Santa Marta Campus, University Iuav of Venice (Italy)

This success story is only focused on the energy system, no measure related building renovation has been performed. But it is an intervention at a district scale of the energy system in a unique context that may be relevant to other similar interventions.

Country: **Italy**

Name of city/municipality: **Venice**

Title of success story: University Iuav of Venice – Santa Marta Campus

Year and duration of the renovation: 2017

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

Schematic figure or aerial overview

Figure 1. Location of Santa Marta Campus in Venice (red square)

In the university campus of Santa Marta in Venice all buildings are schools except a caretaker's house, the property is the University Iuav of Venice for a total volume of about 104,000 m^3 and about 17,500 m^2 of heated floor area.

Introduction and description of the situation before the renovation

The Santa Marta campus is located in the southwest part of the island of Venice, within the Dorsoduro district; it is a predominantly popular and residential area and is characterized by the presence of the maritime merchant station where some warehouses were located.

The university campus of Santa Marta is the main center of the Iuav offices and consists of buildings mainly dedicated to educational activities. There are several buildings:

- ex-Cotonificio Olcese;
- ex-Magazzino Ligabue n. 5, owned by Ca' Foscari University;
- ex-Magazzino Ligabue n. 6 and 7;
- ex-Convent Terese.

The ex-Cotonificio Olcese building was inaugurated in 1883 as a cotton spinning and production company set up in Venice. Partially destroyed by a fire in 1916, the cotton mill was rebuilt. Remained operative until 1960, then it was abandoned for thirty years before its restoration in the 1990s by Iuav.

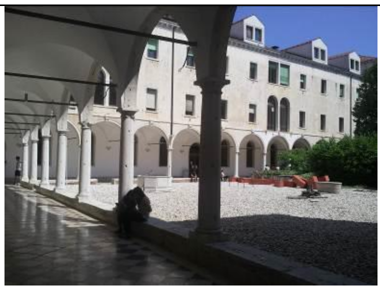
The Magazzini Ligabue were port warehouses built in the 1920s, it grew as port with storage warehouses at industrial scale. Warehouses 5, 6 and 7 have been restructured during the late 2000 by Iuav Studi Progetti ISP and Iuav.

The ex-Cotonificio and Magazzini buildings present the typical brick pre-industrial structure, like other industrial or manufacturing buildings of the time in the area.

The Convent of Santa Teresa was built in the second half of the 17th century. The building complex develops around a single large cloister, characterized by its arched porticos. The former convent was restored by Iuav in the late 1990s and the first 2000s, with architectural renovation and adaptation operations necessary to host the new teaching and research activities. However, the interventions respected the formal structural features of the building, typical of a 17th century convent.

Before the renovation the buildings were served mainly by natural gas boilers and heat pumps, as described below:

Table 1. Characteristics of the heating stations and energy vectors for each university buildings before the intervention.

Building	Existing generator	Energy vector
 Ex Cotonificio Olcese	The central heating station includes 3 generators. Generator: RIELLO TAU-N 450 Bruciatore: RIELLO RS 50/M Nominal thermal capacity (Qmax): 450 kW Rated power (Pn max): 445.2 kW (80°-60°C) Efficiency: 98.9% (Pn max) 107% (Pn min 30%)	Natural gas
 Ex- Convent Terese	Generator: RIELLO TAU-N 350 Bruciatore: RIELLO RS/M MZ Nominal thermal capacity (Qmax): 349 kW Rated power (Pn max): 346.7 kW (80°-60°C) Efficiency: 99.3% (Pn max) 107.3% (Pn min 30%)	Natural gas
 Magazzini 6 (and 5)	Generator n. 1 Model: Generator BALTUR Multiblock 90 Nominal thermal capacity (Qmax): 21-84 kW Generator n. 2 Model: Generator BALTUR Multiblock 145 Nominal thermal capacity (Qmax): 21-84 kW Generator n. 3 Model: Generator BALTUR Multiblock 180 Nominal thermal capacity (Qmax): 21-168 kW	Natural gas
 Magazzino 7	Generator in heat pump n. 1: model HITACHI RAS-20FSG cold rated output 23.6 kW heat rated output 22.7 kW Generator in heat pump n. 2: model HITACHI RAS-8FSG cold rated output 8.9 kW heat rated output 8.4 kW	Electricity

There is no use or generation of renewable energy on-site, but the characteristics and orientation of the roof in the Ex-Cotonificio are potentially usable for the installation of a photovoltaic system.

Description of the renovation goal

The university administration is operating in the continuous maintenance of the university buildings and since the 1990s has implemented various measures of redevelopment and restructuring that mainly concerned the structure and the envelope.

In the last years, Iuav planned to modernize its building stock and to renew the system plant. The main result was the inauguration of the local district heating in the Santa Marta Campus in the November 2017 to minimize energy consumption and GHG emissions derived from the use of heating and maximize energy savings. In fact, it represents a pilot role in technological innovation because it is the first realization of a district heating network in the historical Venetian context and in the venetian public buildings.

The aims of Iuav are linked to the institutional policy in order to increase the environmental sustainability of the university and to realize a research and experimentation opportunity.

The goals of reducing the energy use and cost for heating and cooling has been possible with the technical-financial partnership of ENGIE Servizi SpA and the exploiting of the government economic-financial opportunities that include the Kyoto revolving fund for the environmental value, and the obligation to reinvest 10% of the expected energy expenditure charged to the contractor to an Integrated Energy Services contract (called CONSIP SIE2).

The intervention consists of two measures:

a) a trigeneration plant with natural gas composed of a cogeneration group to produce 238 kW of electricity and 363 kW of thermal energy and of an absorption group of 255 kW refrigerators supplied by thermal waste of the cogenerator and used for cooling summer of the buildings;

b) a hot water district heating based on 90° C supply temperature that serves the 5 neighboring buildings developing over a distance of 1.3 km.

The intervention amounts of approximately 1,100,000 €, about 50% financed by the Kyoto Fund and the remainder from the recovery of the mandatory investment shares provided for and according to the SIE2 contract.

Description of the renovation concept

The intervention consists of two measures: a trigeneration plant with natural gas and a hot water district heating to serve 5 school buildings.

The positioning of the equipment is located on the Ex Cotonificio roof, near the refrigeration units and the thermal plant. The plant is quite compact and prefabricated in ISO containers. It contains all the mechanical and electrical equipment necessary for its operation. Both of them include heat recovery units, while refrigerated ones are performed using an absorber housed in a neighboring container with the relative evaporative tower nearby.

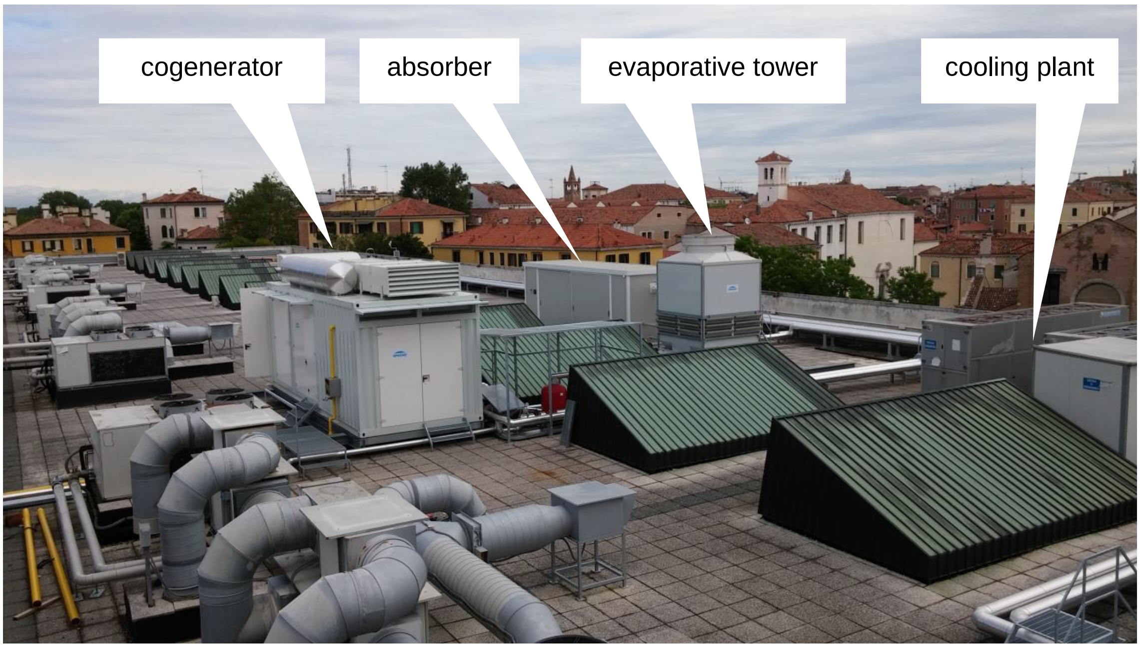


Figure 2. External view of the roof with actual localization of the trigeneration plant on the roof of the Ex Cotonificio

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Project Fact Box (I)

General information

Parameter	unit	before renovation	after renovation
Urban scale of area:	m²	11,000 m²	11,000 m²
Population in the area:	-	4,000	4,000
Number of buildings in the area	-	5	5
Heated floor area of all buildings	m²	17,500 m²	17,500 m²
Building mix in the area:			
Single family homes (SFH)	% of heated floor area of all buildings	-	-
Multi-family homes (MFH) - up to three stories and / or 8 flats		-	-
Apartment blocks (AB) - more than 8 flats		-	-
Schools Educational space		90	90
Office buildings Office space		10	10
Production hall, industrial building		-	-
other (please specify)		-	-
Consumer mix in the area:			
Small consumers: SFH + MFH – < 8- MWh/a	in % of annual heat demand	-	-
Medium consumers: AB, schools, etc. – 80-800 MWh/a		100	100
Large consumers: industrial consumers, hospitals, etc. > 800 MWh/a		-	-
Property situation of buildings:			
Private	% of heated floor area	-	-
Public		100	100
Property situation of energy supply system (district heating):			
Private	% of heated floor area	-	-
Public		100	100

Project Fact Box (II)

Specific information on energy demand and supply:

Parameter	**unit**	**before renovation (2017)**	**after renovation (2018)**
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	96.57	160.01
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	97.13	82.67
(Thermal) energy supply technologies:			
decentralized oil or gas boilers	% of heated floor area	80	-
decentralized biomass boilers		-	-
decentralized heat pumps		20	-
centralized (district heating)		-	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	-	-
- building envelope renovation costs	Euro/m²	-	-
- heating/cooling supply costs	Euro/m²	-	86.67
- renewable energy production costs	Euro/m²	-	-
LCC available	yes / no	No	No

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

The system plant represents the first example implemented in a university campus in Italy and also the first public building in Venice. The innovative approach consists on the combination of a trigeneration plant with a district heating network, applied to school and historic buildings that are listed by Superintendence. The project is considered a best practice because the system can produce renewable energy in an urban context where the installation and the requirements are severely binding.

The district heating network consists of a delivery pipe, which carries hot water at a maximum temperature of 90 ° C, and a return pipe, which conveys water to an average temperature of 60 ° C. The dimensional characteristics of the network are characterized by a development equal to 1056 m of divided double pipes.

Table 2 – Description of the installed power on the 5 users.

Users	Power installed Heating (kW)	Power installed DHW (kW)
Ex Cotonificio	150	50
Ex Convento Terese	400	50
Casetta Asi	35	35
Magazzino 6	100	50
Magazzino 7	100	50
Total installed	785	235

<u>Technical features of the machines</u>

The tri-generator system is characterized by 238 kWe electrical power, 363 kWt thermal power, 256 kW cooling power, but most important is the reduction of environmental emissions, because the plant guarantees an emissions reduction of 340 Ton $C0_2$ compared to previous years.

The choice of the cogeneration engine was considerably influenced by the need to obtain the tax benefits on the purchase of natural gas intended for the functioning of the boilers. To achieve this, according to the law 10 of 09/01/1991, art.11, it is necessary that:

• the installed electric power for cogeneration is equal to at least 10% of the thermal power supplied to the user;
• the electricity produced is at least 10% of the total thermal energy supplied to the system.

The choice of the absorber size is based on the available thermal power (approximately 363 kWt)

<u>Cogeneration group MAN natural gas engine</u>

The co-generator identified for the installation is a MAN E 2842 E 312 powered by natural gas, with heat recovery from the engine block and from the fumes in the water, optimized for heat recovery interlocked to absorption group. It is characterized by the following main data:

- Nominal electrical power: 238 kWe
- Nominal cogenerated thermal power: 363 kWt

- Nominal thermal power input: 667 kWt
- Emissions: CO <600 mg / Nmc, NOx <450 mg / Nmc (referred to 5% oxygen).

Absorber

The system will be coupled with an absorption chiller powered by hot water, for indoor installation, brand SMART HWC 350-255 VS.

Decision and design process

General / organizational issues:

The intervention was performed to meet the sustainability goals planned by Iuav. The university aims to renovate the university buildings in order to reduce the energy use (and consequently energy bills) and the CO_2 and other pollutant emissions.

Stakeholders involved

In 2017, the Iuav administrators planned a district heating network with the technical support of ENGIE group.

Main steps

The main step of the process for its successful implementation has been the inclusion in the Kyoto revolving fund, in order to incur the economical investment.

Resources available before the project

Before to the project the buildings were served by individual boilers at the end user. The energy carrier before the project consisted of fuels harmful to the environment. There were no resources available before the project.

Drivers and barriers (opponents)

The main driver is the university administration and ENGIE and the main barrier has been the feasibility of the intervention in such an historical context with cultural heritage requirements to observe.

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.)	University Iuav board	Decision maker	Energy savings, CO_2 reduction, quality of living improvement
Users/investors (individual owner, housing association, building managers, asset manager, project developer)	University Iuav board and management	Influencer	Savings, standards improvement
District-related actors (Community/occupants organizations, etc.)	University Iuav community (researchers, students)	Influencer, researcher	Pilot Case study, monitoring study, dissemination of results,
Energy network solution suppliers (Distributor system operator, energy supply company, energy agency, ESCO, renewable energy companies)	ENGIE group (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.)	ENGIE group (ESCO)	Technical advisor	Profit, experience, fame
Other intermediaries (public bodies, trade organizations, NGO's, consultancies, research institutes)	ENGIE technical team and university research team	Technical advisor, influencer	To reply the experience and to repeat the project

Design approach:

The design target was the minimization of energy cost, maintenance cost and the emission reduction.

Decision steps

The main steps are as follows: discussion between Iuav and ENGIE, design delivery for Superintendence review and then delivery to Environmental and Economic Ministries, fund approval, construction and realization.

Main challenges in the design phase

The calculation of energy profile, schedule and energy need; moreover, the definition of the feasibility estimate and the economic convenience by ENGIE.

Technical issues:

Major technical challenges have been the implementation time of intervention during summertime (when didactic activities are stopped) and the construction site for installing the pipe grid under the public pavement, with compliance with the requirements fixed by the Cultural Heritage Venetian Superintendence.

Financing issues:

The project was funded in part by public money (Kyoto fund) and by private money, meaning the main role of ENGIE group as Energy Service Company (ESCO).

Subsidies or other financial incentives

The main subsidies are linked to the inclusion of the Kyoto revolving fund (50%) and the obligation to reinvest 10% of the energy expenditure charged to the contractor as per contract (CONSIP SIE2).

The choice of the cogeneration engine was considerably influenced by the need to obtain the tax benefits on the purchase of natural gas intended for the functioning of the boilers.

Main challenges/constraints regarding financing

In term of financing the main challenge was to meet the requirements set by the Environmental and Economic Ministries (REF, MISE call) in order to access the Kyoto fund and to submit the request for funding in accordance with the terms of the call and benchmarks.

Business models

Energy Service Company model.

Management issues:

The biggest challenge regards the bureaucratic and contractual aspects, namely the preparation of the contract and the procurement arrangement given that the project involves the public administration. In addition, there were some issues about the management and the availability of consumption data and maintenance information for university during the duration of the contract.

Policy framework conditions:

The key policy actors were the Environmental and Economic Ministries.

Regulations which stimulated / hindered the process

The project has been carried out respecting current national requirements for energy efficiency measures and thermal energy production from renewable sources.

Police instruments that moved the district into action

Carrots-policy: 50% subsides by Kyoto fund, no-tax for the purchase of natural gas;

Lessons learned

The main result consists on the reduction of operation and maintenance costs by the reduction of energy costs and the scale resizing of heat central with the possibility of reinvesting savings also in the conservation of buildings, so giving a benefit for the whole context in terms of buildings and energy system.

The realization demonstrates the feasibility of interventions traditionally considered with high landscape impact even in historical-cultural contexts and in full respect of the requirements and the restriction given by the Cultural Heritage Venetian Superintendence.

The project represents also a unique testbed realized in Italy in a university campus in terms of environmental context and scientific nature of the subject, as the demonstration for repeating the experience in another similar context.

Finally, this project represents a responsible response to the demands of sustainability, image improvement, satisfaction of the end users and re-use of the case study for the purposes of institutional university teaching.