Global District Energy Climate Award 2015

Lodi District Heating System

2010-2014: a constant increase in efficiency and sustainability

Location: Lodi, Italy

Owner: Linea Group Holding SpA - via dei Comizi Agrari, 10 - 26100 Cremona

Operator: Astem Gestioni Srl (100% Linea Group Holding) - Strada Vecchia Cremonese – 26900 Lodi

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Summary

Lodi is an Italian city of 45.000 inhabitants located in North Italy.

District Heating system has been operating since 2004: although it was originally studied to supply heat to a new district that hosts many organisations involved in the ag-biotech sector (including the Faculties of Veterinary and Agricultural Sciences of the University of Milan) it was then re-designed to cover the heat demand of the south-west part of the city.

In 2010/11, even if the DH system was recently built, the fast-changing scenario in the energy sector with the growing interest in Renewable Energy Sources (RES) made it necessary to reflect on how to reach an elevated level of environmental and economic sustainability compared to new technologies in competition with DH.

It had become necessary a **modernization of the system**, taking the example of the best practices in the sector and evaluating their compatibility with Lodi DH and the territory.

The programme was implemented with several projects (mainly from 2011 to 2013) with the common aim of increasing both efficiency and sustainability, including:

- an agreement with a group of local entrepreneurs to recover the heat from their biomass CHP located in a farm 2 km from Lodi
- Construction of a thermal storage system.
- Demand-Side Management of substations, through remote control system, continuously changing according to the season the settings of substations

A first step in the transition to efficiency has been done: the system is much more efficient, sustainable - and even reliable - than 5 years ago, and today the new programme is the expansion of the network to the north and south-east area of the city. This new programme of expansion has started in 2014 and will continue in the coming years, with the goal of doubling the size of the network compared to 2013.

The CHP / DH Plant after the modernization, with Thermal Energy Storage on the right

1. Introduction

1.1. City of Lodi

Lodi is an Italian city of 45,000 inhabitants. The territory of Lodi, which covers 41.38 km², is located in the south central part of Lombardy, 25 km south-east of Milan.

Lodi was one of the first cities in Italy to have a natural gas network to cover most of the city, and has a District Heating System from 2004.

1.2. Linea Group Holding S.p.A. - Astem Gestioni S.r.l.

Linea Group Holding S.p.A. ("Gruppo LGH") is a multi-utility company established in October 2006 following the merger of five local utility companies mainly owned by Municipalities of Cremona, Pavia, Lodi, Rovato (BS) and Crema (CR). Its organisational structure is characterised by the concentration of corporate functions in the parent company, Linea Group Holding S.p.A. and by the management of the business units through dedicated companies or special-purpose companies.

LGH operates in the sectors of gas, electricity, waste management and district heating: the customer base accounts for over a million inhabitants in 250 municipalities in the provinces of Brescia, Cremona, Lodi and Pavia.

With almost 700 M€ of revenues and 1,300 employees, LGH is positioned among the top 10 multi-utility groups in Italy in terms of revenues and EBITDA, and is the fifth operator in the district heating sector for the volume heated by its controlled companies.

Astem Gestioni S.r.l., with headquarters in Lodi, is a company controlled by LGH. Main Business are:

- Operation of Lodi District Heating (owned by LGH)
- Waste management for the municipality of Lodi and other neighboring villages;

Astem Gestioni activities are all certified with ISO 9001, ISO 14001 and OHSAS 18001 standards.

2. Lodi District Heating System

2.1. History of the system

The origins of Lodi District Heating System are on the Agreement signed in 2001 between Lombardy Region, University of Milan, Province of Lodi, Municipality of Lodi and the Chamber of Commerce of Lodi for the construction of a new neighbourhood ("Lodi Cluster") dedicated to research in the ag-biotech sector (including the Faculties of Veterinary Medicine and Agricultural Sciences of the University of Milan).

Municipality of Lodi, through its controlled company (ASTEM), was in charge of providing all utilities, including heat: consequently, in 2002, Lodi and Astem signed a memorandum of understanding to the develop a district heating system, that originally was considered only for "Lodi Cluster", but soon was extended to cover also the heat demand of other part of the City.

Feasibility studies and projects of the system were carried out between 2002 and 2003, with the support of external specialists, due to the lack of expertise in Astem about DH.

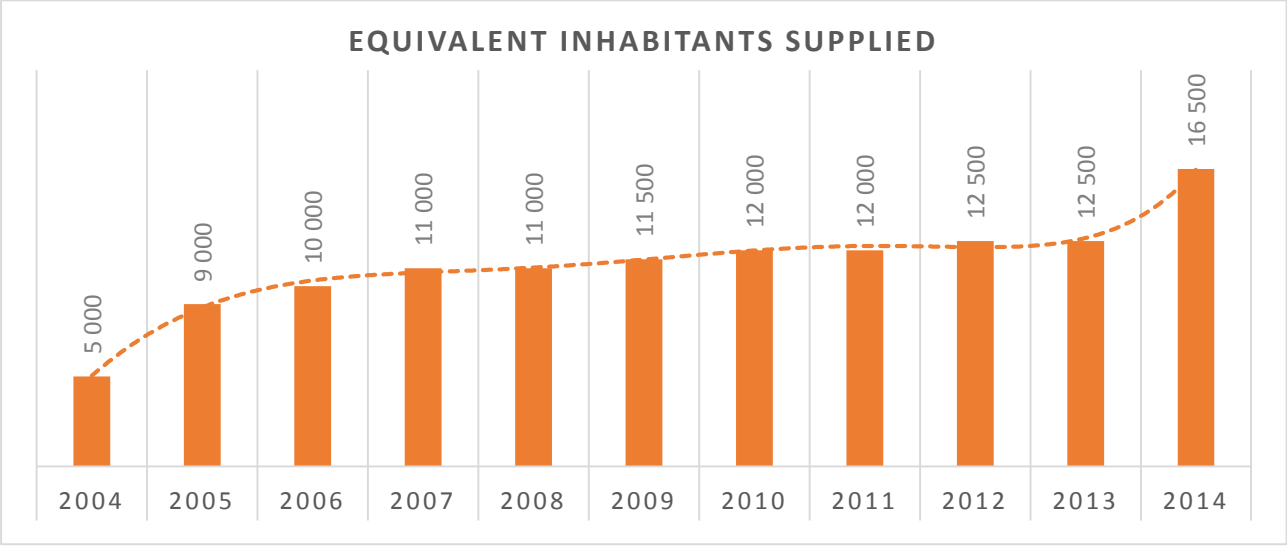
The CHP Plant was built between the end of 2003 and October 2004, the commissioning of the thermal section dates back to the end of September 2004, while the continuous service to first customers started at 15/10/2004.

The Network was mostly realized in two phases:

- The first one during 2004 (January – October)
- The second one during 2005 (January – October)

Minor expansion were built over the following years, mainly to connect new users not previously acquired.

In 2006, with the establishment of Linea Group Holding, all the activities were re-organized, and in 2010 LGH became the owner of all DH assets, while Astem Gestioni remain the operator.



2.2. Configuration before the Modernization

The CHP / DH plant

The plant is located in the south-west area of the city, in the "Lodi Cluster" district and consists of the following equipment:

- a CHP unit: gas-fired reciprocating engine 3.86 eMW, 3.86 thMW
- 3 auxiliary gas-fired boilers: total 29 MW (2 x 11 MW + 1 x 7 MW, the latter installed in 2011)
- A pumping station with 4 variable speed pumps
- A pressurization and expansion system, with DH water treatment

The plant is fully automated, with a DCS control system designed to manage the plant without operators' supervision: the presence of people it is correlated to maintenance activities and periodical controls.

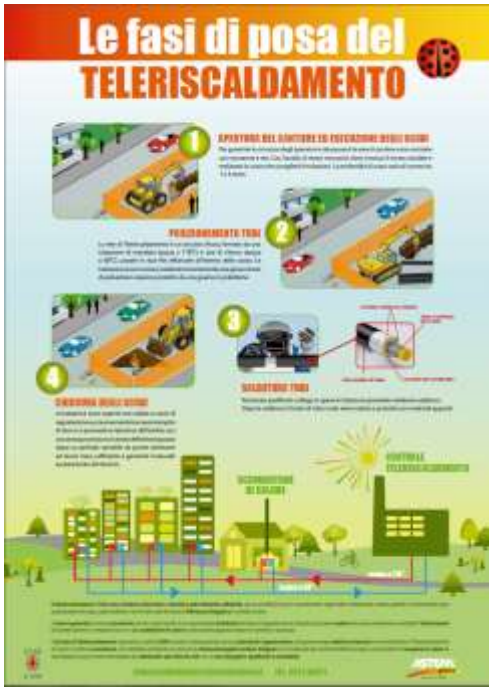
The Distribution Network and Substations

The distribution network was built with pre-insulated pipes with DN range from 300 to 40.

Heat exchangers of substations usually are in the range from 50 to 1000 kW, with some customers having skids with more HX to cover the heat demand.

The system was designed with an operating temperature of 118 / 68 °C (supply / return), and a design temperature of 130°C.

The total length of the network was approx. 12 km of double pipes, with about 100 substations.



3. The programme of Modernization

3.1. The Programme: a transition to a more efficient and sustainable system

In 2010/11, even if the DH system was recently built, the fast-changing scenario in the energy sector with the growing interest in Renewable Energy Sources (RES) made it necessary to reflect on how to reach an elevated level of environmental and economic sustainability compared to new technologies in competition with DH.

It had become necessary a modernization of the system, taking the example of the best practices in the sector and evaluating their compatibility with Lodi DH and the territory.

3.2. Different Projects, a common target

The programme has been developed through the evaluation of different possible project, with the common aim of increasing efficiency and sustainability.

The main categories of the activities were:

1. New procedures, e.g. for the operation of the substations
2. Maintenance actions targeted not only on reliability, but also on efficiency
3. Relevant modifications, focussing on the best practices in the sector: this required a study of the solutions implemented by other DH

Substation control

The remote control system of substations was running from 2010, but it was not used at the best of its potential until 2011, when new procedures for the operation of the substations where introduced.

The new idea was to apply Demand-Side Management technics to control the heat load of substations, with two main goals:

- optimization of peak-shaving effect, which coupled to Thermal Energy Storage System increased reserve margin of the plant
- lower operating temperatures: supply temp. from 118°C to <110°C, return form 68°C to <60°C, maximizing heat recovery from existing CHP and biomass plant, and therefore lowering cost of heat

Currently, substations parameters are changed according to the season, in order to optimize the functioning of the entire system.

Maintenance actions on existing equipment

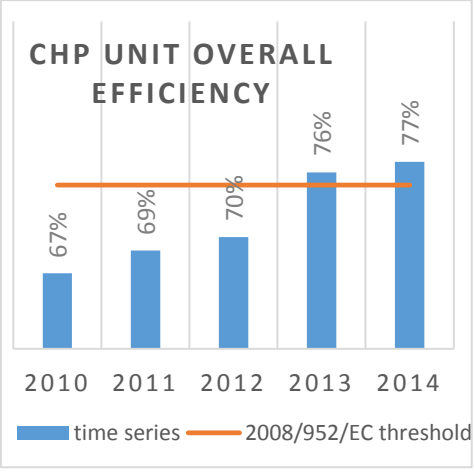
After almost 10 years of activities, part of the equipment need a major overhaul: in some cases, replacing some components could have a relevant impact on the system, for example: old boiler burners with Low-NO_X ones (reduction of pollutant emissions) and pump motors with new IE3 class (reduction of electricity consumption).

Thermal Energy Storage System

The project of TES system started with a feasibility study in 2011, and became full operative in the first quarter of 2013.

The aim of the project was originally to allow an increase of the over-all efficiency of the existing gas-fired CHP unit, but - with the contemporary project of heat recovery from biomass plant- it was modified in the construction phase, to be fully integrated in the control system of the plant, to maximize efficiency in every operational condition.

The system (2 x100 mc tanks) is designed to storage up to 10 MWh, with a peak charge/discharge of 5 MW.



Transition to RES

A very complex challenge in the programme was the transition from fossil to renewable energy sources: it was quite clear that this point would have been the most important, but it was also difficult to find "how" reach the goal in a few time, considering that one of the most interesting RES was Biomass.

Fortunately, the solution came on September 2011, when we met a group of entrepreneurs (with a company called "LODIENERGIA") interested in investing in renewable, due to the high incentives of Italian laws on electric RES.

Their project was to build a biomass plant in a farm located in a village 2 km from Lodi (Cornegliano Laudense), and they were evaluating how to use the waste-heat.

During 2012, an agreement have been achieved for the recovery of the heat from the CHP biomass plant.

Biomass CHP Plant
Owner: LODIENERGIA (full private ownership)
Location: Cornegliano Laudense (LO)
Technical Data:
- Organic Rankine Cycle (Turboden)
- 1 eMW / up to 5 thMW
- Operating Temperatures of the network connecting the two plants: 115 / 85°C

The two plants were connected, with a substation placed in Lodi District Heating Plant, in continuous service from April 2013. The plant is powered with secondary bio fuel, such as residues from forest maintenance.

Another possibility regarding RES is related to the use of heat pumps combined with geothermal source: this chance will be assessed during 2015, as a part of the expansion programme, which will be presented later in this report.

3.3.Achievements

Present situation

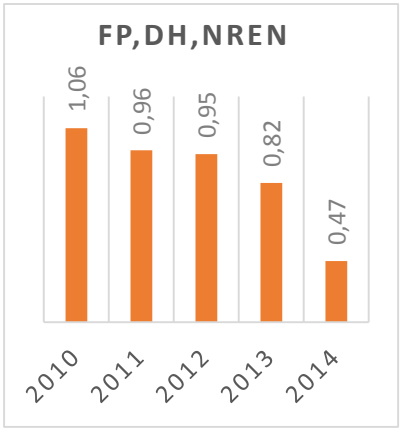
The programme has been completed: the system is much more efficient, sustainable - and even reliable - than 5 years ago.

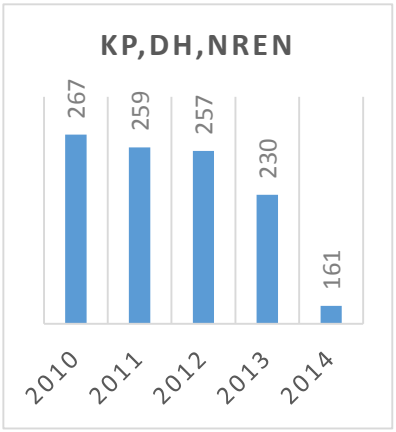
Another positive effect of the success of the modernization programme is the starting of a new programme, this time of expansion, as explained in the dedicated paragraph.

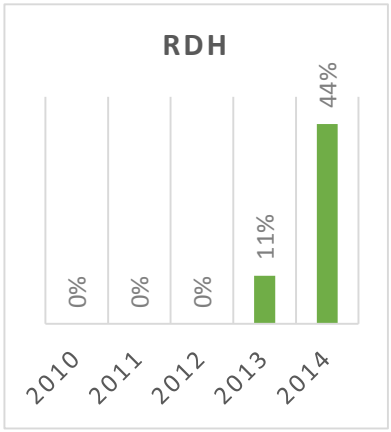
A focus on Environmental indicators

In the following tables and graphics, it is clearly shown how the different parameters have evolved in the last five years.

System Energy Efficiency, Emissions and Environmental Benefits		2010	2014	Δ
$f_{P,dh,nren}$	*Primary energy factor*	1.06	0.47	*-56%*
$K_{P,dh,nren}$	*Greenhouse gas emission* [kg CO2/MWhHi]	267	161	*-40%*
R_{dh}	*Renewable and surplus heat fraction*	0%	44%	*n.a.*
SO_2	*Gas emissions [tonne]*	*negligible*[1]	3.6[2]	*n.a.*
NO_X	*Gas emissions [tonne]*	12.5	6.9	*-44%*







Energy indicators have been calculated according to the instructions[3] provided with the application form. Electricity from cogeneration $E_{el,chp}$ and the related amount of fuel has been determined according to 2008/952/EC.

It is important to highlight that the data used as "post-programme" for the application are based on 2014, the first full year in the system after the modernization. Unfortunately, **during 2014 the gas-fired CHP unit has run few hours**, due to failures and related maintenance activities that have caused long shutdowns: this has had a negative impact on environmental performances as calculated in the application form. For a better understanding of the "expected" impact of the programme implemented, in the following table is shown a simulation with data taking into account **minimum operating hours** of the gas-fired CHP unit in a "typical year" (approximately 3,500 hours in the heating season).

	2010 baseline data	2014 real data[4]	baseline VS real data	2014 CHP min. Op. Hours	baseline VS CHP min. Op. Hours
$f_{P,dh,nren}$	1.06	0.47	*-56%*	0.21	*-80%*
$K_{P,dh,nren}$	267	161	*-40%*	136	*-49%*
R_{dh}	0%	44%	*n.a.*	44%	*n.a.*

[1] *Only natural gas as fuel*
[2] *For gas emissions the combustion of biomass negatively impacts calculations of SO_2*
[3] *Electricity from cogeneration $E_{el,chp}$ and the related amount of fuel has been determined according to 2008/952/EC*
[4] *Actual operation of gas-fired CHP unit during 2014: 1,250 running hours*

3.4. A new challenge: Expansion Programme (2013-18)

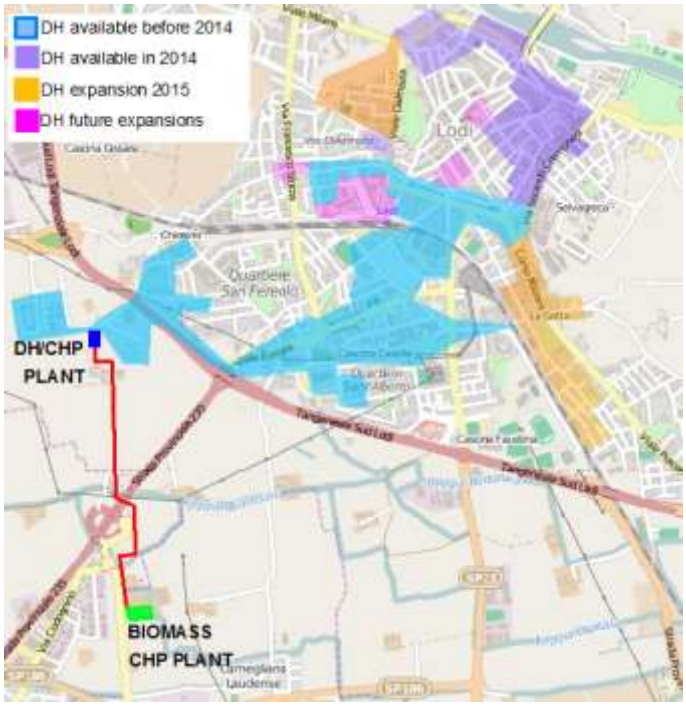
From the beginning of the programme of modernization there was the trust that, if the system had become much more efficient, with lower production costs, it would be possible to develop the network to neighbourhoods of the city not yet reached by DH.

This "prediction" became a fact when the major projects of the programme entered in the construction phase and the increasing efficiency was just a matter of time.

For these reasons, after the first rough estimates in 2012, a new programme of expansion was studied in 2013, which has entered the construction phase in 2014, with the first part of the expansion of the network (north area).

This new programme will continue in the coming years, with the goal of doubling the size of the network compared to 2013, covering both north and south-east area.

This programme has obtained a loan from EIB, with other projects on gas and electricity networks owned by Linea Group Holding.



4. District Heating and the Community

The programme has improved the quality of life of the community in different aspects.

From an economic point of view, the cost of heat for the customers has been cut approximately by a 5%, thanks to public incentives on the heat supplied from biomass fuelled DH systems.

The programme has had also positive Employment effects: during the construction of biomass CHP and thermal energy storage, temporary employment have been created (average ten per year) and at the end, three permanent jobs were created (including LODIENERGIA).

A specific customer satisfaction survey on the programme has not been done, but Community has a good attitude toward District Heating, as evidenced by the growing number of customers served every year.

Every year, we lecture in schools (from 6 to 18 years old) to explain the importance of RES and Energy Efficiency for environment sustainability: one of the key-point is the role of district heating, and an example is the modernization programme implemented in Lodi. Students can also visit our CHP/DH plant with their teachers.

ANNEX A: Two examples, a lesson learned

Introduction

In the following sections will be treated two projects that have been stopped at an early stage.

They have been reported to give an overall portrait of how has evolved (and still is evolving) the programme of transition to a more efficient and sustainable DH: as you can imagine not all projects have come in the operational phase, but they all have contributed to the growth of an awareness that studying more alternatives is essential to succeed.

Heat Supply from Tavazzano & Montanaso Power Station

The thermoelectric power station of Tavazzano and Montanaso is located 5 km from Lodi.

The plant is gas-fired and composed by:

- Two CCGT (800 + 400 MW)
- One conventional group with steam turbine (320 MW)

During 2012 it was studied the feasibility to convert one CCGT to CCGT/CHP with steam extraction (60 MW) to feed Lodi DH, coupled with an expansion of the network. The evaluations ended because of the situation of uncertainty due to the crisis of the power generation sector, also considering that economic impact of the heat demand for Lodi DH was negligible for a power station of that size.

Solar District Heating: a study on SDH distributed

Lodi DH network has some peripheral branches with few customers using domestic hot water; those branches in summer have elevated losses compared to heat sold, and the possibility to "disconnect" those branches was investigated.

With AIRU (Italian association of DH) and "Politecnico di Milano" (an Italian University) has been carried out a study, within the platform dedicated to Solar District Heating by the programme Intelligent Energy Europe (SDHplus Project), to assess the feasibility of solar thermal plants distributed along the network on roofs of some peripheral buildings, for disconnect the "main network" during summer. The study was published on the website of SDH during 2014.

Under current conditions, the project is not economically remarkable, but it was useful to evaluate other alternatives.

http://www.solar-district-heating.eu/Documents/SDHCasestudies.aspx