General overview about Alperia Ecoplus and the District Heating System of Bolzano within its process towards modernisation in the years 2013-2019

Alperia Ecoplus

Alperia Ecoplus is the Alperia subsidiary that provides district heating in South Tyrol. It operates 5 plants – Bolzano, Merano, Sesto, Chiusa and Lazfons – and has **2.335 exchangers** serving thousands of South Tyrolean households (of which 291 in Bolzano).
To produce thermal energy, Alperia Ecoplus uses both biomass (60% local) and natural gas. In addition, it utilises residual heat from industrial processes as well as heat from Bolzano's waste-to-energy plant, which uses municipal waste. For demand peaks or in the event of failure of the biomass boiler, district heating plants also have gas or gasoline boilers. Three plants are also equipped with cogenerators (plants that produce electricity and heat at the same time and therefore ensure extremely high energy efficiency levels) that are fuelled by natural gas.
The network continues to expand every year. In Bolzano, where a Maxiplan worth €70 million is planned, there is a 26 km network, plus 5 km of pipes for condominium connections. Via Resia, Via Druso, a large part of the industrial area and the hospital, which was connected in 2019, are already covered. Alperia Ecoplus covers 100 MW of installed power, which will be doubled by 2025.
Currently, 262 apartment blocks are connected in the city, and another 250 will be connected to the network by 2025. When the investment plan for Bolzano will be completed, around 7.5 million cubic metres of gas will be saved each year, saving somewhere in the region of 15.000 tonnes of avoided $CO2_{eq}$ emissions, equivalent to a virtual forest of two thousand hectares appearing in the city. In the upcoming years, Alperia Ecoplus has already plan to build new production plants in order to face the growth of the city heat demand and to guarantee the heat supply also in the case of an incinerator failure. In Merano, Alperia Ecoplus supplies 491 substations with district heating, providing green heat to more than 5.660 families and approximately 420 additional company, school and office users. A phase change storage tank has been installed here and is currently being tested. The tank is the result of one of Alperia Startup Factory's innovation projects. Currently, the district heating system saves 8.000 tonnes of CO2 emissions every year, roughly equivalent to the CO2 absorption of a 5-square-kilometre forest. This represents 1/5 of the Municipality of Merano's surface area. in Merano, a new biomass plant will be completed in summer 2021. This thermal plant will not only facilitate the switch from gas to biomass, but will also permit to continue the expansion of the district heating network. The aim is to contribute to the reduction of CO2 emissions from heating as early as winter 2021. The new plant will be able to produce 27.000 MWh of thermal energy per year, equivalent to the heat required to heat approximately 2.500 traditional-energy-class apartments of 100 m2 each. The plant will produce total dust emissions comparable to those generated by no more than 50 conventional domestic fireplaces. The biomass used will be tightly controlled and, as for the other plants, priority will be given to local virgin biomass or biomass coming from up to 250 km away.
Connections also continued in Chiusa and Lazfons. In Chiusa, a cogenerator for self-consumption will also be installed, while in Sesto, the installation of a second electrofilter is at an advanced research stage, which will allow the two biomass boilers to be operated completely separately, thus increasing efficiency. In the past, during maintenance, it was necessary to switch off biomass heat generation, using a gasoil boiler with very high consumption instead. Now, this will no longer be necessary.
In addition, the conversion factor has been certified for all plants and the calculation of CO2 emitted is being planned to offset operational emissions with green gas.
The aim is to reach around 100 MW of new thermal power connected to the Alperia Ecoplus district heating network by 2024.

It is also noted that to reduce environmental impact, district heating plants have been built differently depending on the area where they are located. In the South Tyrolean capital, Alperia , in collaboration with the Bolzano Association of Architects, launched a competition for ideas for the external covering of the thermal storage tank to both contribute to the city's architecture and minimise its visual impact. In Chiusa, the district heating plant takes the form of a large wing rising from the ground. In Sesto, due to its proximity to the Dolomites Unesco World Heritage site, the structure was made entirely of wood. In Merano, geometric cubes were chosen to blend in with the surrounding landscape and make the most of the slope for the installation of a photovoltaic system. The Bosin plant features a corten finish and a green roof as well as numerous external green areas with various species of trees planted.
Finally, to offer an even more efficient service, Alperia Ecoplus set up a freephone emergency number in 2020. The Alperia Ecoplus integrated system is certified according to the UNI ISO 9001:2015, UNI ISO 14001:2015 and UNI ISO 45001:2018 standards and has an EMAS declaration.

image 1: Key information about Alperia

A brief history of the Bolzano DH system

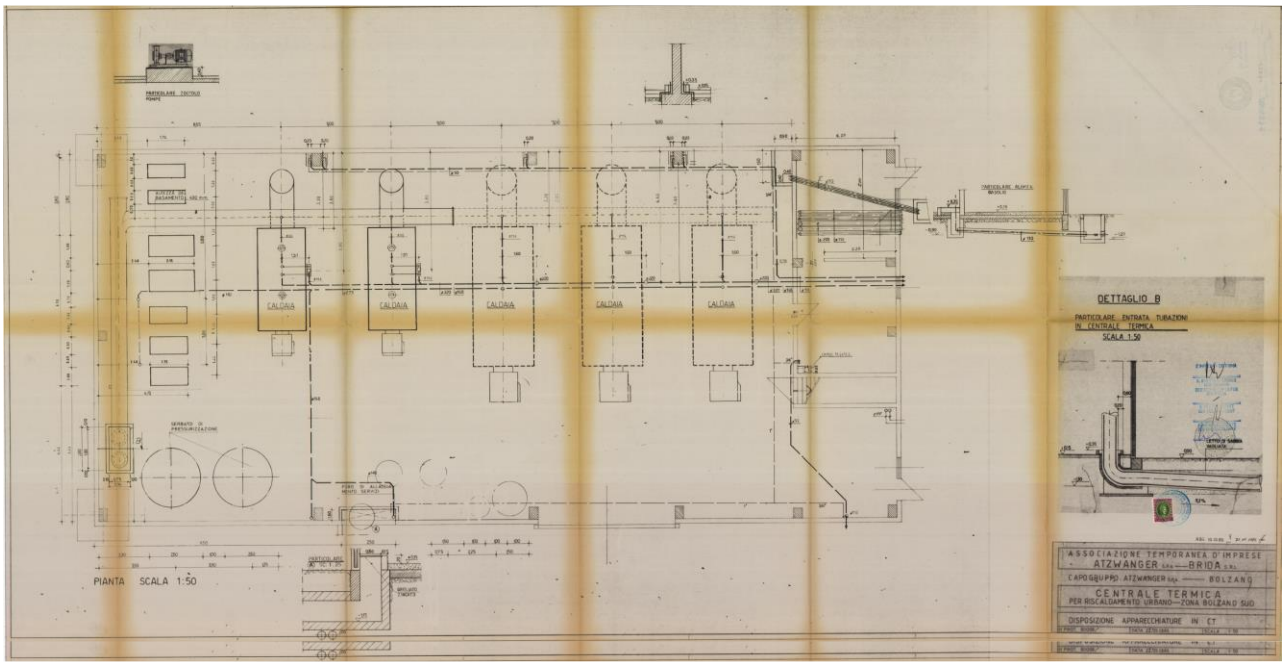

image 2: original plan of the DH plant (source: Alperia Ecoplus)

The district heating system was built in 1986 to supply a social housing area. The supply was based on natural gas-powered boilers and a hot water network. At that time there have been already forward-looking plans that provided for a doubling of the building with an expansion of the production capacity with gas turbines. The original output power was composed by two 3,5 MWth and three 8 MWth hot water boilers. Later on, one of the small boilers was substituted with the same 8 MWth boiler, the last small one remained as an gasoil-fired reserve.

In the late 1990s, the newly expanded commercial zone in the south of Bolzano ("Bolzano Sud") was developed with district heating and the connection to the then existing waste incinerator was planned, with its finally implementation in 2001.

Modernisation and extension

image 3: DH plant after 2008 enlargement – there can be seen the exhausts of the two CHP-engines (source: Alperia Ecoplus)

From 2006 the predecessor company of Alperia Ecoplus, ECOTHERM, took over the district heating system with the mission of expanding and empowering it. In the years 2008-2009 the heating plant was accordingly enlarged and architecturally upgraded. An absorption chiller was installed in the heating plant to gain personal experience. The district heating network was expanded to include the new "Casanova" urban district and part of the Bolzano Sud commercial zone.

The existing boilers have been converted into warm water operation mode and two Jenbacher gas-based CHP engines have been added with an output power of 1,84 MWth and 1,82 MWel.

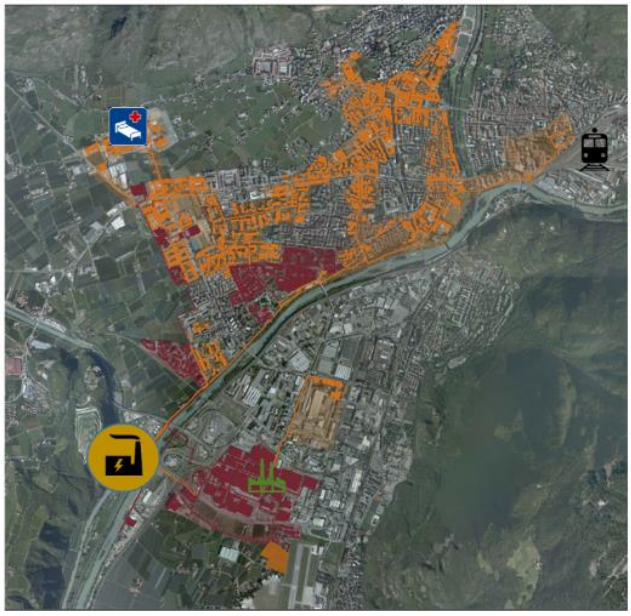

image 4: existing (2018) DH network (red) and planned network (orange), major sites are indicated (DH plant, industrial zone, hospital, railway station (should be converted into urban district within the next years) (source: Alperia Ecoplus)

At the same time, planning for the new waste incineration plant and the extensions to the hospital and the city of Bolzano started. The basic concept planned that a large part of the city, including the hospital, would be supplied with district heating. In order to ensure sustainable summer consumption, the Bolzano hospital will be equipped with absorption cooling machines. In addition, a back-up center has to be built on the hospital site to supply both the hospital and parts of the city. Now, waste incineration plant, district heating and hospital are tied to different operating companies. This made coordinating the various activities a major challenge.

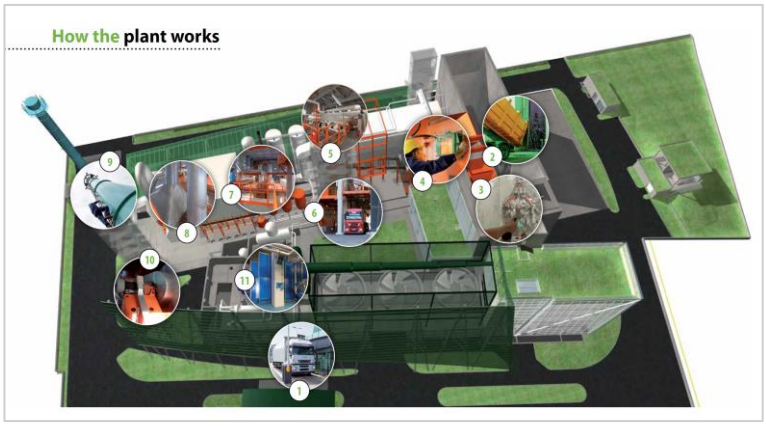

image 5: build-Up of the new waste inceneration plant (source: Ecocenter)

The waste incineration plant was first to be completed and went into trial operation in 2013 and regular operation in 2014. During this time, the connection to the district heating network was also established, initially as a temporary solution on the existing connection, and then as a definitive new built connection. In 2016, the expanded Bolzano heating plant with the 5.600 m³ buffer storage and a new, highly efficient (all IE4-drives) pump system became operational. In this new pumping station, the outlets for the three main pipelines (existing city, hospital and industrial zone) have already been realized. This pumping station represents the heart of the Bolzano's district heating system, here is collected the heat from the incinerator and the heating plant as well as the buffer storage's heat and sent on its journey towards the consumers.

image 6: sight of the complete DH plant with pump station in the front and the thermal storage tank in the background (source: Alperia Ecoplus)

The Bolzano district heating system in detail

Waste to Energy Plant		
Dimension	U.M.	Measure
Annual capacity	[ton]	130.000
Furnace nominal power	[MW]	59
Electrical power output	[MW]	15
Thermal power output	[MW]	up to30 + 2 *(turbine + stack)*

Production unit	Fuel	Nominal power [MW_{th}]
Waste to Energy	MSW	25.0
Boilers	Natural gas	32.0
Boiler	Oil	3.5
CHPs	Natural gas / Hydrogen	3.7

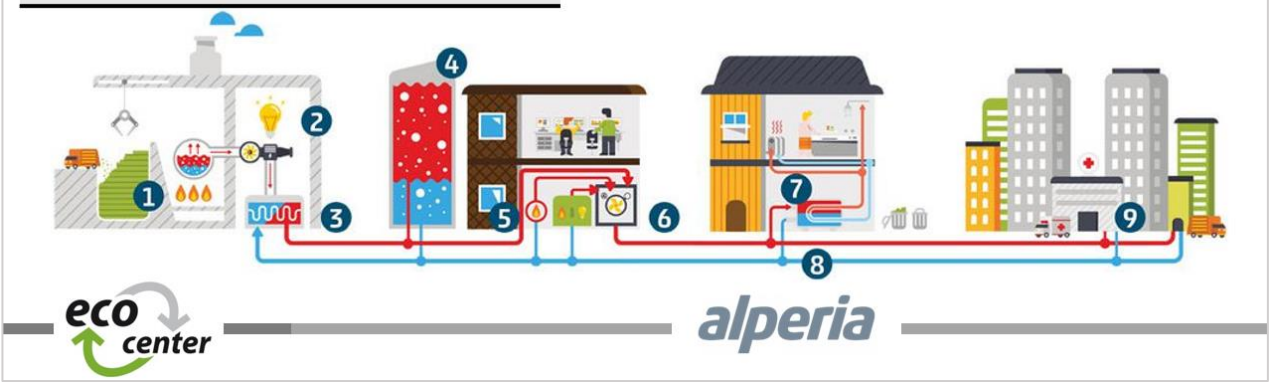

image 7: the Bolzano district heating system (source: Alperia Ecoplus)

(1) Steam produced by combustion in the Bolzano waste-to-energy plant drives a turbine (2) to produce electricity. The residual heat (3) is used by the Alperia district heating plant, meeting citizens' needs. In addition to the heat from the waste-to-energy plant, Alperia has a heat storage tank (4) and spare boilers and cogenerators (5) which allow it to cope with demand peaks. From the power plant, the heat, in the form of hot water, is fed into the district heating network (6) made up of a closed circuit of underground pipes. The hot water flows into the district heating network, then onwards to individual homes. Here, thanks to a heat exchanger (7), energy is used to heat the sanitary water of homes and heating systems. All this happens without the loss of any water. After the heat has been released, the water goes back to the plant through the district heating network (8) to be reheated and resume its cycle. In addition to heating private homes, the district heating system meets the energy needs of many public buildings in the city, including the Bolzano hospital (9).

Thermal Energy storage

Thermal Energy Storage		
Dimension	U.M.	Measure
Internal diameter	[m]	14
Height	[m]	40
Volume	[m^3]	5619
Capacity	[MWh]	230

image 8: 5.600 m^3 thermal energy storage with architectural cover (source: Alperia Ecoplus)

Further plant's data:
occupied surface: 8.190m², therefrom 2. 374 m² of building structure, 2.880 m³ with bitumen and 2.936 m² of green.

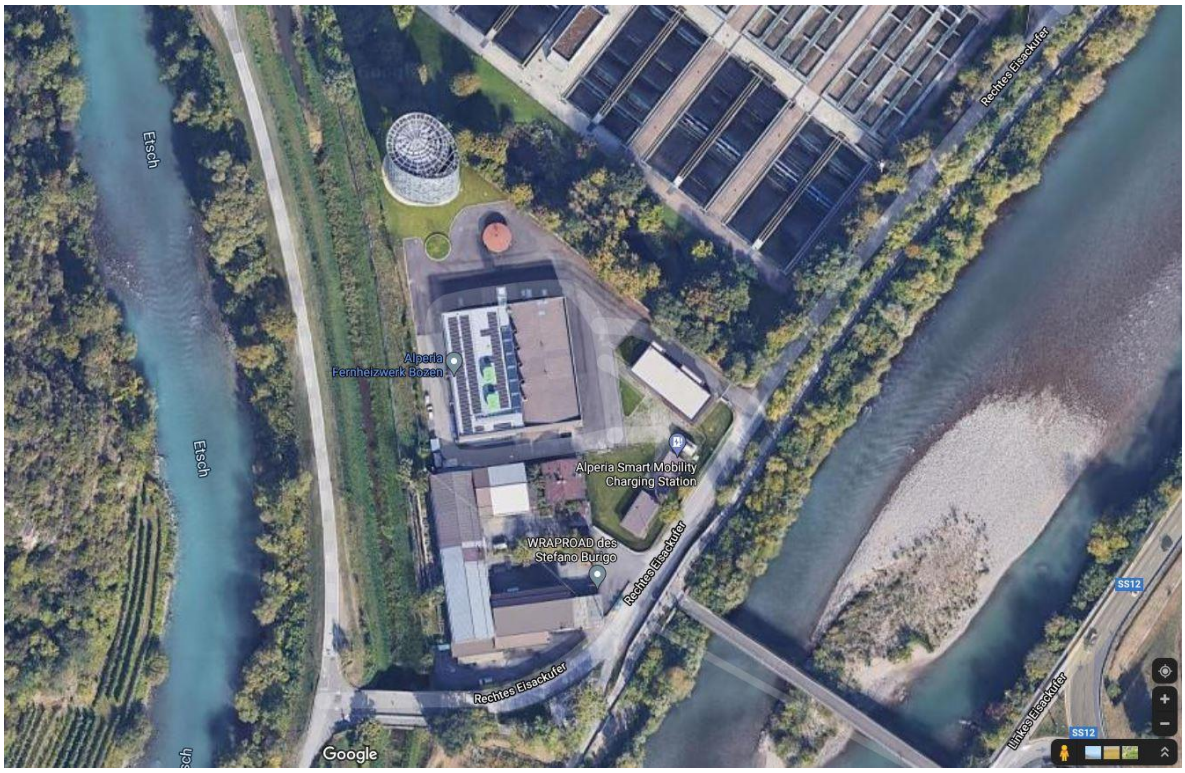

image 9: Bolzano DH plant – aerial view (source: google maps)

Thermohydraulics

As already pointed out, heat comes out from the incinerator and the DH plant. The heat storage tank buffers excessive heat production and releases that heat, when production is lower than the network's need. It was determinant to have an increased failure safety for the pumping system. All the heat for the Bolzano DH system passes through that structure, so a stand still has to be avoided. Thus, all pumps have been dimensioned with the same characteristics, putting together groups of four or five, so they are interchangeable. The pump collector is continuous, intercepted in regular function by clapet valves. In case of need, the valves can be opened, providing pumping volume by an alternative pump group. Three main pipelines start toward the city (hospital zone, citiy, industrial zone).

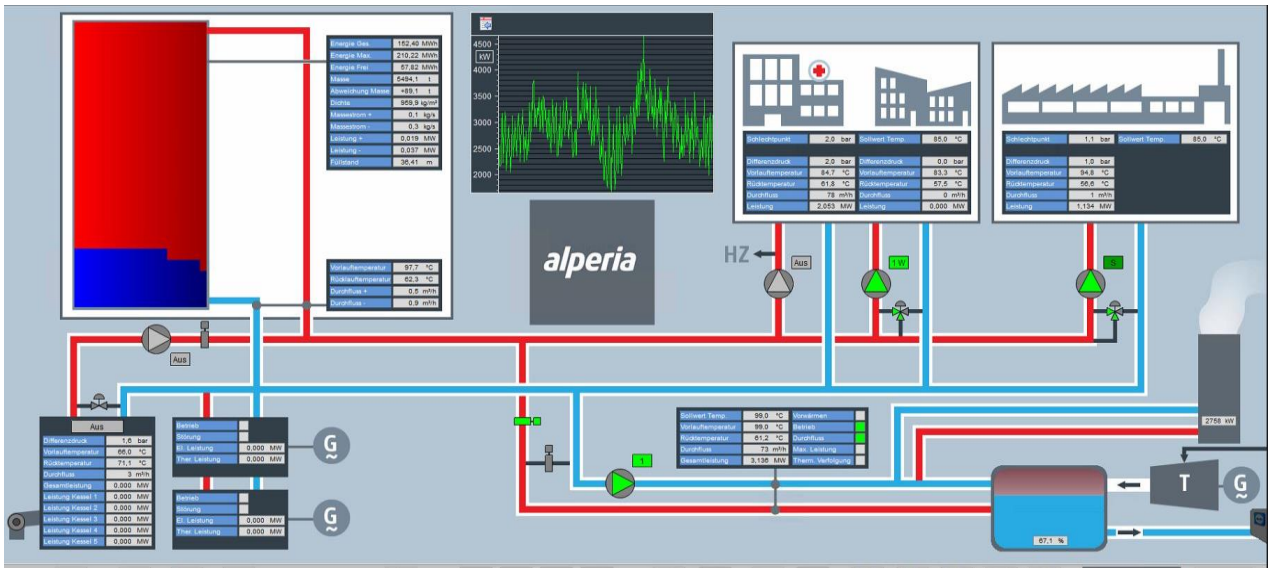

image 10: thermo-hydraulic SCADA-scheme of the Bolzano DH plant after modernisation 2016 (source: Alperia Ecoplus)

The SINFONIA project was a five-year initiative to deploy large-scale, integrated and scalable energy solutions in mid-sized European cities. At the heart of the initiative is a unique cooperation between the cities of Bolzano and Innsbruck, working hand in hand to achieve 40 to 50% primary energy savings and increase the share of renewables by 20% in two pioneer districts. This had be done through an integrated set of measures combining the retrofitting of more than 100,000m² of living surface, optimisation of the electricity grid, and solutions for district heating and cooling. (source: http://www.sinfonia-smartcities.eu/en/project)

Alperia Ecoplus' major workpackages cosidered reduction of NOx-Emissions due to Hydrogen admixture, load forecast and prevention of heat peaks demands in DH networks.

The target of the load forecast was to simulate a digitalized network using measured data to calibrate the real-time calculated model. The highly sophisticated software reads data of the distributed substations and of field distributed sensors, runs its simulation and is giving advice to the DH system operator to lower or rise temperatures and/or pumping volumes.

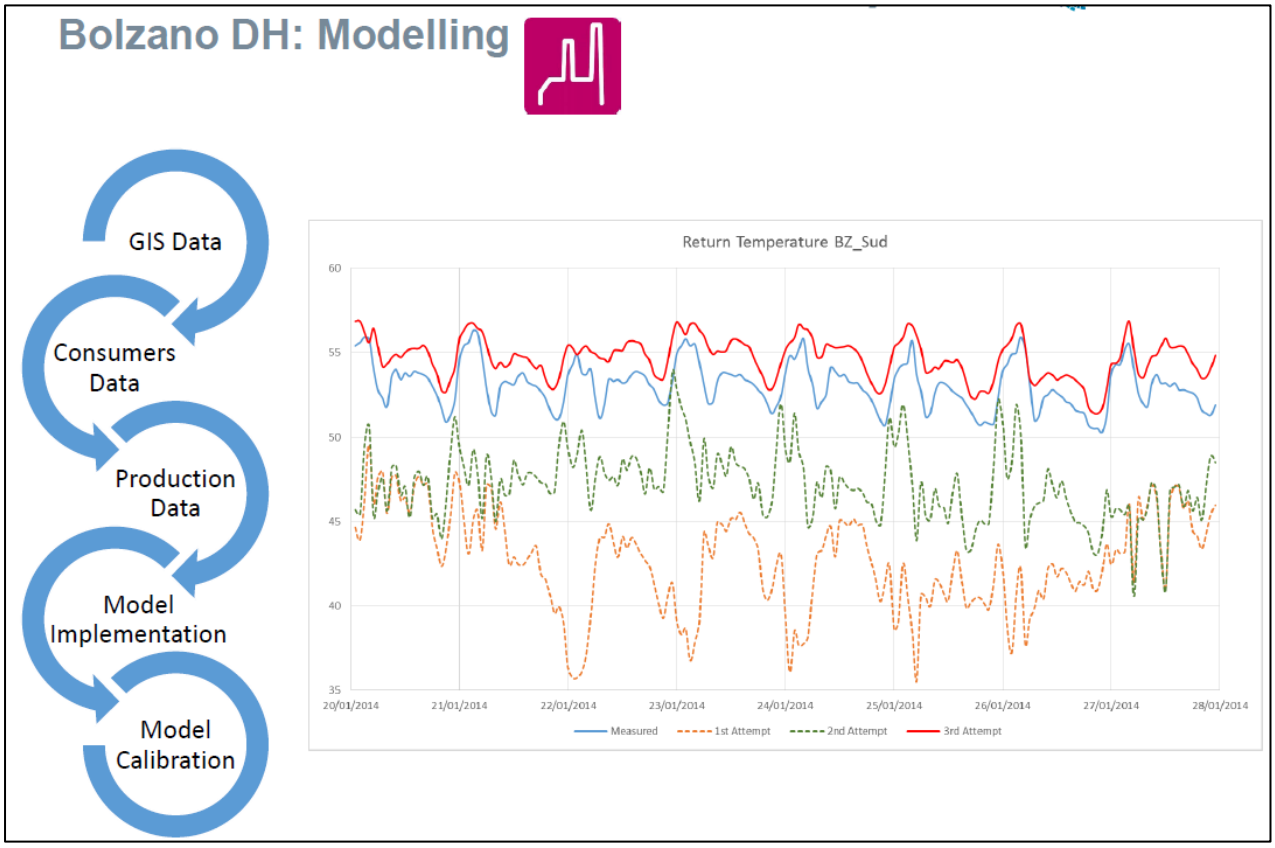

image 11: step-by-step data integration and a graphic result of network's temperature simulation (source: Alperia Ecoplus)

Task 8.4.2

Figure 2
Real time monitoring

Figure 3
Heat load forecasting tool

Figure 4
Temperature optimization tool

image 12: major simulation targets within the Termis-software (source: Alperia Ecoplus)

Participation in the Sinfonia project enabled Alperia Ecoplus to use intelligent software for the optimal operation of the extended district heating network. It is an innovative control system that provides additional measuring points along the pipelines and is based on an extremely effective network model in terms of hydraulics and energy efficiency. This system enables the operator to monitor heat generation and distribution in real time, predict load peaks and optimize the operating temperature in the network.

The result was partially satisfying, as the major target, a substantial reduction of heat losses due to temperature reduction, was not fully reached for several problems found during the process.

On the other hand, Alperia achieved a very deep knowledge of its DH system. Another result was the conclusion that for Alperia Ecoplus' operational management such a sophisticated system was rather too complex to be used as a regular daily application.

So there will be implemented a less complex system witch reads the data of the substations and acts on the substation's regulation in order to lower the power needed by the customer. Thus, more demand can be covered with te waste heat, holding low the level of CO2-emissions.

Summary/Key information

The DH System of Bolzano in South Tyrol (northern Italy) was began in 1986 in order to satisfy a social housing district's need for heat. From the end of the 1990 years began a first expansion and optimisation and from 2008 took place a massive expansion, made possible through the construction of a new waste incineration plant. Thus, a strong reduction of CO2 emission was possible despite a massive expansion of the network. The maximum value of reduction was achieved in 2018 with 95%! Due to continuous optimisation, a high level should be hold.
When the investment plan for Bolzano is complete, 70 mill. € will be spent, around 7,5 million cubic metres of gas will be saved each year, saving somewhere in the region of 15.000 tonnes of avoided CO_{2eq} emissions, equivalent to a virtual forest of 2.000 hectares appearing in the city.

Various activities were undertaken to implement the programme: the planning and realization of the DH network extension (in 2019 30 km of pipelines distributing more than 70 GWh of clean and safe heat per year); the integration of the waste incineration plant; the construction of a large buffer storage tank (storage capacity: 240 MWh); the implementation of an innovative DH net optimization software (Termis); a feasibility study to examine the potential for recovering waste heat from industrial activities in Bolzano as a new source to supply the grid; the testing of the technical feasibility of operating the gas boiler with a hydrogen-natural gas mixture in order to reduce CO2 emissions. From 2013 to 2019 the number of customers connected to the DH network has increased of 60%.