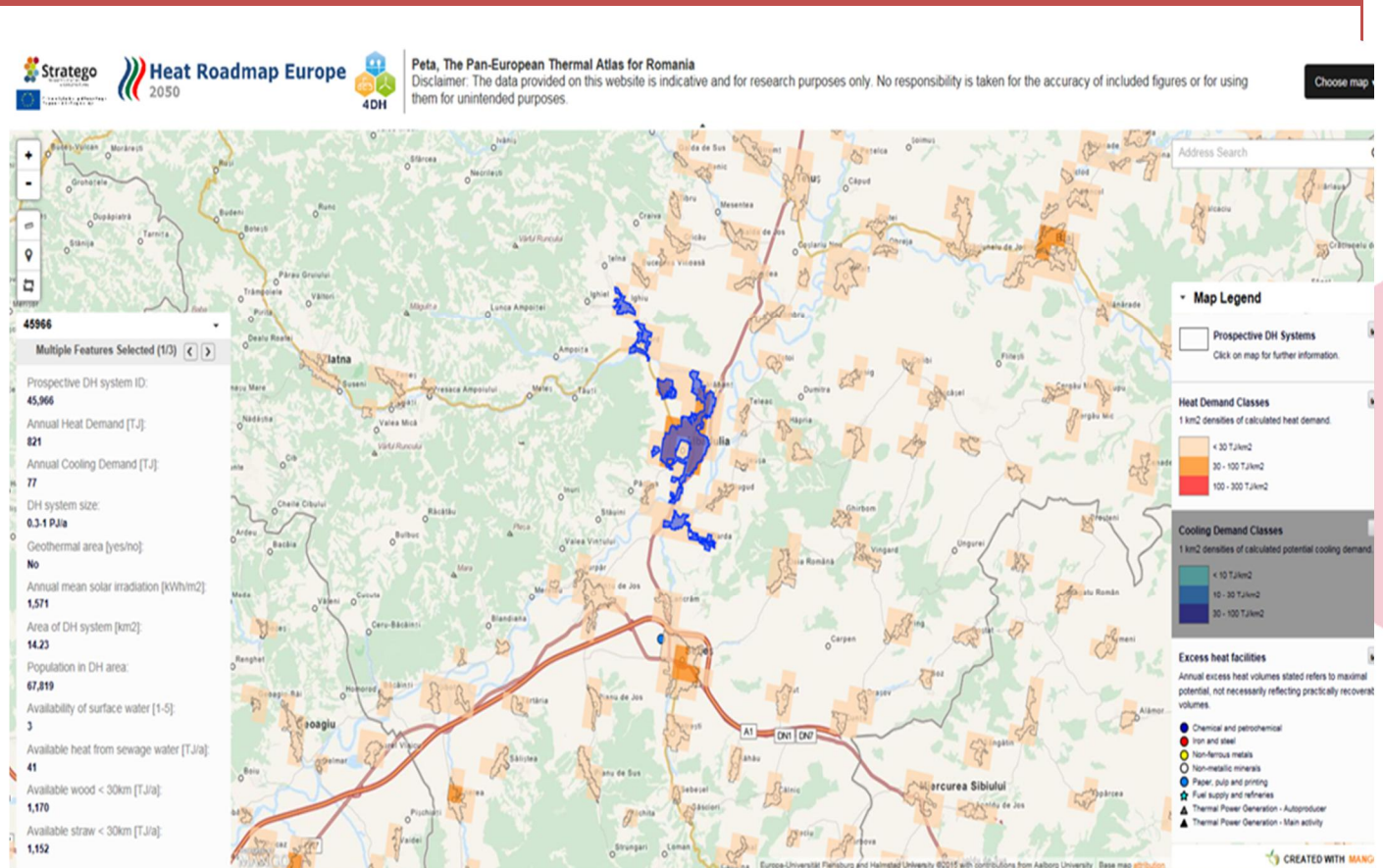


City	Alba Iulia, Romania
Supporting partner	Tractebel

Map showing local heating and cooling demand and supply



Maps indicated:

- annual heat demand: 821 TJ
- annual cooling demand: 77 TJ
- annual mean solar irradiation 1,571 kWh/m²
- population in DH area: 67,819
- other features.

Mapping methodology

		City only	Neighbour- hood only	Individual installation		
				No details	Additional Info	Monitored data
H/C demand						
H/C infrastructure						
Sustain- able H/C potential	Energy efficiency					
	Excess heat					
	Geothermal					
	Bio-energy					
	Solar thermal					

An extract from the Pan-European Atlas was taken. It indicates the heating and cooling demand on a 1 km x 1 km grid. An area with a high enough heating demand is indicated. For that area, the annual mean solar irradiation, the wood and straw potential at 30 km, the potential to tap geothermal energy and the available heat from the sewage system is indicated. Potential supply points for excess heat (energy intensive industry and power plants) are indicated as well.

Current challenges - opportunities

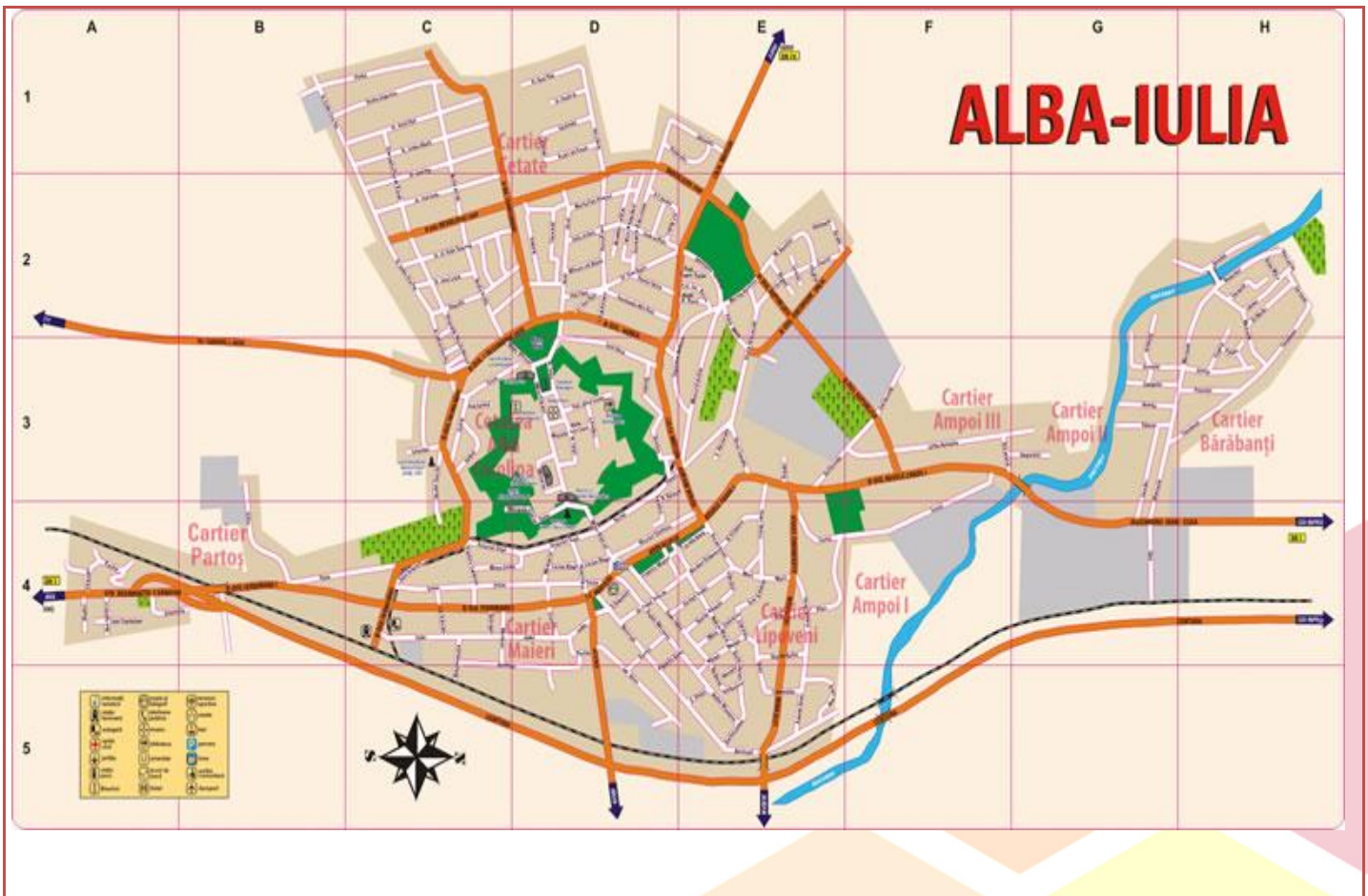
The main challenges of Alba Iulia Municipality is:

- Improving thermal insulation of the envelope for residential buildings from Alba Iulia City (external walls, windows, doors, upper floor, floor above the basement), roofs and covers and, if the case, including measures on structural strengthen of buildings;
- Improving indoor comfort of thermal rehabilitated flats;
- Reducing energy consumption by at least 30% after thermal rehabilitation of the 30 proposed residential buildings (housing blocks);
- Reducing the maintenance costs for heating and hot tap water;
- Reducing pollutants emissions generated by the production, transport and consumption of thermal energy.

all these being possible by investing in thermal rehabilitation of the block of flats.

Alba Iulia is a medium-sized Romanian city, with around 63,000 inhabitants, situated in the heart of the historical region Transylvania, in Alba County.

Alba Iulia City is situated at 270 m altitude, distanced at 380 km from Bucharest (the capital of Romania), 100 km from Cluj-Napoca City and 241 km from Arad City. Alba Iulia lies in the perimeter formed by the rivers Ampoi and Sebes and the top of the Apuseni Mountains that mount mildly and lithely towards the terraces of the river Mureş and the Transylvanian hills.



Areas of priorities

After various meetings with the local stakeholders and the Municipality's representatives, have been established the areas of intervention in two main areas of the city, representing two neighbourhoods of residential buildings as mandatory to be improved from energy efficiency point of view, in order to reduce energy consumption, decrease the energy cost of thermal energy.

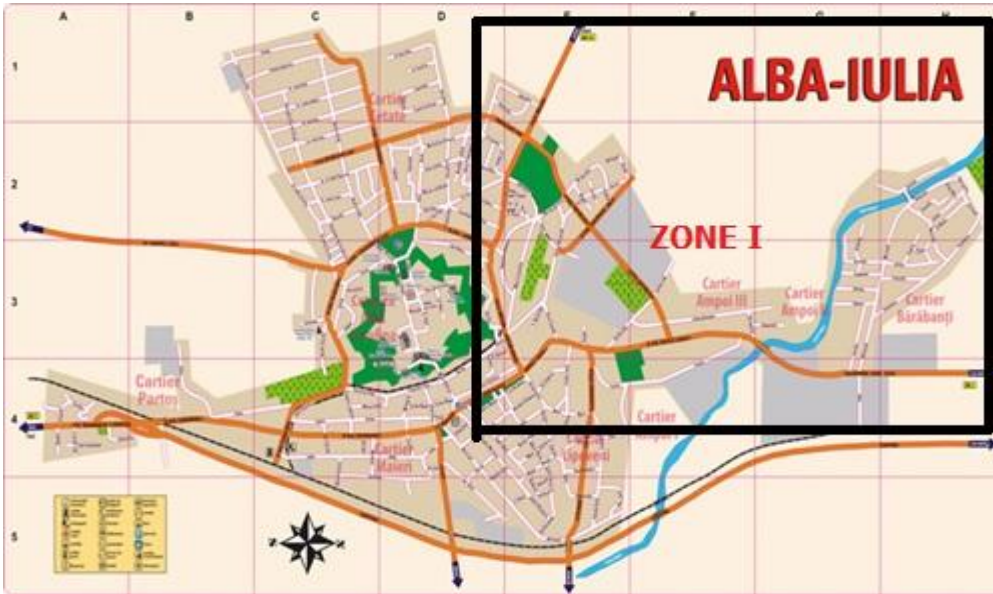
Identified projects

List of considered projects:

1. Increasing energy efficiency of 30 residential buildings from Alba Iulia city

2. Increasing energy efficiency of 44 residential buildings from Alba Iulia city

The buildings are located inside in two neighborhood areas of the city , as shown in the pictures below.



General location of streets from Zone I



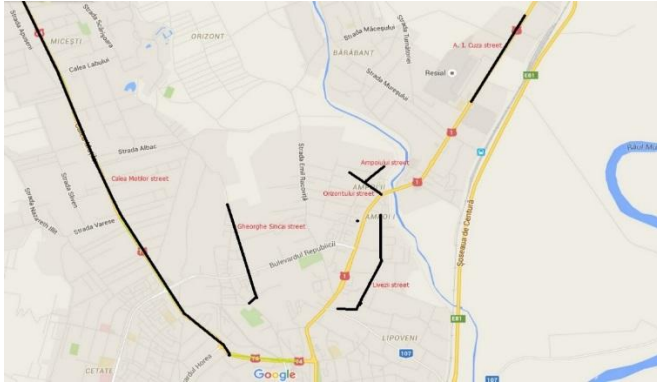
General location of streets from Zone II

Project 1

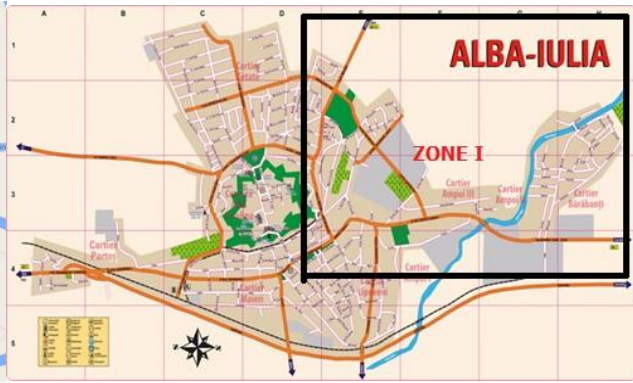
The 30 residential buildings proposed for thermal rehabilitation, in order to reduce energy consumption for space heating, were built between 1978 and 1988, in total 659 apartments. Most of these buildings (25) are GF + 4 storeys

The project "Multi level actions for enhanced Heating and Cooling plans – STRATEGO" (IEE/13/650/SI2.675851) is co-funded by the Intelligent Energy Europe Programme of the European Union. Project website : www.stratego-project.eu

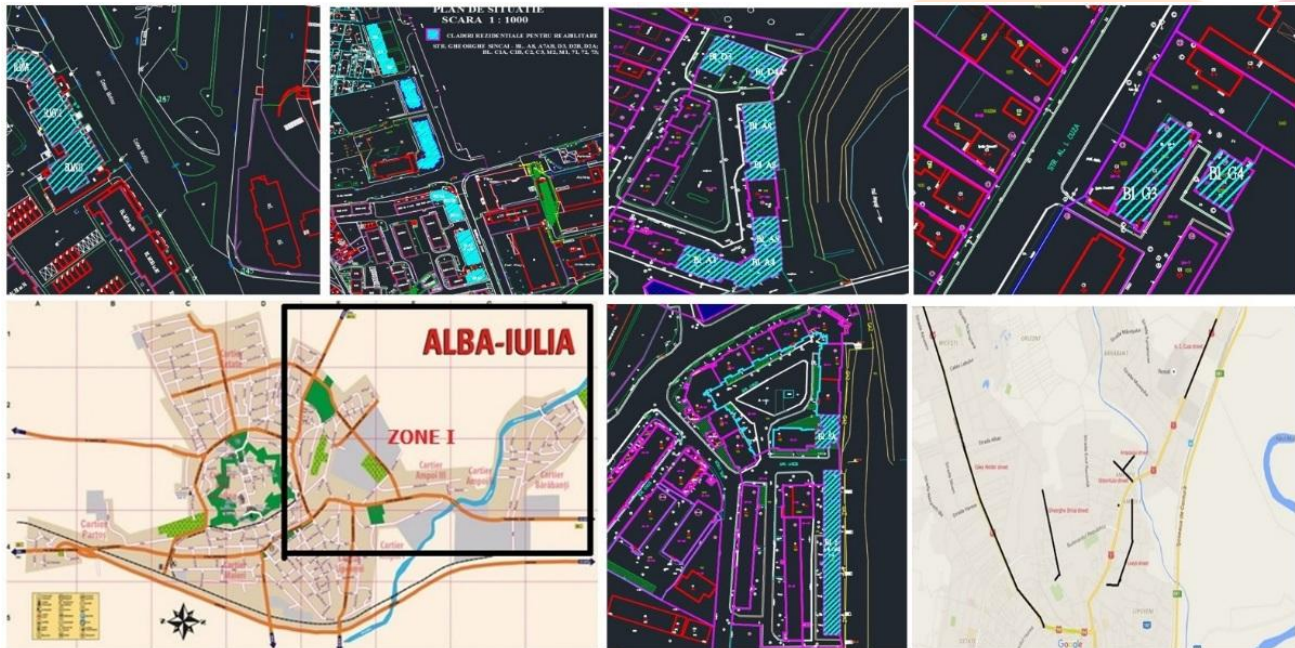
height, the rest of them (5) having a storey height of GF + 6 (2), GF + 7 and GF + 9. The buildings are located inside Zone I, as shown in the pictures below.



Streets map for Zone I (site location)



General location of streets from Zone I



Buildings location on streets

The total heated surface area of all 30 residential buildings is 44,957 m² and the total volume is 114,640 m³. The analysed residential buildings needs thermal rehabilitation because it features high energy consumption for heating (150 ... 200 kWh/m² year).

The heat losses for these buildings are substantial, as the constructive structure of the envelope is degraded, resulting high air infiltrations (single glass, wood/metallic frames, glass broken, etc.).

For simplification, it can be made the following assumptions:

- all 659 flats are using individuals heating boilers (as is not currently in operation a district heating system);
- the overall efficiency of the heating boilers for thermal energy production is around 80%;
- the common areas are also included in the total surface area and total volume;
- average of needed inside temperature for thermal comfort assurance is (20÷22)°C;

- about 70% of the 30 analysed residential buildings has a constructive system from concrete prefabricated panels;
- about 30% of the 30 analysed residential buildings has a constructive system from reinforced concrete frame;
- the space heating is achieved with static radiators.

Thermal energy needed for heating all the 30 analysed residential buildings in the conditions described above is 7,821.77 MWh/year.

Considering an overall efficiency of the heating boilers for thermal energy production of about 80%, the above determined necessary heat demand of 7,821.77 MWh/year represents about 9,777 MWh/year (1,075,494 Nm³/year) of natural gas consumption.

Related to necessary heat demand of 7,821.77 MWh/year, the specific medium energy consumption for heating, before thermal rehabilitation of these 30 residential building is 174.41 kWh/m²/year, with a maximum of around 194 kWh/m²/year (the buildings from Livezii street) and a minimum of 154 kWh/m²/year (the buildings from Calea Moșilor street).

Buildings that were designed and constructed on the basis of standards applicable before 1990 are of poor energy performance and present high potential for energy savings in space heating consumption, so, can be said that these buildings are the most energy inefficient buildings. Their energy consumption is high as a consequence of the poor thermal insulation as of the design (even lower now as deteriorated in time), inefficient interior installations (old and not properly maintained). In buildings with old wooden window frames, excessive air infiltration occurs, significantly contributing to heat losses. When old windows are replaced with tight PVC/aluminium framed windows, ventilation through infiltration is practically eliminated and indoor air quality deteriorates. Therefore, the provision for adequate ventilation should be made in such case.

In order to estimate the heat losses of the proposed buildings, it was made a comparative analysis of specific consumption of the buildings before thermal rehabilitation against the buildings after thermal rehabilitation. This comparative analysis demonstrates the scope for actions to reduce energy consumption for the buildings proposed for thermal rehabilitation, in order to reduce the energy consumption for heating. The comparative analysis (from the heating point of view) was carried out according to Romanian applicable legislation.

This analysis led to identify the most appropriate measures to rehabilitate the building in terms of energy.

Thermal rehabilitation proposed solutions are:

- External walls insulation;
- Replacing the existing external old windows and doors with insulated double glazed/PVC joinery;
- Roof insulation;
- Floor above the basement insulation.

After thermal rehabilitation, by implementing the above described measures, thermal energy needed for heating all the 30 analysed residential buildings will be 4,450.74 MWh/year. The heat demand for heating (and hot water preparation) will be covered by the same individual heating boilers for thermal energy production (individual wall thermal stations).

Considering the same overall efficiency of the heating boilers of about 80%, the above determined necessary thermal energy of 4,450.74 MWh/year represents about 5,563 MWh/year (611,977 Nm³/year) natural gas consumption.

Related to necessary heat demand after thermal rehabilitation of 4,450.74 MWh/year, the specific medium energy consumption for heating, after thermal rehabilitation of these 30 residential buildings, will be around 100 kWh/m²/year. In order to obtain these value for the specific energy consumption, for all the 30 residential buildings will be applied the most appropriate thermal rehabilitation solution, taking into account the constructive structure of each building, cardinal orientation, etc.

Before and after rehabilitation were calculated energy consumptions during the heating season, taking into consideration also the climatic conditions for Alba Iulia City as it follows:

- Climate in which the building is located: Zone III
- Local wind characteristic: Zone IV

- Internal temperature: (20÷22)°C.
- External temperature: -18°C.

TABLE 1.1 - ENERGY CONSUMPTIONS AND ENERGY SAVINGS

Description	M.U.	30 buildings before thermal rehabilitation	30 buildings after thermal rehabilitation	Energy savings
Thermal energy demand	MWh/year	7,821.77	4,450.74	3,371.03
Specific energy consumption	kWh/m ² year	174.41	99.00	75.41
Natural gas consumption	MWh/year	9,777.22	5,563.43	4,213.79
Energy saving	MWh/year	4,213.79		
	Nm ³ /year	463,516.82		
	%	43.10		

After the implementation of measures for refurbishment the residential buildings, the energy consumption for heating will decrease to 5,563 MWh/year. The energy savings will be achieved from decreasing the quantity of natural gas consumption (about 4,214 MWh/year), or about 43% from actual consumption.

The total investment cost of the component is ca. 1,384,676 EUR, excluding VAT.

The total cost related to specific materials needed for thermal rehabilitation of all 30 residential buildings, including works execution is estimated at 1,348,710 EUR. The total combined specific cost was considered as the medium Romanian market prices, of 30 EUR/m².

Business model of project 1 - business model for implementing the project

Key Partnerships
The Municipality;
Gas supplier;
Construction
companies with
capabilities in
refurbishment;
The population.

Key Activities
Buildings
refurbishment for
energy efficiency
increasing

Value Proposition
Increasing the
energy efficiency;
Decreasing of the
invoices prices
for heating

Customer Relationships
Maintain the
refurbishment
works

Customer segments
Buildings
occupants
(Buildings
associations)

Key Resources
Gas consumption
Refurbishment
works

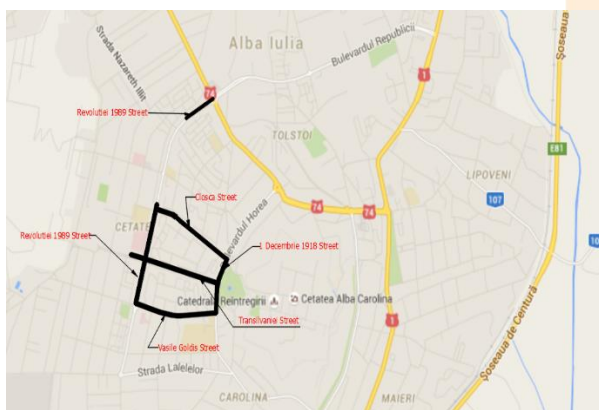
Channels
Common public
information;
Awareness
campaigns

Cost structure
Refurbishment costs
Costs can be reduced by a partnership between
Municipality and buildings associations

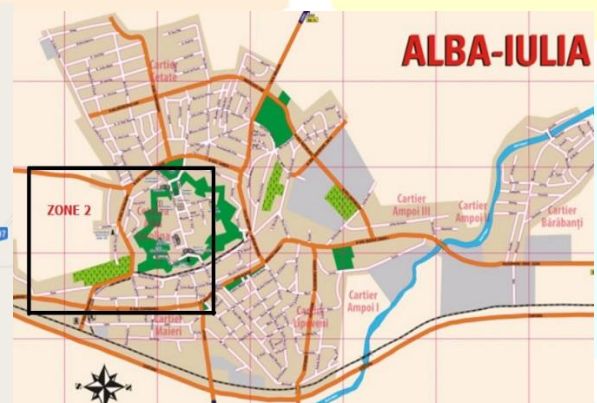
Revenue Streams
Customer's affordability is low.

Project 2

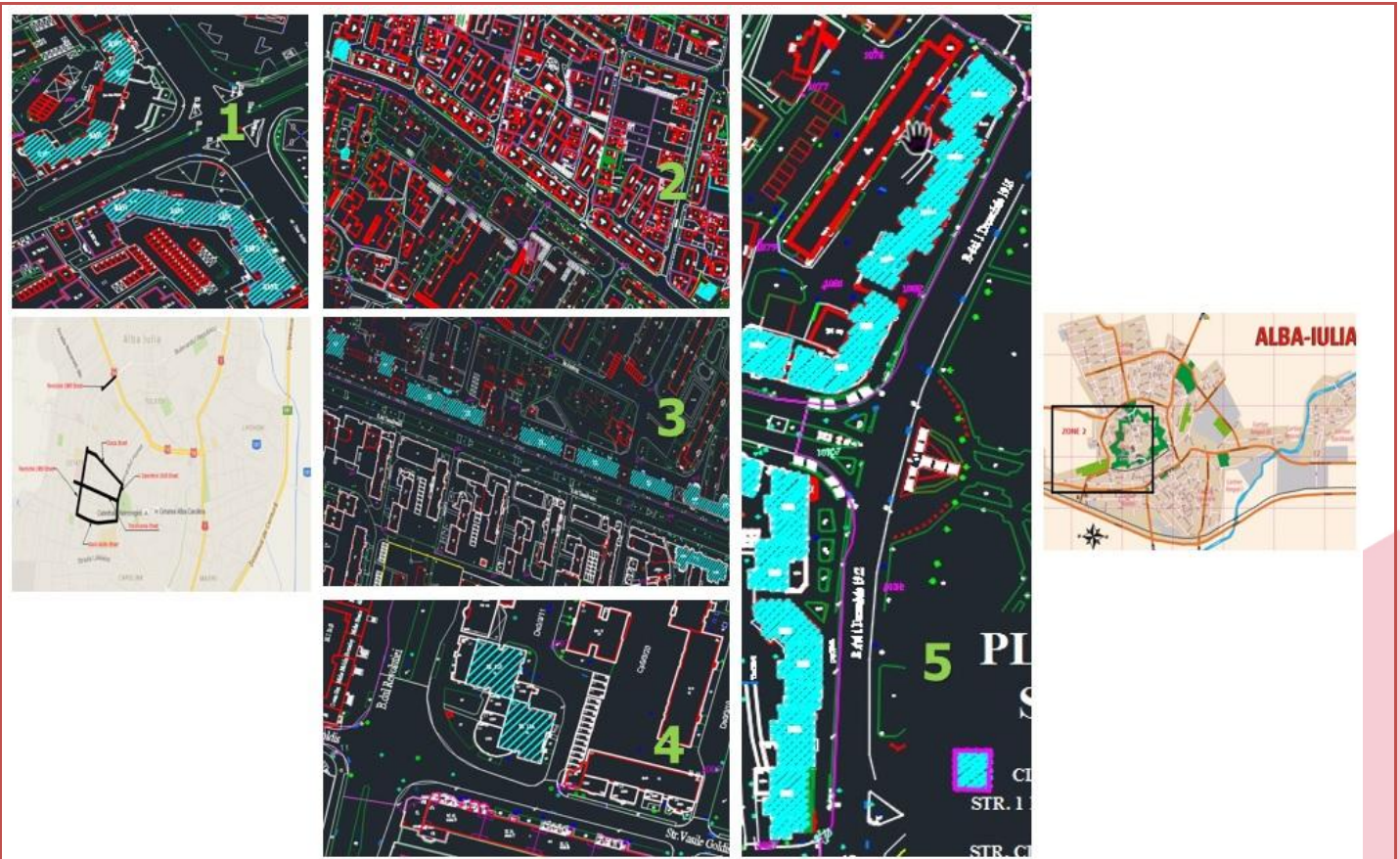
The 44 residential buildings proposed for thermal rehabilitation, in order to reduce energy consumption for space heating, were built between 1967 and 1988, in total 1,410 apartments. The buildings are located inside Zone II, as shown in the pictures below:



Streets map for Zone II (site location)



General location of streets from Zone II



Buildings location on streets

The total heated surface area is 121,823.50 m² and the total volume is 310,650 m³.

The analysed residential buildings need thermal rehabilitation because they feature high energy consumption for heating (150 ... 200 kWh/m² year).

The heat losses for these buildings are substantial, as the constructive structure of the envelope is degraded, resulting in high air infiltrations (single glass, wood/metallic frames, glass broken, etc.).

For simplification, the following assumptions can be made:

- all 1,410 apartments are using individual heating boilers (as is not currently in operation a district heating system);
- the overall efficiency of the heating boilers for thermal energy production is around 80%;
- the common areas are also included in the total surface area and total volume;
- average of needed inside temperature for thermal comfort assurance is (20÷22)°C;
- about 27% of the 44 analysed residential buildings have a constructive system from concrete prefabricated panels;
- about 41% of the 44 analysed residential buildings have a constructive system from reinforced concrete frame;
- about 32% of the 44 analysed residential buildings have a constructive system from brick masonry and concrete floors;
- the space heating is achieved with static radiators.

Thermal energy needed for heating all the 44 analysed residential buildings in the conditions described above is 20,247.04 MWh/year.

Considering an overall efficiency of the heating boilers for thermal energy production of about 80%, the above determined necessary heat demand of 20,247.04 MWh/year, represents about 25,309 MWh/year (2,783,968 Nm³/year) of natural gas consumption.

Related to necessary heat demand of 20,247.04 MWh/year, the specific medium energy consumption for heating, before thermal rehabilitation of these 44 residential building is 181.74 kWh/m²year, with a maximum of around 198 kWh/m²year (the three buildings built in 1967 from Transilvaniei street) and a minimum of 154 kWh/m²year (two buildings built in 1988 from Transilvaniei street).

Thermal rehabilitation proposed solutions are:

- External walls insulation;
- Replacing the existing external old windows and doors with insulated double glazed/PVC joinery;
- Roof insulation;
- Floor above the basement insulation.

After thermal rehabilitation, by implementing the above described measures, thermal energy needed for heating all the 44 analysed residential buildings will be 12,060.53 MWh/year. The heat demand for heating (and hot water preparation) will be covered by the same individual heating boilers for thermal energy production (individual wall thermal stations).

Considering the same overall efficiency of the heating boilers of about 80%, the above determined necessary thermal energy of 12,060.53 MWh/year represents about 15,076 MWh/year (1,658,322 Nm³/year) natural gas consumption. Related to necessary heat demand after thermal rehabilitation of 12,060.53 MWh/year, the specific medium energy consumption for heating, after thermal rehabilitation of these 44 residential buildings will be around 100 kWh/m²year. In order to obtain these value for the specific energy consumption, for all the 44 residential buildings will be applied the most appropriate thermal rehabilitation solution, taking into account the constructive structure of each building, cardinal orientation, etc.

These specific measures (for each building) will be exactly established by a certified residential auditor in the energy audit. Thus way, for each building, it will be made an energy calculation. Before the energy audit, for all 44 proposed buildings for increasing energy efficiency by thermal rehabilitation, a technical expertise will be conducted by analysing the building concrete structure, in order to evaluate the structural status of the buildings.

Analysis in time of overall behaviour of the rehabilitated buildings has positive effects on the building energy consumption, environmental pollution and ensures an interior thermal comfort at a low cost prices.

As it was mentioned above, the 44 analysed residential buildings have a total heated surface area of around 121,824 m² and a total heated volume of 310,650 m³; the internal needed temperature for thermal comfort assurance is between 20 and 22°C. External walls, doors, windows and roof and floor above the basement will be thermal rehabilitated. Before and after rehabilitation were calculated energy consumptions during the heating season, taking into consideration also the climatic conditions for Alba Iulia City as it follows:

- Climate in which the building is located: Zone III
- Local wind characteristic: Zone IV
- Internal temperature: (20÷22)°C.
- External temperature: -18°C.

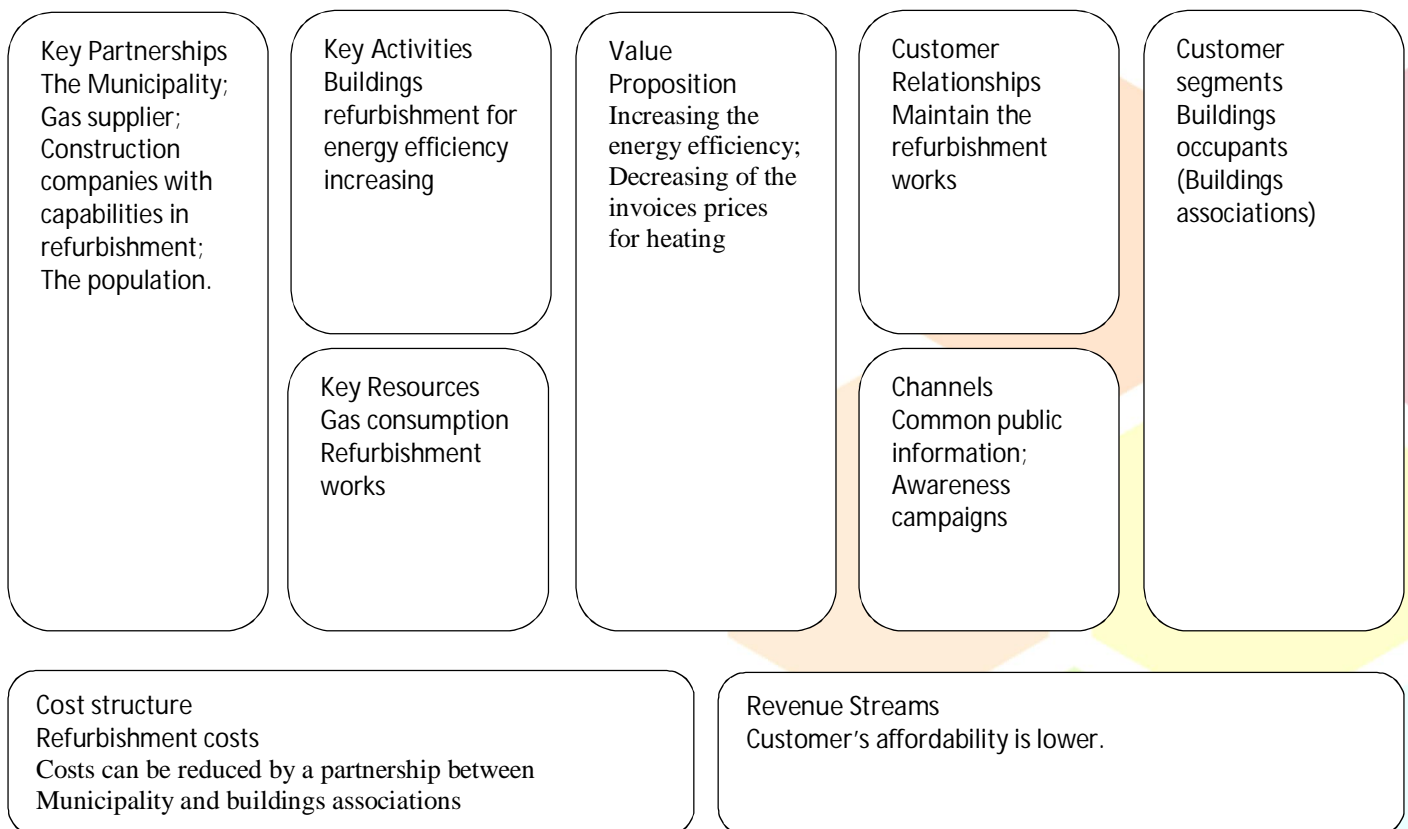
TABLE 1.2 - ENERGY CONSUMPTIONS AND ENERGY SAVINGS

Description	M.U.	44 buildings before thermal rehabilitation	44 buildings after thermal rehabilitation	Energy savings
Thermal energy demand	MWh/year	20,247.04	12,060.53	8,186.51
Specific energy consumption	kWh/m ² year	181.74	99.00	82.74
Natural gas consumption	MWh/year	25,308.80	15,075.66	10,233.14
Energy saving	MWh/year	10,233.14		
	Nm ³ /year	1,125,645.30		
	%	40.43		

After the implementation of measures for refurbishment the residential buildings, the energy consumption for heating will decrease to 15,076 MWh/year. The energy savings will be achieved from decreasing the quantity of natural gas consumption (about 10,233 MWh/year), or about 40%.

The total investment cost of the component is ca. 3,752,164 EUR, excluding VAT.
The total cost related to specific materials needed for thermal rehabilitation of all 44 residential buildings, including works execution is estimated at 3,654,705 EUR. The total combined specific cost was considered as the medium Romanian market prices, of 30 EUR/m².

Business model of project 2 – business model for implementing the project



Results of the stakeholder meeting

Date	Quarterly
Participants	Tulcea City's representatives; Energoterm's representatives
<p>Several meetings took place in Alba Iulia and Bucharest with Alba Iulia representatives, presenting the STRATEGO maps, to enable to identify areas of priority for intervention.</p> <p>Based on the map of local heating and cooling demand and supply, areas of priority for intervention have been defined. These are areas where are located residential buildings with high energy consumption. These buildings that</p>	

were designed and constructed on the basis of standards applicable before 1990 are of poor energy performance and present high potential for energy savings in space heating consumption, Moreover, for both projects have been developed the associated business models/plans.

Input into the local heating and cooling plan

Areas of priorities of intervention were established in the residential areas, as mandatory to be improved from energy efficiency point of view, in order to reduce energy consumption, decrease the energy costs for buildings occupants.

