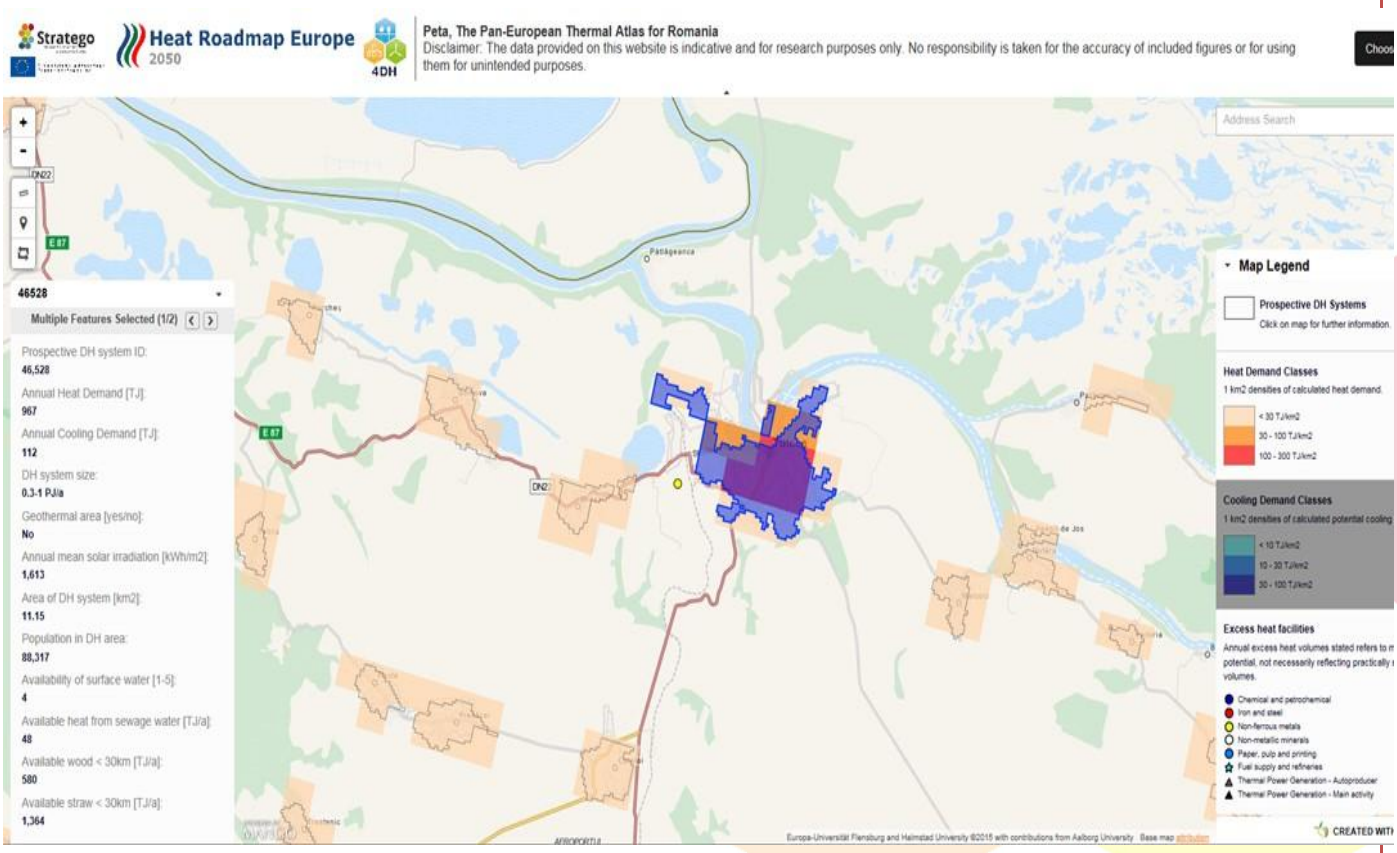
City	Tulcea, Romania
Supporting partner	Tractebel

Map showing local heating and cooling demand and supply



Maps indicated:

- annual heat demand: 967 TJ
- annual cooling demand: 112 TJ
- DH system size
- annual mean solar irradiation 1,613 KWh/m^2
- population in DH area: 88,317
- other features.

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

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 Tulcea Municipality is:

- Increasing the energy efficiency of the DH system in Tulcea Municipality,
- Delivering the heat to the consumers at competitive and affordable prices, to keep the existing consumers connected to the DH network
- Compliance with the environment requirements.

all these being possible by investing in DH system for energy efficiency increasing.

Tulcea County is located in south-east of Romania, occupying the northern half of Dobrogea region. Tulcea City is located in Tulcea County.
S.C. Energoterm S.A. is the local operator of DH system and is subordinated to the Tulcea Municipality Hall. The Municipality Hall is the owner of Tulcea district heating system. Currently, the company Energoterm operates the following:

- One HoB with a thermal capacity of 50 Gcal/h that provides hot water to thermal substations;
- Several local thermal plants;
- Transmission and distribution networks.

The existing HoB which is located in the north part of Tulcea, on the Tulcea – Galati city road is characterized by the following:

- It is old and obsolete and involves high costs for repairs that have to be supported by Tulcea Municipality Hall;

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

- ensures the heating needs for 7,157 apartments;
- the delivery period of heat for assigned consumers is the second half of October – till the first half of April (f.a. 6 months/year)

it is oversized, related to the current thermal load.

In 2014, SC Energoterm SA took over the substations belonging to Dalkia SA, so becoming the only heat and hot water producer and supplier in Tulcea municipality.
The distribution network is composed of 14 HoBs, the length of the distribution network for heating is of 9.630 m and the distribution network for hot water is of 8.760 m.

Areas of priorities

After various meetings with the local stakeholders and the Municipality's representatives, have been established the areas of intervention in the DH action zone, as mandatory to be improved from energy efficiency point of view, in order to reduce energy loses, decrease the energy prices for customers.

Identified projects

List of considered projects:

1. The specific objective of the first project is to replace the existing old and oversized HoB with:
   - two CHP gas engines 2 x 4MWt/4MWe which will be installed in the existing location of HoB
   - two boilers that cover the heating need for the HoB area (2 x 18 MWt)

2. The proposed second project consists in the rehabilitation of the distribution network and of the existing HoBs, which belonged to Dalkia SA, located in red part of Tulcea Municipality

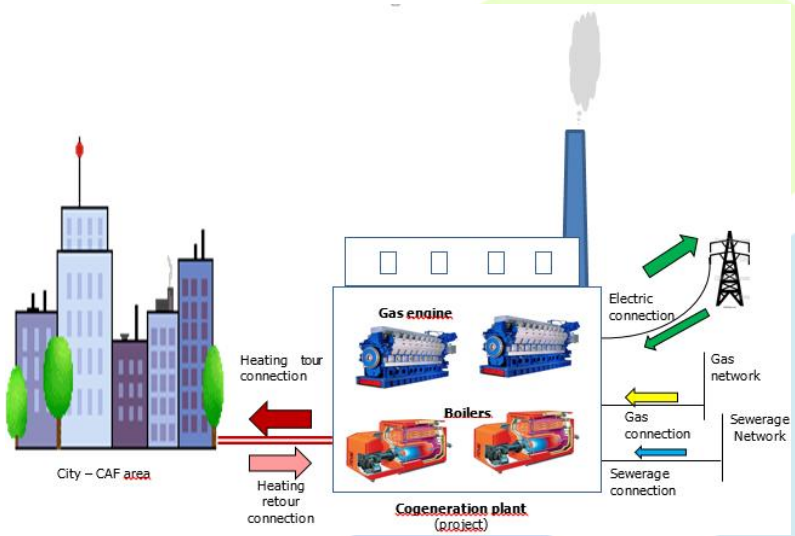
The location of the projects is in the blue part figure, as presented below:

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

Project 1

The cogeneration unit has been chosen taking into account the following requirements:

- Thermal energy has to cover the thermal demand of HoB consumers;
- Concerning electrical capabilities, it has been chosen an equipment with the highest possible efficiency and very reliable for frequent starts and stops.
- Gas engines will cover the maximum possible heat demand and the boilers will cover the difference
- Hot water boilers: 2 x 18 MW
- Gas engine: 2 x 4MWe/ 4MWt
- to minimize the connection costs, the location will be the same with the existing HoB that will be decommissioned afterwards
- According to 2015 reports, there are 7,157 residential consumers connected to the local DH system.



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

Picture 1 – Cogeneration plant configuration

The technical specifications of the existing HoB are:

- Nominal heat output load: 50 Gcal/h
- Constant water flow circulated through boiler: 402.8 kg/s
- Boiler hot water pressure output (working): 0.84 ÷ 0.86 MPa
- Boiler water pressure loss: 0.2 MPa
- Boiler water volume: 40m3.

The technical aspects to be taken into consideration when choosing the CHP plant location were: the available space, equipment access, land owner, available pressure, distance to the gas network which has consequences on the gas price (transport gas price is lower than distribution gas price), distance to the available electric station, the heating network, the location of residential buildings, distance to the water and sewerage network.
After all these aspects were analyzed, it was decided to establish the new CHP on the same site as the existing HoB. This location will allow easy access for auxiliary equipment.
As the distance to the gas station is only 300 m and the connection is already done, the gas price will be low and at the desired pressure level (10 bar).
Concerning the heating network, the location on the same site as HoB will allow to use the same heating and utilities connections.
Based on the thermal energy and electricity demand, the resulted cogeneration configuration requires two heat only boilers 2 x 18 MWt and two gas engines 2 x4 MWt/4MWe with the auxiliary equipment listed in the following table.

TABEL 1.1 – LIST OF THE PROPOSED EQUIPMENT

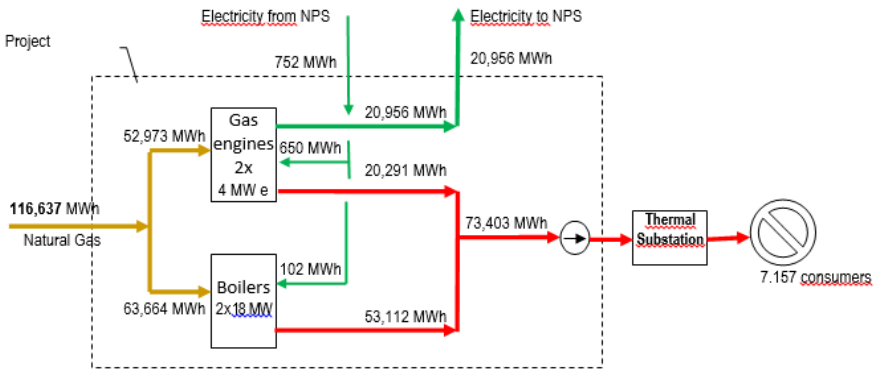
CHG plant – List of equipment		
Nr. crt.	Equipment	Pieces
1.	Heat only boiler 95/70°C, 18 MW	2
2.	Cogeneration unit – cogeneration engine 4 MWe /4 MWe,: - Gas engine - Power generator - Heating recover 95/70°C– - Crash cooler – battery	2
3.	Heat exchanger - engines	2
4.	Heat exchanger - boilers	2
5.	Treatment water station	1
6.	Circulating pumps - engines	2
7.	Circulating pumps - boilers	2
8.	Heat pumps	3
9.	Measuring and control gas station	1
10	Power Substation	1

The future CHP plant will work in the same working regime as the existing heating source. Both boilers and the gas engines will work only on cold season, from the second half of October until the first half of April.
The two gas engines will produce simultaneously thermal energy and electricity, ensuring the maximum possible heat demand, working 16 hours/day on 90% load, approximately six months per year. Part of

the produced electricity will be used internally (for own CHP consumption), and balance will be sold into the grid – National Power System (NPS).
The two heat only boilers will work alternatively and simultaneously from 10 to 100% load in the cold season (the heating season), from the second half of October until the first half of April. The boilers will provide the heat difference demanded by the consumers connected to the DH.
The thermal energy produced by the existing HoB ensures the demand for the 7,157 consumers, namely 73,403 MWh/year for the heating delivery period. The electricity represents the maximum power produced by the gas engines.
The energy production/delivery is shown in the table below:

TABLE 1.2 – PRODUCTION/DELIVERY OF ENERGY

Production/ Delivery of the each period [MWh]			
	Winter (181 days = 4,344hours)	Summer (184 days = 4,416 hours)	Total
Electricity - 2 gas engines	20,956 MWh (16 h/day)	0 MWh	20,956 MWh
Thermal - 2 gas engines - 2 boilers	20,291 MWh 53,112 MWh	0 MWh 0 MWh	73,403 MWh



Picture Error! No text of specified style in document..2 – Cogeneration plant configuration

The natural gas consumption is expressed in MWh at the gross calorific value of 10.49 kWh/m³, at p= 1 bar and t=15°C, according to the gas bill.
The electricity bought from NPS is used internally. The cost related to the electricity consumption for the district heating pumps is not taken into consideration. This cost will be covered by the Municipality, so it will be ignored.
The two gas engines and boilers will produce hot water at 95/70° C and will supply the same collector. In order to maintain a good quality of the circulated water through the heat exchangers of the engines, the solution is to separate the engines circuit from the boilers circuit form hydraulic point of view, by using heat exchangers. In this way, the primary hydraulic circuit of the engines and boilers will function at 6 bar pressure and the secondary circuit (heating circuit) will function at the district heating pumps pressure.
The thermal energy generated by the CHP will be used in the primary circuit of Tulcea district heating system.

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

CHP is designed as a compact module that is connected with electric generator and together with the heating exchanger are mounted on the same chassis.
The considered gas engine components are:

- Thermal engine – a four-stroke spark ignition engine, with 24 "V" cylinders.
- 6.3 V Electric Generator
- Heat recovery assembly: first and second stage intercoolers, oil cooler, water cooler and heat recovery from fuel gases

The 18 MW heat only boiler with three way flue gases is presented below:

TABLE 1.3 – BOILERS CHARACTERISTICS

Installed thermal power	18,200 kW
Fuel type	Natural gas
Gas supply pressure	min 0,4 bar, max. 4 bar
Maximum pressure	10 bar
Maximum temperature	110°C
Maximum operating temperature	105°C
Maximum difference temperature	40°C
Nominal water boiler volume	40 m³
Efficiency at the nominal thermal load	92,9%

Business model of project 1

Key Partnerships
The Municipality is the owner of DH assets.
Energoterm as operator of the DH system was established by the reorganisation of the Thermal Services Direction Tulcea on July 2005 and it has the Local Council Tulcea as unique shareholder.

Key Activities
Operation of the DH infrastructure;

Optimization of operation

Key Resources
Gas consumption
Electricity consumption
Maintenance

Value Proposition
Increasing the energy efficiency of DH system; lower thermal energy price; increasing the affordability of customers

Customer Relationships
For maintaining the number of consumers - operational and technological costs reduction by improving the thermal energy supply service.

Channels
By taking complaints by phone and solving them in the shortest time possible are leading to enhanced customer ; Invoicing

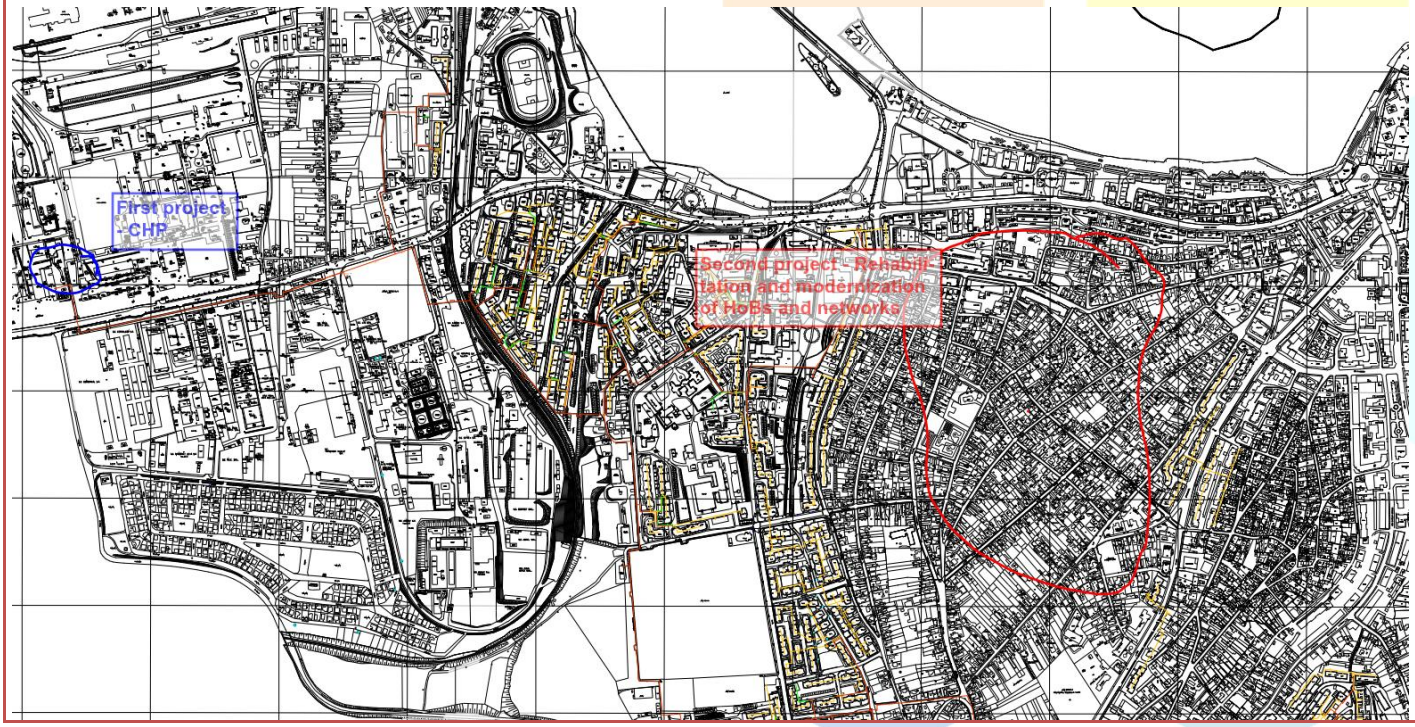
Customer segments
Entire population of Tulcea City

Cost structure
Natural gas and electricity prices; Personnel costs; Repair and maintenance costs

Revenue Streams
Customer's affordability is lower in Tulcea, the price of thermal energy is higher than they afford.
Competitors: Apartment boilers running on gas

Project 2

The proposed second project consists in the rehabilitation of the distribution network and of the existing HoBs, which belonged to Dalkia SA, located in red part of Tulcea Municipality, as below:



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

The distribution network is composed of 14 HoBs, the length of the distribution network for heating is of 9,630 m and the distribution network for hot water is of 8,760 m.
Beside the rehabilitation of the distribution network, Tulcea Municipality intend to modernize 14 HoBs which belonged to Dalkia before Energoterm take it over in April 2015.
The measures for the modernization of HoBs include:

- Replacing the electrical installations, lighting installations and lighting panels
- Rehabilitation of buildings – masonry, coating, hydrofuge and thermal insulation
- Replacing pumps, electrical engines, measuring and control devices, heat exchangers, valves, expansion vessel, admission valves.
- Replacing the sanitary installations
- Thermal insulation of the distribution network of HoBs
- Equipping with tele-management system with long distances data transmission

The total investment value rises around 1.688.889 EUR (without VAT).
After the implementation of the proposed measures presented above, there will be obtained about 1700 MWh/year natural gas savings.

Business model of project 2

Key Partnerships
The Municipality is the owner of DH assets.
Energoterm as operator of the DH system was established by the reorganisation of the Thermal Services Direction Tulcea on July 2005 and it has the Local Council Tulcea as unique shareholder.

Key Activities
Operation of the DH infrastructure - optimizing

Key Resources
Operate the network efficient

Value Proposition
Increasing the energy efficiency of DH system; lower thermal energy price; increasing the affordability of customers

Customer Relationships
For maintaining the number of consumers - operational and technological costs reduction by improving the thermal energy supply service.

Channels
By taking complaints by phone and solving them in the shortest time possible are leading to enhanced customer; Invoicing

Customer segments
Entire population of Tulcea City

Cost structure
Natural gas and electricity prices; Personnel costs; Repair and maintenance costs

Revenue Streams
Customers affordability is lower in Tulcea, the price of thermal energy is higher than they afford.
Competitors: Apartment boilers running on gas

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

Results of the stakeholder meeting

Date	Quarterly
Participants	Tulcea City's representatives; Energoterm's representatives

Several meetings took place in Tulcea City, presenting the STRATEGO maps, to enable to identify areas of priority for intervention.
Based on the map of local heating and cooling demand and supply, areas of priority for intervention have been defined. These are areas where the local conditions are favorable for developing projects first, such as the development of district heating networks. Based on those meetings two concrete projects have been proposed in the City.
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 DH action zone, as mandatory to be improved from energy efficiency point of view, in order to reduce energy loses, decrease the energy prices for customers.

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