EBC
Energy in Buildings and Communities Programme

Quartiere Giardino, Modena (Italy)

This success story is not an example of best practice in terms of cost-effective implementation of building renovation and renewables, it is only focused on the energy system, no measure related building renovation has been performed and it was implemented in the 1970s but it may be relevant to other similar interventions.

Country: **Italy**

Name of city/municipality: **Modena**

Title of case study: Quartiere Giardino in Modena

Year and duration of the renovation: 1970 - nowadays

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Link(s) to further project related information / publications, etc.:

Schematic figure or aerial overview

Figure 1. Location of Villaggio Giardino (red square) in Modena

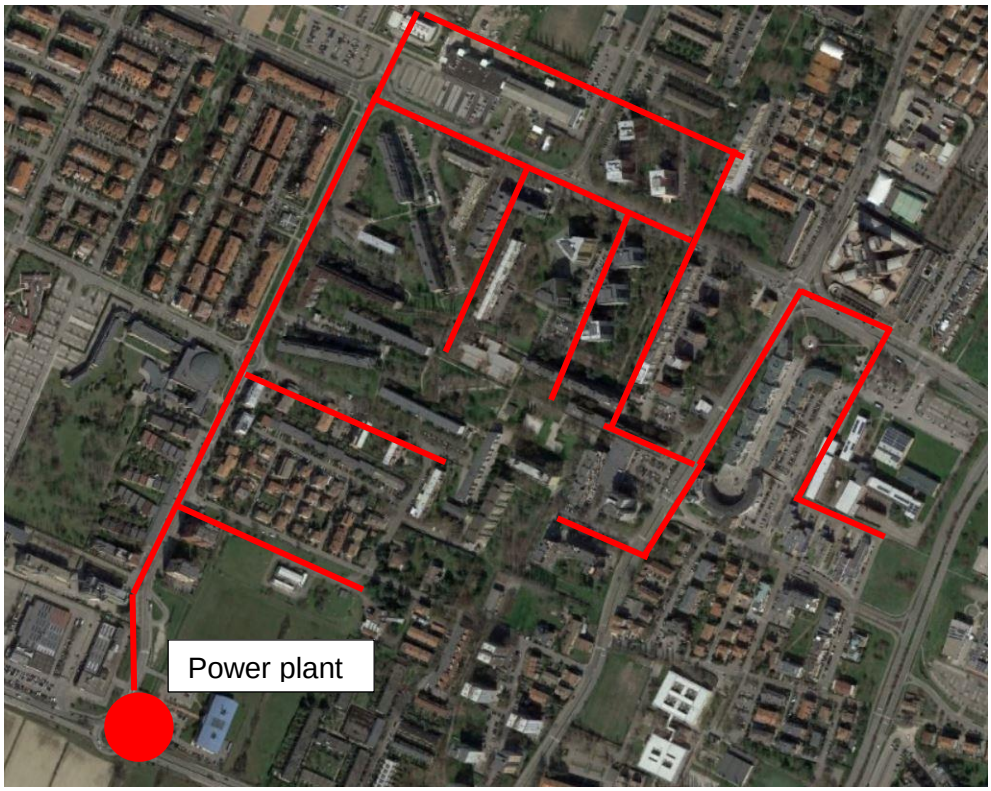

Figure 2. Extension of the district heating network in the considered area

Introduction and description of the situation before the renovation

The area called “Villaggio Giardino” (garden Village in English) is a part of the south district of Modena. The housing complexes in the area are immersed in a vast green area, as designed in the urban plan, that starting form a nearby park, extends towards south. Some buildings of the "village", in particular those of the northern sector, are built by the IACP (public housing association), while others are built by private individuals under a contracted building scheme. The residential blocks are arranged freely in the lots in groups of bodies perpendicular to each other. The most commonly used typological scheme is the linear block, with considerable long plans and limited height. In some parts of the Village this scheme is interrupted by means of higher buildings.

The apartment complexes in the area were built between 1950 and 1970 due to a high request for housing across Italy. In this time the main used construction system for residential buildings was masonry walls; the stratigraphies of the façade in the linear typology reflect this trend. From the exterior side these walls are composed of: external plaster, two masonry structure with an air layer in-between and internal plaster. For this kind of building, the heating demand is satisfied by means of individual boilers fired up mostly using natural gas. Tower buildings, on the other hand, present a reinforced concrete structure with masonry infill walls without external plaster. In this case, the heating demand is satisfied with a central boiler that use natural gas as well. In both cases, the cooling supply is granted by the installation of single unit air conditioning systems, but not all apartments are equipped with this technology.

In the considered example all buildings are apartments, the property is mixed between municipality and private owners for a total heated floor area of about 147,000 m^2.

Description of the renovation goal

In the 1970s the administration of the city of Modena wanted to modernize the housing stock and give the urban context of the city a higher value. For that reason, the local administrator decided to build a district heating network to minimize energy consumption and harmful emissions derived from the use of individual heating devices in the apartments and maximize the energy savings that a district network can offer. The basic idea of this project was to connect to the heating network residential buildings specifically built by the municipality to help families that could not afford a private accommodation.

Moreover, since the district is immersed in a green area and open spaces have already a good quality and livability, the aim for the administrators was to increase the quality of living even for less fortunate families and create an attractive environment for private investors as well.

The administration of the city stated that the main objective of the project was to maximize the use of a singular central system in place of private heating devices to gain an energy saving useful for the whole city. The project was developed in urban areas where this change of heating system would produce a significant reduction in energy consumption and harmful emissions, an optimization in the use of energy, and a lower impact on families' income.

Description of the renovation concept

The buildings in “Villaggio Giardino”, owned by both municipality and private entities, were improved by means of the following measures:

- Construction of a district heating network and connection to the existing buildings. The network is still powered by a cogeneration plant consisting in 3 gas engines producing a total power of 3,660 thermal MW and 3,600 electrical MW. The municipality is planning the construction of a waste incinerator to connect to the district, but the works are not yet started.
- Since the old apartments were still running on single heating devices, these systems were changed by connecting the buildings to the network and switching from individual systems to a modern central heating system, supply lines were laid to each apartments complex.

For the thermal renovation of the buildings own by the municipality the city administrators didn’t plan any action concerning retrofit measures. The situation is similar for private owned buildings: no plan for envelope renovation were considered during the work or the laying of the district heating network.

Following table shows the U-values of the 2 typologies of existing buildings (in average).

Table 1. U-values in W/m^{2}K before the renovation.

	Line buildings	**Tower buildings**
	U-value [W/m²K]	
component		
exterior wall	1.76	1.10
ceiling to cellar	2.48	1.56
ceiling to attic	1.80	1.80
roof	1.79	1.46
windows	2.8	2.8
ventilation	Natural	Natural

In the following graph, it is possible to see the increase in the volume reached by the district heating network starting from the year 2000 and the thermal energy delivered for heating and domestic hot water. The decrease in the energy supplied can be explained with an increase in the renovation rate of the Italian building stock regarding envelope insulation and heating systems improvement.

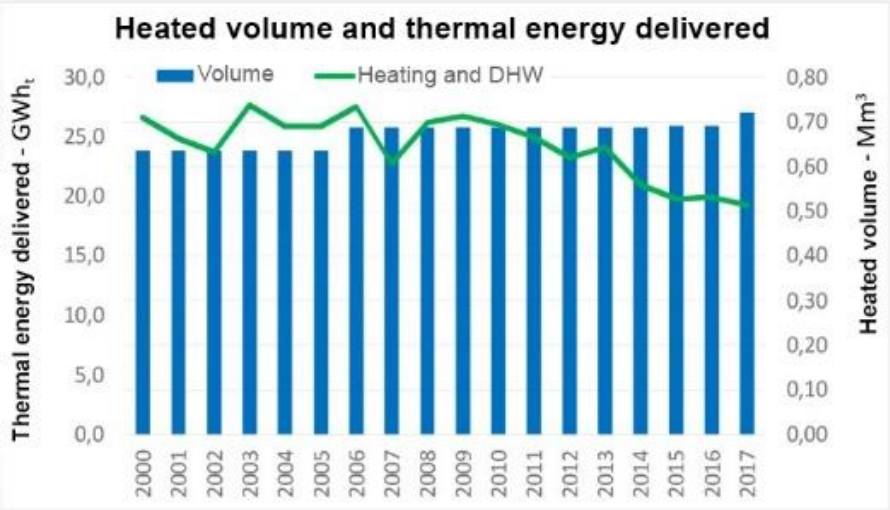

Figure 3. Thermal energy supplied to users in GWh$_t$ for heating and DHW (green line) and volume of housing heated by DH in Mm^3 (blue columns) from the years from 2000 to 2017

The next two graphs depicts the situation before and after the construction of the district heating network (TLR=teleriscaldmento, italian word for district heating network) in terms of fossil energy consumption and CO_2 emissions.

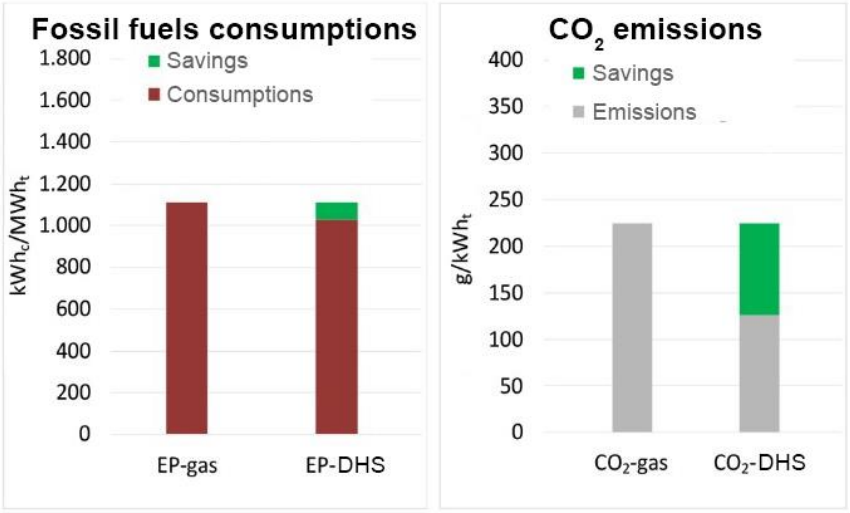

Figure 4. Left: comparison in fossil fuel consumption (brown column) before and after the installation of the DH system (in the second column the green part represents the savings in fossil energy consumption due to the switching from individual systems to a district heating system). Right: comparison in carbon dioxide emissions (grey column) before and after the installation of the DH system (in the second column the green part represents the savings in CO_2 emissions due to the switching from individual systems to a district heating system)

Project Fact Box (I)

General information

Parameter	unit	before renovation	after renovation
Urban scale of area:	m²	-	-
Population in the area:	-	10,000 (1,500 users)	10,000 (1,500 users)
Number of buildings in the area	-	2,586 apartments	2,586 apartments
Heated floor area of all buildings	m²	147,000 c.a.	147,000 c.a.
Building mix in the area:			
Single family homes (SFH)	% of heated floor area of all buildings	-	77%
Multi-family homes (MFH) - up to three stories and / or 8 flats		-	
Apartment blocks (AB) - more than 8 flats		-	
Schools		-	23%
Office buildings		-	
Production hall, industrial building		-	-
other (please specify)		-	-
Consumer mix in the area:			
Small consumers: SFH + MFH – < 80 MWh/a	in % of annual heat demand	unknown	unknown
Medium consumers: AB, schools, etc. – 80-800 MWh/a		unknown	unknown
Large consumers: industrial consumers, hospitals, etc. > 800 MWh/a		unknown	unknown
Property situation of buildings:			
private	% of heated floor area	~50	~50
public		~50	~50
Property situation of energy supply system (district heating):			
private	% of heated floor area	100	0
public		0	100

Project Fact Box (II)

Specific information on energy demand and supply:

Parameter	unit	before renovation	after renovation
heating demand (calculated)	kWh/m²a	-	-
domestic hot water demand (calculated)	kWh/m²a	-	-
cooling demand (calculated)	kWh/m²a	-	-
electricity demand (calculated)	kWh/m²a	-	-
heating consumption (measured)	kWh/m²a	Unknown	21.3MW/11,430MWh/a
domestic hot water consumption (calculated)	kWh/m²a	included in the heating consumption	included in the heating consumption
cooling consumption (measured)	kWh/m²a	-	-
electricity consumption (measured)	kWh/m²a	-	-
(Thermal) energy supply technologies:			
decentralized oil or gas boilers	% of heated floor area	100	0
decentralized biomass boilers		-	-
decentralized heat pumps		-	-
centralized (district heating)		0	100
other *(please specify)*		-	-
renewable energy generation on-site:			
solar thermal collector area	m²	0	0
photovoltaics	kWp	0	0
other (please specify)	kW	0	0

Financial issues:

Parameter	unit	before renovation	after renovation
total investment costs of the renovation	Euro/m²	€ 2,000,000 for network renovation and cogeneration plant	
- building envelope renovation costs	Euro/m²	-	-
- heating/cooling supply costs	Euro/m²	-	-
- renewable energy production costs	Euro/m²	-	-
LCC available	yes / no	no	no

Description of the technical highlight(s) and innovative approach(es)

The main highlight in the experience of the district heating of Modena is the innovation that brought in the Italian energy sector in the 1970s. It is the first example of such a technology implemented in the country and because of that it has always been watched as an example.

Once the system was built by the municipality, it was handed over the administration to a company with the technological resources and right know-how for the expansion and optimization of the network: the owner of the district system is still the municipality, but the use of the network is very cheap for the company making possible for them to keep the prices low for their clients and, at the same time, making a profit with the selling of the energy to the connected households.

This particular type of partnership between public entities and private companies is nowadays commonly used for important public works. In the case of Villaggio Giardino's district heating, the partnership is working from 1970, meaning that is a feasible solution for district renovation works.

Decision and design process

General/organizational issues:

The main highlight in the experience of the district heating of Modena is the approach that led to the creation of the heating network. The process started from the willingness of the city municipality to give a better quality of life for the people living in social accommodation. This decision was made following the consideration that a district heating network could help in reducing the energy needed for the heating and the production of DHW and thus helping destitute people and, at the same time, reducing the utilization of individual systems for heating reducing hazardous emissions. With these two main reasons a series of other consideration came in support of the construction of the network such as the risk reduction for gas leaking and explosions, avoidance of costs for the users linked to chimneys, maintenance and periodical control on the heating device, the ease in installing new parts in the event of a reconversion to different primary energy source, among others.

The intervention was performed to meet the sustainability goals planned by Modena municipality. The city wanted to start a renovation process starting from municipal owned buildings to set an example and to produce and distribute heating and domestic hot water to users with the least possible CO_2 and pollutant emissions.

Stakeholders involved

The stakeholders that made possible the intervention were mainly two: the administrators of Modena that in 1970 decided to build a DH and entrust the management to AMCM (a municipal utility for public services, the second stakeholder) later bought by Hera group and the AMCM itself.

Main steps

Since the project was supported by the municipality with the use of public funds one of the most important steps was the initial decision of building this district heating systems to improve the living condition of the people in the area and to be an example to be replicated by private owners. After that step, the use of technical know-how for the implementation of the project and, at the end, entrusting a dedicated agency for running the network.

Resources available before the project

Before the project, buildings were served by individual boilers and the only resources available were public funds reserved by the municipality for renovation works of the housing stock owned by the municipality. Other than the merely economical resources, the know how to implement such a process was in the hands of the company that the municipality used for this kind of renovation processes.

Drivers and barriers (opponents)

One of the most important drivers for this project was the initial interest shown by the municipality in investing in such a system. The entire investment was carried out with the use of public money and only after the works ended the system was given to an external society to administrate it and expand it during its life. Some barriers were encountered with the residents of the area since these measures were top-down decisions taken without a participatory planning stage.

Stakeholders' role and motivation:

Main stakeholder	Specify which organization(s) was (were) involved	Role (decision maker, influencer, technical advisor, delivery)	Driver/motivation
Policy actors (municipality department, government body, innovation agency, etc.)	Municipality	Decision maker	Savings, CO_2 reduction, quality of living improvement
Users/investors (individual owner, housing association, building managers, asset manager, project developer)	Municipal housing association	Influencer	Savings, standards improvement
District-related actors (Community/occupants organizations, etc.)	Households occupants	Influencer	Savings, standards improvement
Energy network solution suppliers (Distributor system operator, energy supply company, energy agency, ESCO, renewable energy companies)	ESCO	Decision maker/delivery	Profit, experience, fame
Renovation solution suppliers (Planning and construction parties, urban planners, architects, design team general contractors, products suppliers, ESCO, contractor, energy monitoring, facility manager, installation provider, one-stop-shop, etc.)	ESCO	Technical advisor	
Other intermediaries (public bodies, trade organizations, NGO's, consultancies, research institutes)	Dedicated agency	Technical advisor	

Design approach:

The installed systems are capable to satisfy the heating needs of the whole connected area, even if the energy is produced with non-renewable energy sources (natural gas), there are energy savings and reduction in CO_2 emissions. This is possible thanks to an optimal work done during the design phases: the working teams carried out the project for the detailed design of the piping systems and the dimensioning of the three engines, in order to answer the needs of the community.

Technical issues:

The main challenges related to the technical implementation of the project were related to the pipe lying in an already consolidated environment and connected to that the difficulties in find a right place for the power plant.

Financing issues:

In order to guarantee the growth of the households connected to the district heating and to ensure a unified and stable strategy, the municipality decided to stop the incentives for the old boiler substitution in the area where the district heating network was already in place. The private company that manage the network is interested in an economic return of the investment, so households pay a price little higher than the price for the energy production, but it offers discount up to 25% for the connection of the buildings to the network. The society that manage the DH system guarantees annual savings between 5 and 10% in comparison to the situation with individual heating systems.

Management issues:

There was no particular challenging situation while dealing with the management of the project.

Policy framework conditions:

The municipality was driving the process. One of the most important aspect was the initial interest shown by the municipality in investing in such a system. The entire investment was carried out with the use of public money and only after the works ended the system was given to an external society to administrate it and expand it during its life.

Lessons learned/interesting findings

With district heating it is possible to eliminate the costs for the construction of the flues and the purchase and maintenance costs of the boiler and its revision, verification and cleaning. The district heating service is proposed to users with central heating and new buildings or renovations. The current legislation makes the district heating a convenient solution since the energy is sold at the price of production and incentives for personal boilers are no longer granted. Given the absence of combustion, installation and maintenance interventions are simplified and for the end users district heating is cheaper than the other available energy vectors. The increase in oil price in recent years makes district heating and becoming independent from fossil energy imports economically very interesting.

From this experience we can see an increase in the comfort perceived by the inhabitants in their houses and a parallel increase in the quality of life in the municipal housing thanks to a good planification of the project and a better management of the heat and DHW demands.

The municipality of Modena sets a good example that need to be followed in deciding and support the investments for the realization of a district network: in this way a lot of attention has been drawn towards the good example that the municipality showed in planning such a project. Moreover, since a private company is now managing the district heating, it is in their interest to satisfy the customers in order to increase the connections to the network and to not create situation that may cause losses to the company. In this way, the municipality does not need to focus on the managing of the network, the inhabitants improve their living condition and the private company is earning money that they reinvest in the network for its maintenance and eventually its expansion.