the class average while maximizing the average deviation of each class from the averages of the other classes.

• With this method, we represented electricity consumption in 2018 (kWh), electricity expenditure, gas consumption in 2018 (Sm³) and gas expenditure.

• Where consumption is high, energy expenditure is high. In general, the trend follows that of the population, as consumption is higher in the census sections that have the largest number of residents.

• Representation through the application of the quantile classification technique: this method foresees that the type of data selected is divided into 5 classes with the same number of elements - in each of the classes, we have the same number of sections of census. Each class is represented on the map by a different color and, consequently, each section of census will have the color corresponding to the class to which it belongs.

• Advantages: within the type of data selected, the presence of values that deviate too much from the average does not create problems because these peaks do not influence the division into intervals.

• Disadvantage: the data can be influenced by the number of buildings present in the specific section of census, making poorly inhabited census sections appear on the map as those characterized by the worst consumption.

• With this method, we represented the consumption of electricity and gas per m², consumption of electricity and gas per capita, total consumption in toe per m² and per capita, total consumption in toe, expenditure for electricity and gas per capita.

• The analysis of the graphical representations produced with the types of data that have been represented using this method is much more significant. It is immediately evident that a high electrical consumption per unit area does not always correspond to equally considerable consumption of natural gas since it can be explained by the fact that a part of the thermal demand could be satisfied through the consumption of electric energy. The total consumption in toe per m² highlights the fact that it is not correct to assume that in the sections of census where there are the greatest consumptions there is also the highest specific consumption: in this case, we notice that consumption peaks expressed in toe per m² are reached near the city center and in areas of the city characterized by having buildings whose construction period is less recent. Comparing the map that illustrates the specific consumption with the one showing the consumption per capita, we notice a general similarity, with the central areas taking on an even greater incidence than previously noticed. Finally, the per capita expenditure for electricity and natural gas corresponds to what was described above.

An important clarification: the values regarding the number of residential buildings, the age of construction, the number of floors above ground, the number of internals per house, the total number of dwellings and the state of conservation of the houses refer to the last ISTAT census dating back to the year 2011. Consumption data
are related to the years 2017 and 2018 (in particular, the elaborations for the year 2018 will appear). This aspect can give rise to results that are clearly “out of scale”: a specific consumption clearly higher than that of the other sections of census can be due, for example, to the increase in the number of houses built on the section of census in analysis, with a consequent increase in consumption. It is appropriate to consider the possibility of discarding the cases where this type of trend occurs, which can lead to incorrect considerations in identifying the sections of census that have the greatest potential for energy renovation.

The map below shows the city of Padova divided in its 6 administrative neighborhoods:
The PadovaFIT Expanded project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement N° 847143.

This map shows the sections of census divided into five classes according to the average age of construction of the buildings present in the section. In this case, the representation was obtained using the technique of normalization with the max-min method, which allowed to associate to each section of census a value between 0 and 1, where the greater this value is, the more recent the construction of the buildings contained in the section is. We notice a situation with buildings of more recent construction as we move towards the boundaries of the city, with some isolated exceptions located in the most peripheral areas, which are in red. This anomaly is usually due to the presence of a single house (by now obsolete) located in the census section, which affects the entire classification of the section.
This map shows the sections of census divided into five classes according to the state of conservation of the houses that are present in the section. In this case, the representation was obtained using the technique of normalization with the max-min method, which allowed to associate to each section of census a value between 0 and 1: the higher the value, the better the state of conservation of the buildings contained in the section. We observe that the sections of census characterized by buildings kept in excellent or good condition, with rather rare exceptions, are well distributed on the municipal surface.

Some areas in red may have a precise motivation: this anomaly is usually due to the presence of a single house (now in a state of abandonment) located in the census section, affecting the entire classification of the section.
The PadovaFIT Expanded project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement N° 847143.

MAP 3 – Specific consumption of electricity (kWh/m²)

In this map, the sections of census have been represented divided into five classes according to the specific consumption of electricity in the year 2018. The technique used is the representation by quantiles, which allows obtaining a map that does not take into account the presence of areas with particularly high or almost no specific consumption. On the one hand, this type of representation appears to be advantageous to have an overall view of the city without the risk of having the sections of census concentrated within a single class; on the other hand, in the two extreme intervals, we find sections where the consumption values are very different. For example, in six sections of census (identified by the number 851, 743, 243, 867, 1484, 1522) there is a specific consumption exceeding 200 kWh/m²: these are characterized by the presence of maximum four houses built in the territory they represent, with the total value of the surface of the residential buildings that are very small compared to the consumption of electricity; this circumstance considerably increases the ratio between them, recording peaks of specific consumption that significantly deviate from the average of all the sections of census (20.83 kWh/m² in 2018).
MAP 4 – Specific consumption of natural gas (Sm³/m²)

In this map, the sections of census were represented divided into five classes according to the specific consumption of natural gas for the year 2018. The technique used is the representation by quantiles, which allows obtaining a map that does not take in consideration the presence of particularly high or almost zero specific consumption areas. On the one hand, this type of representation has the advantage of giving an overall view of the city without the risk of having the census sections concentrated within a single class; on the other hand, in the two extreme intervals, there are sections where the consumption values are very different. For example, in four sections of census (identified by the number 115, 243, 1522, 743) there is a specific consumption exceeding 100 Sm³/m²; these are characterized by the presence of at most 1-2 houses built on the territory they represent, with the total value of the surface of the residential buildings that are very small compared to the gas consumption; this circumstance considerably increases the ratio between them, recording peaks of specific consumption that significantly deviate from the average of all the sections of census (10.3 Sm³/m² for the year 2018).
MAP 5 – Total specific consumption (toe x 1,000/m²)

In this map, the sections of census are divided into five classes according to the total specific consumption for the year 2018, adding the consumption of electricity and natural gas after having converted them to toe using the appropriate conversion factors. The technique used is the representation for quantiles, in which each class refers to the same number of sections of census. As already identified in the two previous maps, there are sections of census that have consumption that deviates from the class average (whether they are very high or zero), whose description is impossible with the use of this type of data normalization. From the overview of the city, we can see how difficult it is to identify large areas where specific consumption is high. In fact, we note that the distribution is almost uniform along the entire city surface, an eventuality that we could have deduced from looking at the two previous maps. In particular, we note that the map of the specific consumption of natural gas is largely overlapping, an aspect that suggests that the demand for energy for space heating influences the trend of total consumption. The average total specific consumption is $12.51 \times 10^{-3}$ toe/m².
4. Mapping households energy needs in the city of Padova: conclusions and further steps

The result of this initial analysis represents the starting point in the process of identifying a number of buildings that have the greatest potential to become PadovaFIT EXPANDED "case study buildings". This was done by selecting the census sections according to the following criteria:

- total specific primary energy consumption greater than 15.62 toe x 1000/m²;
- specific natural gas consumption greater than 13.5 Sm³/m²;
- at least 10 residential buildings in the census area.

The total specific primary energy consumption is considered as a parameter to select the case studies since it includes both thermal and electric energy (even if the latest data are partial). Thermal consumption is considered because most of the interventions for the energy upgrading of buildings will result in a reduction of thermal energy consumption. Finally, with the aim of selecting sections of census containing buildings of interest, the sections with few residential buildings were excluded.

The census sections meeting the criteria outlined above, and therefore more interesting for the buildings' energy refurbishment are 105; the graphic result of these sections is represented below.
The result of this initial analysis represents the starting point in the process to identify a number of single buildings that have the greatest potential to become PadovaFIT EXPANDED “pioneer buildings”. The next steps are:

Check if in the selected census section there are buildings meeting certain parameters (such as building type, energy class, etc.);

Look for the most interesting buildings in the database showing gas consumption in 2018 for each building of the Municipality: by doing this, we can identify (besides the section of census) also the street name and the street number where they are located;

From the address we can find at least one-two buildings with a valid Energy Performance Certificate (APE in Italian) with relevant performance data and, possibly, a list of potential improvements to be used as a starting point;

The Financial aspects will be explored by SINLOC, the project partner leading the mapping of households’ financial capacity.

Further steps also include the merging of the results of the mapping of energy needs with the mapping of households’ financial capacity to find the right strategy to approach most kinds of technical and financial needs of potential beneficiaries of the services of the one-stop-shop.

The same methodological approach will be suggested for the 3 project pilot areas to be selected in Romania and Bulgaria. However, the possibility to use this methodological approach highly depends from data availability.
5. Mapping households energy needs in the municipality of Timisoara (Romania)

Timisoara is a city with a polynuclear urban structure. The current urban structure, as a result of historical evolution, is relatively clear: in the middle of the city lies the historical center (Cetate neighborhood) around which the other neighborhoods gravitate. Due to their independent development, they have distinct functional and architectural characteristics. Two linear elements, parallel to each other, running from east to west - the Bega canal and the railway to Bucharest - divide the city into a southern half and a northern one. At the same time, these two elements provide the geographical limit of the city center. The development of the city over the last few decades, as well as that of the main traffic arteries, have caused previously disconnected areas of the city to merge, forming a radial & concentric unitary structure.

![The territorial evolution of Timisoara between 1750 and 1998](image)
Today, the center of the city is separated from the other areas quite clearly, from a spatial point of view. In the northern part, the separation is done by the railway line and by the old industrial areas behind it, and in the southern part by the parks located along the banks of Bega channel. The rest of the city is characterized by several very different structural types that are not clearly delimited from one another due to their evolution over time. Outside of the city center, the following structural types are present:

- Historic suburbs
- Neighborhoods of villas
- Condominium areas of the communist period
- Areas with rural characteristics
- Old industrial areas
- New industrial and commercial buildings and new housing units

In order to identify the areas most suited for intervention and most relevant in the frame of the PadovaFIT EXPANDED Project we are taking into account three main factors:

- Built Urban Environment (type of building present in the area and it's suitability for integrated refurbishment measures)
- Projected Impact (how many people will potential refurbishment actually impact based on population density)
- Observed Willingness of Owners (how likely owners associations are to want to participate in a program focused on building rehabilitation based on past experiences)
Build Urban Environment

The various stages of territorial evolution of the city and the necessity of satisfying different functions caused the appearance of different types of urban morphology:

1. The type established during the time when the city came under the administration of the Austrian crown characterized by relatively narrow streets, without vegetation, with multi-storey buildings forming continuous road fronts.

2. The second morphological type is similar to the first. It was common for the second half of the nineteenth and early twentieth centuries and is characterized by multi-storey buildings forming continuous fronts, found mostly in compact assemblies, built in order to unite the Cetate neighborhood (city center) with the other historic neighborhoods such as Fabric and Iosefin.

3. Dating from the first half of the 20th century, the third morphological type is represented by neighborhoods of villas that appeared predominantly in the spaces that remained undeveloped between historical neighborhoods. At the periphery of the city, this morphological type sometimes resembles rural settlements but these areas have been developed with houses of western inspiration since the fall of the communist regime.

4. Lastly, the 4th morphological type is represented by condominium buildings typical of the communist and post-communist eras. These are buildings between 4 and 10 stories (sometimes more) with industrial, residential and socio-cultural functions. These appear either in the form of large assemblies in the areas previously undeveloped, or, in isolation, within historical neighborhoods.

The actual stock of buildings for residential use as of 2002’s Census is of 23,233 buildings. Of these, around
40% were built up to 1944 and around 30% up to 1970. Approximately 70% of the residential buildings in Timișoara are between one hundred years old - the oldest - and about 30 years old in the case of the newer ones. Around 30% of residential buildings are 30 years old and younger. This in itself presents a challenge.

Taking into account the characteristics described for the various urban morphologies, and the fact that in the case of historic buildings the legislation is far less friendly to integrated energy efficiency solutions (e.g. it is impossible to apply thermal insulation to facades or install modern windows due to the fact that it is illegal to modify them from an architectural and aesthetic point of view), the areas of focus from the perspective of the built urban environment should be those where the 4th morphological type predominates, and more specifically neighborhoods developed during the communist era, where the age of the buildings and the fact that energy efficiency was not a priority for the communist state provide ample opportunities for intervention.

Projected Impact

In 2015, Romania's overcrowding rate was 49.7%, the highest of the EU-28 countries, three times the average of 16.7%. The overpopulation rate among the population at risk of poverty in Romania was 63.7%.

Over the past 5 years the population of the City of Timisoara has seen a slight decline. However, this is on par with the previous observed trends. The evolution of the number of inhabitants of Timisoara during 2007-2012 was fluctuating. Thus, if in the 2007-2009 period the number of inhabitants with permanent residence in Timisoara sees a strong upward evolution with the maximum being reached in 2009 while from 2010 to 2012 the number decreases slightly.

![Municipality of Timisoara - Population](image)

Source – Romanian National Statistical Institute – Timis County Regional Directorate (provisional data for 2019)

The city of Timisoara forms the most densely populated area in Timis County and one of the most populated nationally. The average value of the surface / inhabitant indicator, for the analyzed period, is 0.04 ha / inhabitant in the municipality of Timisoara (1.3 ha / inhabitant at county level).
Due to the massive migration of people towards urban areas that started in the 1960s, the communist government was forced to build a large number of cheap, affordable housing. Many of the areas with the highest density of population in Timisoara are the areas developed during the communist regime. Thus, from the perspective of projected impact, a focus on these areas is appropriate.

**Observed Willingness of Owners**

Contrary to public buildings where the municipality has control over the nature and timings of works, in the case of private residential buildings, apartment owner associations are often reluctant to undertake renovation works on their own or capable of supporting the costs ensued. However, thermal rehabilitation registered positive, albeit modest developments during the 2009-2011 period when the local administration of the Municipality of Timisoara, through the local multi-annual Growth Program for the Energy Performance of condominium buildings helped 61 owners associations cover the costs of the thermal rehabilitation of their buildings. The program saw 80% of the costs covered by the national and local government with the owners associations only having to provide 20%. Similarly, retrofitting and rehabilitation works for private condominium buildings were supported through the 2007-2013 and 2014-2020 Regional Operational Programs respectively, where owner associations would have to make a contribution of 25% of costs. These programs involved a more integrated approach to building rehabilitation with measures including: exterior thermal insulation, closing off open balconies, replacing low performance doors and windows, thermal insulation and waterproofing of rooftops, thermal insulation of basement flooring or insulating heating pipes and fitting taps with thermostat heads.
In other cases, private developers agreed to take on the costs for the thermal rehabilitation of condominium buildings in exchange for the owners association agreeing to allow the developer to build an additional floor over the existing ones (where the structure permitted) and sell off the resulting apartments at his discretion.

The fact that there are still approx. 900 unfinanced applications from owners associations to join the rehabilitation program through the 2014-2020 Regional Operational Program show a willingness from the part of the owners but also reveals that public funding can only go so far. For this reason, the Municipality of Timisoara believes that it is important to develop a one-stop-shop in order to support the existing demand by providing an entity capable of providing the know-how, supplier contacts, financing option, etc. in one place.

In order to identify the areas to focus on from this point of view, we split the 900 unfinanced application mentioned above according to their geographical location and found out that the largest concentration of applications can be roughly grouped into four distinct areas of the city. These areas are located roughly in the N-NE, S-SE, S-SW and C-W, namely the areas roughly comprising the Torontalului-Aradului-Lipovei neighborhoods, Girocului-Soarelui neighborhoods, Sagului-Dambovita neighborhoods and Circumvalatiunii-Dacia neighborhoods respectively. All of these neighborhoods are comprised to a relatively large degree by condominium buildings dating back to the communist era.

Conclusion

Taking into account the fact that communist era condominium neighborhoods provide some of the best rehabilitation opportunities from a structural point of view, the population density data provided and the geographical distribution of potential demand for the services of a one-stop-shop in building rehabilitation the Municipality of Timisoara’s main focus will be on the areas mentioned above. The target areas are marked in red on the picture below:
The PadovaFIT Expanded project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement N° 847143.
6. Mapping households energy needs in the municipalities of Vidin and Smolyan (Bulgaria)

Methodological approach for data collection

The last Census in Bulgaria was held in 2011 and the next one will be held in 2021. The statistical information, provided by National Statistical Institute (NSI) in Bulgaria is out of date or is not available with the same level of detail provided by the Territorial Information System (S.I.T) in Padova municipality.

The municipalities of Vidin and Smolyan do not have an administrative separation of the territory by city districts. All available data are given at municipal level hence the main barrier for applying a methodological approach in line with the one adopted by the municipality of Padova is that the statistical data from NSI are available at municipal and regional level. There is no available information at district level.

Moreover, no data base for energy performance of buildings has been completed for Bulgaria. The energy profile of the existing residential building stock has been prepared on the basis of the information set of surveyed and certified residential buildings in the period 2015-2019, maintained by SEDA (Sustainable Energy Development Agency).

Collected data

The Energy Agency of Plovdiv analysed data from the municipal programs, strategies and surveys in order to collect more information. Statistical data for electrical and thermal energy consumption are available at national level.

Heating of the dwellings in Bulgaria is provided mainly by wood and coal (53.9%), followed by electricity (28.6%), central heating (heating plant, supplying households with heating and domestic hot water - 15.1%) and central gas (1.3%)1. The latest is a gas transport infrastructure with the presence of a gas supplier (operator/company). The households are connected to the gas supplying system in city.

In order to analyze the energy consumption at municipal level, the Energy Agency of Plovdiv used data from the municipal programs, strategies and surveys. The Energy Agency of Plovdiv used data for the household energy consumption by analyzing the following available information:

For the municipality of Smolyan:

- Municipal Program and action plan for Air quality
- SEAP Monitoring report
- Data from InventAir Project
- Data from the energy audits of the renovated dwellings
- Survey through the households on municipal level

For the municipality of **Vidin**:

- **Municipal Development Plan for Vidin Municipality**
- **Municipal and action plan for Air quality Program**
- **Municipal Programme and Action Plan for Energy Efficiency**
- **Municipal Programme for integration of RES and use of biofuels**
- **Plan for Energy Efficiency for Vidin District**
- **Data from the energy audits of the renovated dwellings**
- **Survey through the households on municipal level**

In **Vidin**, energy consumption shows a high share of electricity (38%), coal (23.5%) and raw wood (20.2%). The use of fuel oil and gas oil is also high (10.1%). Fuel oil and gas oil are used for heating municipal buildings and in the industrial sector. In 2016, the final energy consumption of Vidin was 297 GWh. The largest share in the housing sector with 223 GWh or 75%, followed by the industrial sector with 51 GWh or 17%. The share of the Municipal Buildings and Facilities sector (3%) and Municipal Lighting (1%) is relatively small. Transport in Vidin represents 3.8% of the final energy consumption.

According to the process of monitoring the SEAP in the municipality of **Smolyan**, around 80% of the final energy consumption of the city belongs to buildings and facilities having biomass (44%) and electricity (26%) as primary energy sources. The buildings and facilities sector account for 81% of the CO₂ emissions, with electricity accounting for 72% of the CO₂ generated. The residential sector has the greatest share of the final energy consumption (75%) and has also significant impact on the emissions – 68% of the CO₂ emissions and 98% of the particulate matter emissions. Thus, special attention needs to be paid to the residential sector and the most intensive measures need to be realized within it. The energy mix in the residential sector is mostly comprised of electricity, wood and coal, and pellets. Even though the electricity for domestic use (incl. heating) has a 26% share in the final energy consumption in the residential sector, it corresponds to 92% of the CO₂ emissions. The raw wood for heating has the biggest share – 69%, and even though it has no impact on the CO₂ emissions, it is responsible for 95% of the particulate matter pollution.

**Energy consumption** of the residential buildings sector at municipal level is reported in the table below:

<table>
<thead>
<tr>
<th>Area of analysis</th>
<th>Electrical consumption [kWh]</th>
<th>Coal Consumption [kWh]</th>
<th>Wood for heating consumption [kWh]</th>
<th>Wood pellets consumption [kWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipality Smolyan</td>
<td>40,000,000</td>
<td>9,500,000</td>
<td>80,000,000</td>
<td></td>
</tr>
<tr>
<td>Municipality Vidin</td>
<td>85,569,000</td>
<td>69,660,000</td>
<td>59,885,000</td>
<td>7,368,000</td>
</tr>
</tbody>
</table>

About 97% of the dwellings in Bulgaria are privately owned, 96.5% owned by individuals and 1.1% by legal entities (2011 Census, National Statistical Institute) and by a large majority are inhabited by the owners. Only 2.4% of the buildings are owned by state or municipal authorities. The **distribution of the dwellings by tenant status** is available for 2011 and at district level. Based on the statistical data the Energy Agency of Plovdiv made an approximation for distribution at municipal level as follows:
The PadovaFIT Expanded project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement N° 847143.

The building structural data are available at municipal level.

The residential buildings and dwellings can be divided in several categories by the year of construction:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Smolyan Buildings</td>
<td>3,221</td>
<td>1,686</td>
<td>2,109</td>
<td>1,674</td>
<td>1,629</td>
<td>651</td>
<td>377</td>
</tr>
<tr>
<td>Smolyan Dwellings</td>
<td>3,864</td>
<td>2,342</td>
<td>4,002</td>
<td>5,081</td>
<td>5,641</td>
<td>1,423</td>
<td>812</td>
</tr>
<tr>
<td>Vidin Buildings</td>
<td>2,266</td>
<td>3,062</td>
<td>5,070</td>
<td>3,498</td>
<td>2,280</td>
<td>921</td>
<td>578</td>
</tr>
<tr>
<td>Vidin Dwellings</td>
<td>2,251</td>
<td>2,972</td>
<td>7,687</td>
<td>9,495</td>
<td>8,320</td>
<td>2,893</td>
<td>1,056</td>
</tr>
</tbody>
</table>

The building stock in both municipalities Vidin and Smolyan is old, most of the buildings were built in the year 1950 – 1980 (52% in the period 1960-1989). In most buildings the structures are without thermal insulation, the joinery is outdated and without thermal insulation qualities. Heating and electrical installations are outdated and inefficient. Only 7% of the inhabited residential buildings were built after year 2000, when the new regulations for the energy efficiency came into force.

Based on the statistical data, data provided by municipal strategies and programs and by the municipal experts the Energy Agency of Plovdiv made an approximation for distribution at municipal level:

<table>
<thead>
<tr>
<th>Area of analysis</th>
<th>Inhabitants</th>
<th>Buildings area</th>
<th>Urban typology</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of inhabitants</td>
<td>Total floor area of buildings [m²]</td>
<td>n° condominium</td>
</tr>
<tr>
<td>Municipality Smolyan</td>
<td>36,475</td>
<td>1,881,455</td>
<td>1,780</td>
</tr>
<tr>
<td>Municipality Vidin</td>
<td>54,737</td>
<td>2,728,134</td>
<td>1,143</td>
</tr>
</tbody>
</table>
The age of electrical systems in general is the same as the year of building construction in both municipalities Vidin and Smolyan.

The age of heating system: both the municipalities of Vidin and Smolyan do not have district heating and gas supply infrastructure. The production of heat for the residential buildings is based on woodstoves, wood/coal and biomass stoves for single apartments and biomass boilers for single family houses. The households use also small electrical heating devices (electric heaters, etc.) to supplement the stoves. The domestic hot water is either boiled on the domestic stoves or through electrical boilers. The deployment of PV and solar thermal installations is relatively low.

The wood and wood/coals stoves, used by households for heating are inefficient (40-50%) and fuelled manually. The households used them, because they are cheap and widespread on the market.

The appliances with high energy impact in both municipalities are: air conditioner, electrical boilers for domestic hot water, electrical radiator for heating, TV, refrigerator, washing machine, clothes dryer machine, electrical stove for heating.

Foreseen and/or planned and/or on-going renovation measures

Three programs for the renovation of residential buildings were approved in Bulgaria. The first program was “Project for the Renovation of Multifamily Buildings 2007–2012” and 50 multifamily buildings and their surrounding public areas were renovated. The municipality of Vidin did not participate to this program. In the city of Smolyan 5 residential buildings were renovated.

The following measures were implemented under the project:

- Energy efficiency measures - thermal and hydro insulation, replacement of windows and doors, treatment of the external façade panel joints and others recommended in the energy survey report;

- Refurbishment on common parts related to EE and safe habitation - repair of the main entrance door, the roof overhang over the entrance and the entrance steps, roof structure, painting of the stairwell walls and others recommended in the technical survey report

- Replacement of old internal plumbing systems - replacement of the vertical main water supply and waste drain pipes

- Renovation of surrounding public areas

The second program was “Energy Renovation of Bulgarian Homes 2012 – 2015”. The program was implemented in 36 cities, which belonged to six regions identified by the Regional Development Act\(^2\). Based on the NUTS (Nomenclature of Territorial Units for Statistics) in Bulgaria there are 2 regions at NUTS level 1 and 6 regions at NUTS level 2. 158 multifamily buildings were renovated with this program. In the Vidin municipality 2 residential buildings were renovated. In the city of Smolyan 15 residential buildings were renovated.

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\(^2\) [https://www.mrrb.bg/en/regional-development-act/](https://www.mrrb.bg/en/regional-development-act/). The regions location is reported in the following link [https://www.mrrb.bg/static/media/ups/articles/attachments/e7ce3983520497406ed1a99a326da566.png](https://www.mrrb.bg/static/media/ups/articles/attachments/e7ce3983520497406ed1a99a326da566.png)
Eligible energy efficiency measures:

- Replacement of joinery
- Thermal insulation, construction of installations for utilization of renewable energy efficiency sources
- Repair or replacement of an internal heating/cooling/ventilation installation, including radiator thermostatic valves and distributors in the common areas of the building/block section
- Repair of electrical installation in the common parts and introduction of energy-saving lighting in the building/block section
- Attendant construction assembly works, related to the implementation of energy efficiency measures and recovering the common areas of the building/block-section as a result of the implemented measures with energy saving effect.

The “Energy Efficiency of Multi-Family Residential Buildings National Programme” was the 3-nd program for residential buildings retrofitting and was oriented to the renovation of multi-family residential buildings. The number of renovated buildings in the city of Smolyan was 28. The number of renovated buildings in the Vidin municipality was 14.

Funding eligible activities are:

- Activities on structural reconstruction/strengthening/, overhaul depending on damages that occurred during the exploitation of multi-family residential buildings, that have been prescribed as obligatory for the building in the technical audit;
- Renovation of common areas of multi-family residential buildings (roof, facade, staircase, etc.)
- Implementation of energy efficiency measures, prescribed as required for the building in the energy efficiency audit.
- Concomitant construction and assembly works related to the implementation of energy efficiency measures and the relevant rehabilitation of common areas of the building as a result of the implemented measures with energy saving effect. The attendant construction and assembly works are related only with the restoration of the initial state, broken as a consequence of the renovation of the common areas and the change of joinery in the separate site.

Methodology

According to the information set of surveyed and certified residential buildings in the period 2015-2019, maintained by SEDA, buildings with poor energy performance (Classes E, F and G) account for 91% of non-renovated buildings: Class G - 18%, F - 34% and E - 39%.

The European directives recommend focusing of the renovation activities on the residential buildings with the poor energy performance- classes E, F, G.
The basic conclusion from the review and analysis is that the housing stock is generally inefficient, with poor energy performance; the vulnerable (energy poor) population is not concentrated in segregated buildings or territories. The identification of a "narrow" segment with the worst performance would therefore be inefficient.

The multifamily residential buildings with energy performance class G have the largest potential for energy savings. At the same time, these buildings have a relatively low share of the renovated ones so far, with 100% public support (financial and administrative). The reason is a complex of barriers (some of these can be overcome others not) causing a slow start of a more large-scale process.

Single-family buildings (and to a large extent low- and medium-sized multi-family dwellings) have not yet developed their renovation potential, although opportunities are great. The problem is mainly related to the insufficient number and scale of appropriate measures and mechanisms and a little accumulated experience. However, 42% of the renovated area by 2030 should come from these buildings.

The vulnerable population of landlords or tenants is not concentrated in Separate buildings / territories (Except for the ghettoized territories).

In Bulgaria passed several programmes for renovation of the dwellings, but they provide a 100% grant. For the national and local authorities will be a big challenge to convince and motivate the citizens to undertake actions for renovation of their dwellings.

The national authorities recommend to approach the implementation of the policies for renovation of the residential buildings over all groups of residential buildings.

The municipalities of Vidin and Smolyan are implementing smart city projects.

The municipality of Vidin is consortium member in the MAKING-CITY project (http://makingcity.eu/).

MAKING-CITY is a 60-month European Horizon 2020 project that focuses on demonstrating the potential of the Positive Energy District PED approach as the basis for efficient and sustainable planning and development of cities. Main objectives and expected impacts include solutions to help cities implement the PED concept. A PED is a delimited urban area composed of buildings with different typologies and public spaces where the total annual energy balance must be positive. Therefore, the district will have an extra energy production that can be shared with other urban zones. The total energy balance is the energy taken from outside the district minus the energy delivered inside the district.

Even if all energy carriers can be considered as potential energy inputs and/or outputs, only primary energy units make a suitable calculation of energy flows to establish the total energy balance. Finally, achieving PEDs means that the amount of energy delivered by the district must be higher than the amount of energy supplied from outside.

As one of the 6 "Followers cities" part of MAKING-CITY, Vidin aims at replicating the PED approach mainly by the retrofitting of residential buildings (windows, better heating systems...). This will maximize infrastructure performance and reduce energy consumption. Another key objective is the integration of renewable energy sources (solar panels and thermal solar panels) into the current grid in order to achieve self-sufficient energy.
The main difficulties and barriers to the implementation of energy efficiency actions in both the municipalities of Vidin and Smolyan are:

- Very high share of the private dwellings
- Lack of traditions for creation of Homeowner's associations
- Lack of professional management of the condominium
- Lack of gasification;
- Lack of district heating in the settlements of the district;
- Insufficient consumer awareness of existing new technologies and opportunities to reduce consumption.

Both municipalities implemented smart city projects with the aim to create Positive Energy Districts (PED), defined as “a district with annual net zero energy import and net zero carbon emissions, working towards an annual local surplus production of renewable energy” in the European Strategic Energy Technology Plan (SET Plan).

The city of Vidin is currently establishing Positive Energy Districts (PEDs) in the city comprised of both public and residential buildings with improved energy efficiency and energy generation facilities.

Whereas the public buildings participate per se in the PED, the residential buildings are reluctant to apply for renovation (i.e. to increase their energy efficiency) without special municipal support. Therefore the municipal authorities seek approaches and methodologies to encourage the citizens to undertake actions for renovation of their homes. For this reason, the city of Vidin has strong ambition to develop a One-Stop-Shop solution for recruiting, processing and supporting applicants for residential renovation and combine the experience from the PadovaFIT EXPANDED project with the concept of Positive Energy District, covering the areas with residential buildings.

The municipality of Vidin is situated to the Danube River.
The main focus of municipality Vidin will be housing complex Himik (g k Himik on the picture above). This area is made of a variety of facilities (public schools and kindergartens, a train station, residential buildings…).

The target area is with red border on the picture below:
In this area 3 multifamily residential buildings were renovated. The data from the energy audits are the following:

<table>
<thead>
<tr>
<th>Address</th>
<th>year of construction</th>
<th>building material</th>
<th>Energy class</th>
<th>Nº of apartments</th>
<th>Nº of inhabitants</th>
<th>electricity, MWh</th>
<th>woods, m³</th>
<th>Pellets, t</th>
</tr>
</thead>
<tbody>
<tr>
<td>block 20</td>
<td>1980</td>
<td>prefabricated concrete</td>
<td>F</td>
<td>84</td>
<td>142</td>
<td>234,509</td>
<td>193</td>
<td></td>
</tr>
<tr>
<td>block 29</td>
<td>1989</td>
<td>bricks</td>
<td>D</td>
<td>24</td>
<td>45</td>
<td>63,561</td>
<td>29</td>
<td>17.5</td>
</tr>
<tr>
<td>2 Sveti Kiril str</td>
<td>1983</td>
<td>prefabricated concrete</td>
<td>G</td>
<td>55</td>
<td>136</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The municipality of Smolyan is consortium member in the +CityxChange project (https://cityxchange.eu/).

Within the +CityxChange project, the cities of Trondheim, Limerick, Alba Iulia, Pisek, Sestao, Smolyan and Võru will experiment how to become leading cities integrating smart positive energy solutions. Through the use of digital services, the quality of life for and together with the citizens shall be improved, more energy produced than consumed, and experiences with cities across Europe exchanged to learn faster together.

The +CityxChange creates solutions for Positive Energy Blocks leading to Positive Energy Districts and Cities through:

- Decision support tools which enable informed decisions to be made by all stakeholders in the community;
- An approach to creating a Positive Energy Block through energy reduction and efficiency measures, local renewables, local storage, flexibility and peer-to-peer energy trading;
- Top-down community engagement driven by the local authority and bottom-up citizen engagement to inform, educate and drive behavioral change.

The municipality of Smolyan is currently establishing a Positive Energy Districts (PEDs) in the city comprised of both public and residential buildings with improved energy efficiency and energy generation facilities. The municipality is focused on the area star center (Old city center), which includes residential, public and business buildings.
In this area 13 multifamily residential buildings were renovated. The data from the energy audits are:

<table>
<thead>
<tr>
<th>№</th>
<th>Address</th>
<th>№ apartments</th>
<th>№ inhabitants</th>
<th>electrical energy - MWh</th>
<th>woods, m3</th>
<th>coal, t</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nevqsta 5</td>
<td>40</td>
<td>100</td>
<td>136.5</td>
<td>237.7</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Nevqsta 6</td>
<td>42</td>
<td>130</td>
<td>141.5</td>
<td>149</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Izvor 3</td>
<td>41</td>
<td>160</td>
<td>161.3</td>
<td>336.3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Block Ela</td>
<td>46</td>
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</table>

The municipality Vidin and Smolyan are focusing on these areas because:

- In these areas there are residential buildings, that were already renovated and will represent a good practice for followers
- In these areas there are residential buildings that urgently need renovation
- In these areas there are buildings of different type - single family, multifamily and middle - with 6 and more apartments
- Most of the residential buildings in these areas are energy class G and F
- The municipality Vidin and Smolyan planned these areas as PED (positive energy district)
- In this areas measures for EE and renovation of the public buildings will be implemented and this could motivate the citizens to undertake actions for renovation of their dwellings.