



MSc  
Energy Engineering



Università degli Studi di Genova  
MCI Applied Science University Innsbruck  
13th of march 2019, Innsbruck

The Double Degree Program EM3ES  
“European Master in Engineering for  
Energy and Environmental Sustainability”

Prof. Marco Fossa, Coordinator of MSc Energy  
Engineering at UniGE

[www.en2.unige.it](http://www.en2.unige.it)



## THE UNIVERSITY OF GENOA

Already in the 13th century in Genoa there were Colleges. The College of Law was certainly established before 1353 while the College of Medicine was promulgated in 1481. The College of Theology was also established around the same time, officially dating back to the 1471 Papal Bull of Sixtus IV.

In 1870 two important institutes of higher education were established in Genoa: the Royal Naval School and the Royal School of Economic Studies.

Currently (2014) the University has about 34000 students (7800 in Polytechnic School), 2700 employees, 125 degree courses, 2000 foreign students and 3 Campuses (Genova, Savona and La Spezia).



# Marco Fossa short CV *marco.fossa@unige.it*



Mech. Engineer, Phd, Research Professor at the University of Genova, DIME Dept., since 1993 ([www.dime.unige.it](http://www.dime.unige.it))

Associate Professor since 2007. Full Professor since 2017

MSc Course in Energy Engineering (En2) Coordinator (since 2014, [www.en2.unige.it](http://www.en2.unige.it))



Teaching: Applied Thermodynamics and Heat Transfer, Renewable Energies, Solar and Geothermal Energy

Research: author of 160 scientific papers, 700 citations, h index=15 (Scopus)

## Visiting appointments:

Cern Geneva, CH (1990-1992, 2001-2003)  
Univ. Nottingham (2001), MCI Innsbruck (2018)  
UNSW Sydney (2006, 2008,  
2010, 2012, 2017) as Visiting Professor

## Collaborations:

Locie Univ. Savoie Mt Blanc, Insa Cethil Lyon  
Cern Geneva, UNSW Sydney, KTH Stockholm

## Areas of interest:

Heat Transfer, Geothermal heat pumps  
two-phase flow, Building Integrated  
PV modules and Hybrid Solar







UNIVERSITÀ DEGLI STUDI  
DI GENOVA



# MSc Energy Engineering (En2) at Savona Campus





## SAVONA CAMPUS



Savona is a small town 50km west of Genova, Italy, and some 170km from Nice, France.





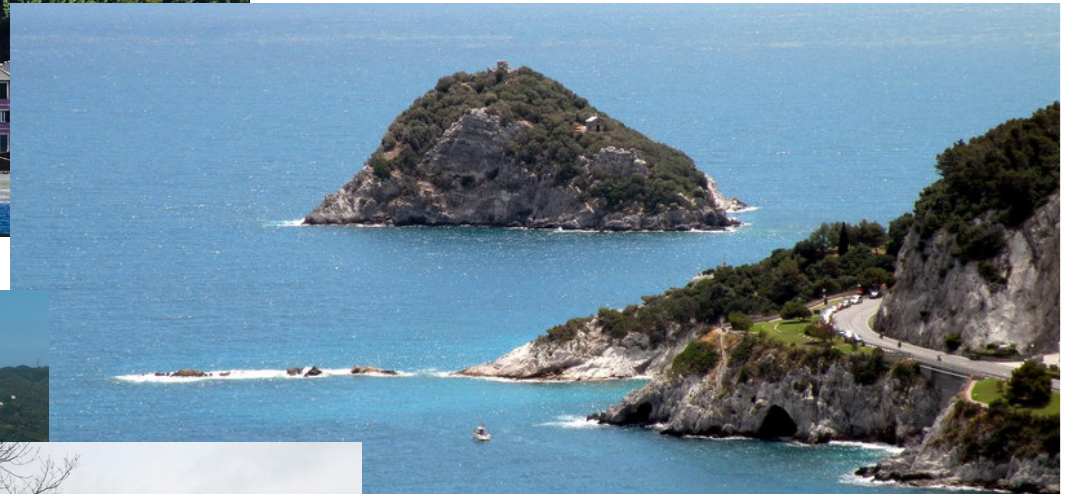


UNIVERSITÀ DEGLI STUDI  
DI GENOVA

## The Double Degree EM3ES and the MSc in Energy Engineering at Univ. Genova, Italy



## SAVONA AND SURROUNDINGS



Savona is located along the Ligurian Sea, very close to the Maritime Alps and to the Appennini mountain chain.

## MSc in ENERGY ENGINEERING (120ECTS)

The course is aimed at students seeking high qualification in:

- Energy conversion processes from chemical, bio-chemical, thermal sources into mechanical and electrical ones.
- Sustainable & Distributed Energy: renewable energy (solar, geothermal, wind, hydro), fuel cells, bio-fuels, smart power grids.
- Sustainable Development: biomass exploitation, energy audit in buildings, energy management.

The MSc course works in partnership with industries and research institutes in Liguria, in Italy and abroad.

- ✓ **All courses are taught in English,**
- ✓ **Free English courses** are offered to En2 students,
- ✓ about 50% of En2 students come from abroad.





## ENERGY ENGINEERING: CLASSES

### 1st YEAR (60 ECTS) (A.Y. 2017/2018)

- **Mathematical Modeling for Energy Systems (6 ECTS)**
  - **Heat Transfer (6 ECTS)**
- **Chemical Plants and Processes for Energy (12 ECTS)**
  - Chemical Processes and Technologies (6 ECTS)*
  - Chemical and Biochemical Processes and Plants for Energy (6 ECTS)*
- **Electric Power Systems (12 ECTS)**
  - Power Systems Modeling and Control (6 ECTS)*
  - Power Systems Management (6 ECTS)*
- **Industrial Fluid-dynamics and Combustion (12 ECTS)**
  - Industrial Fluid-dynamics (6 ECTS)*
  - Combustion Process and Emissions (6 ECTS)*
- **Power and industrial plants for energy (12 ECTS)**
  - Industrial Plants for Energy (6 ECTS)*
  - Power Plants for Energy Generation (6 ECTS)*

## ENERGY ENGINEERING: CLASSES

### 2nd YEAR (60 ECTS) (A.Y. 2017/2018)

- **Renewable Energy in Buildings (12 ECTS)**
  - Energy and Buildings (6 ECTS)*
  - Solar and Geothermal Energy (6 ECTS)*
- **Machines and Systems for Renewable Energy (12 ECTS)**
  - Fuel Cells and distributed Energy (6 ECTS)*
  - Hydro, Wind and Micro-Gas Turbines (6 ECTS)*
- **Models and Methods for Environmental and Energy Engineering (6 ECTS)**
  - Energy Laboratory (6 ECTS)*
- **Master Thesis (11 ECTS)**
- **Training and Orientation (1 ECTS)**

## ENERGY ENGINEERING: CLASSES

### ELECTIVE COURSES (12 ECTS)

- *Propulsion Systems for Low Environmental Impact* (6 ECTS)
- *Project Management for Energy Production* (6 ECTS)
- *Power Systems Simulation and Optimization* (6 ECTS)
- *Remote Sensing* (6 ECTS)



## MSc in ENERGY ENGINEERING, Double Degree EMESB

In December 2016 En2 - Unige started a **Double Degree program** (EMESB, European Master in Energy and Sustainable Buildings) with the University Savoie Mont Blanc - Polytech Annecy-Chambery.

<http://www.en2.unige.it/double-degree-emesb/>

A new Double Degree program has been signed in Sept. 2018 between UNIGE/En2 and MCI Innsbruck (European Master in Engineering for Energy and Environmental Sustainability (**EM3ES**))

EMESB is a shared program focused on Solar and Buildings, EM3ES is energy management oriented, with special attention to chemical process and biomass conversion

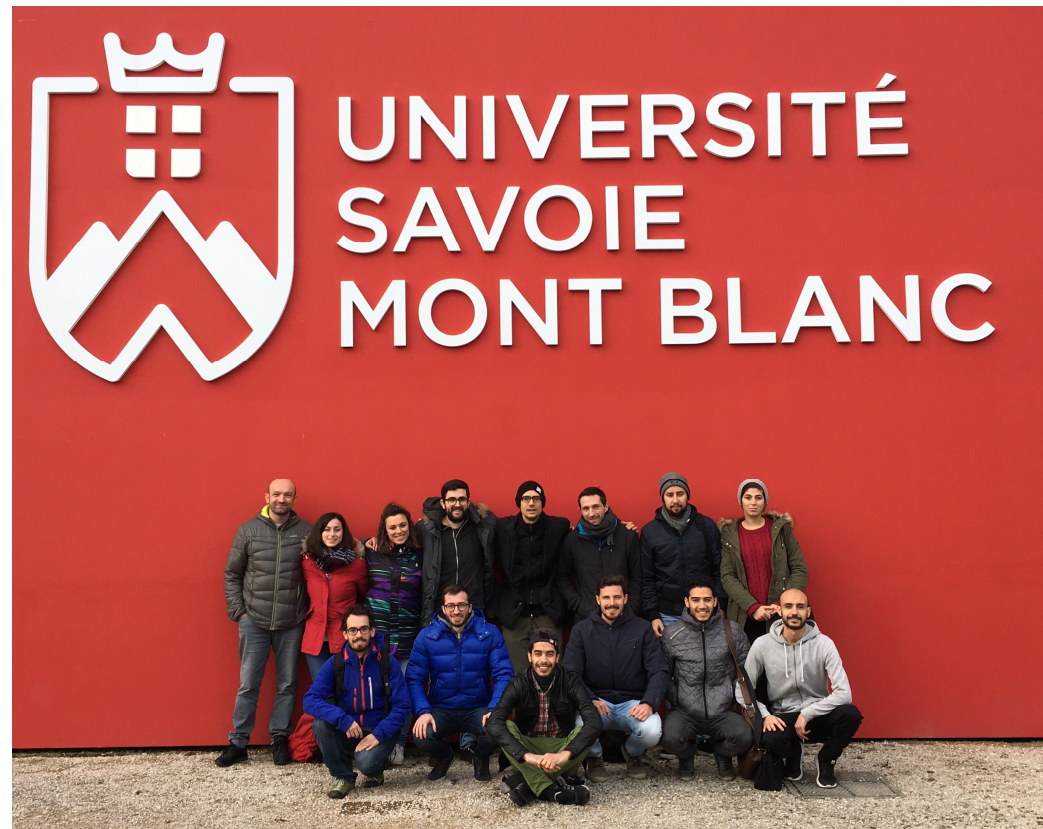


## MSc in ENERGY ENGINEERING, Double Degree EMESB

**Double Degree program** (EMESB, European Master in Energy and Sustainable Buildings) with the University Savoie Mont Blanc.

<http://www.en2.unige.it/double-degree-emesb/>

Scholarships are available as Erasmus or Vinci Programs.



*Students from Unige and University Savoie Mont Blanc  
at Bourget sur Lac, January 2018*

## Free English courses are offered to En2 students

Classes are held in  
Savona, by Professor  
from CLAT Unige  
(Clat, Center for  
foreign languages)

Also Free italian  
courses are offered  
to foreign students







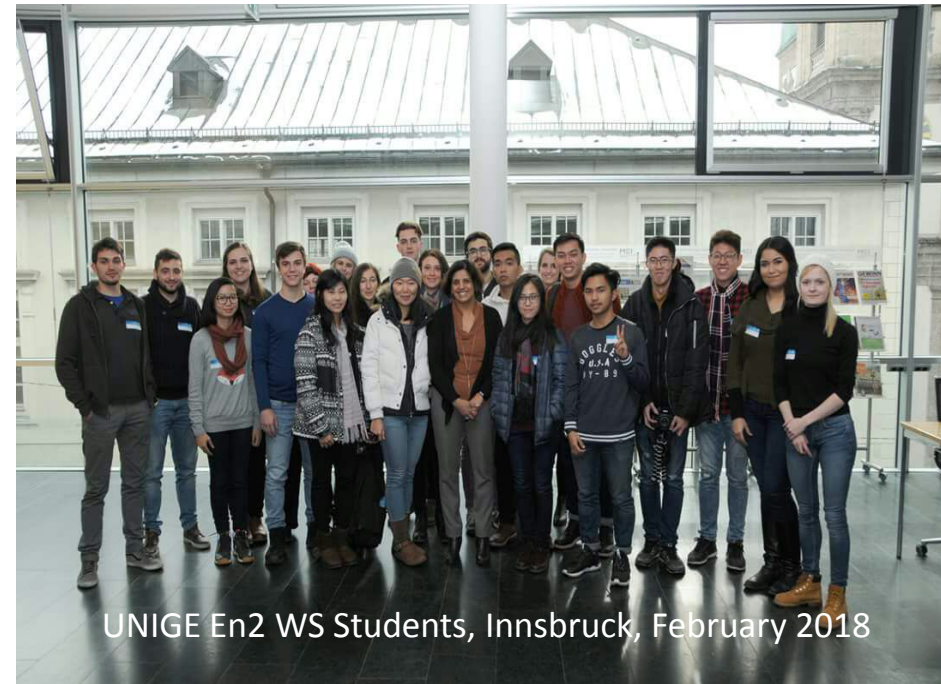
UNIVERSITÀ DEGLI STUDI  
DI GENOVA



# The Double Degree EM3ES

## MSc in Energy Engineering, Double Degree Program EM3ES

MCI and Unige/En2 students can participate for free to the **Double Degree EM3ES Program (European Master in Engineering for Energy and Environmental Sustainability )**



<http://www.en2.unige.it/double-degree-em3es/>

## Double Degree Program EM3ES: Description

The UNIGE-MCI European Master in Engineering for Energy and Environmental Sustainability delivers the Double Degree (MSc) in Environmental, Process & Energy Engineering and Laurea Magistrale (MSc) in Energy Engineering

The EM3ES program is offered to MCI and Unige students that apply for the 2 positions (per Uni) available each academic year. During the Double Degree Program the students will be enrolled in both Universities, with no fee at the hosting university.

Eligible students need at least 24 ECTS (from their first semester at the Registration University) and they apply to the DD program at the beginning of their second semester (march/april).

EM3ES students move to the Hosting University after completing the first year (60 ECTS) of their MSc at the Registration University



## Double Degree Program EM3ES: Description

Unige and MCI students follow a Roadmap (Study Programme) of studies at both Registration and Host universities

The students complete their Double Degree program with a jointly supervised Master Thesis.

The Thesis project, which includes master presentation and master seminar, is awarded 30 ECTS for the MCI students and 17 ECTS (including the Italian Traineeship) for the UNIGE students, based on the local university regulations and to the present agreement Study Programme.

If a Double Degree student fails to complete the Double Degree program, a fall-back option to his/her original study program is available. Such a failure shall not automatically impact his/her status as a study abroad (exchange) student.

## Double Degree EM3ES

### Roadmap (Study Programme) for MCI students

EM3ES for MCI students		TOT ECTS 150
EM3ES semester 1 for MCI students		
Course Title	ECTS	
Process Control	2	
Reaction Engineering	3	
Heat and Mass Transfer	4	
Matlab in Engineering	1	
Revision Course in Process Technology	1	
Legal Aspects of Engineering	1	
Business Economics	3	
Energy Engineering Branch		
Energy Storage	1.25	
Electrochemical Energy Storage and Conversion	1.25	
Plant Design and Operations Branch		
Strength of materials	2.5	
Environmental Engineering Branch		
Waste Engineering	1.25	
Noise Control	1.25	
Chemical Engineering Branch		
Polymer Chemistry	2.5	
EM3ES semester 2 for MCI students		
Academic Writing	1	
Design of Experiments	2	
Ethics	1	
Literature Seminar	1	
Conceptual Process Design & Simulation	4	
Plantwide Control	3	
Apparatus Engineering	3	
Solid Process Engineering - Particle Technology	3	
Advanced Thermal Process Technology	2	
Energy Engineering Branch		
Power and Smart Grids	2.5	
Energy Conversion Technologies and Synthetic Bio-Fuels	2.5	
Plant Design and Operations Branch		
Process Integration	1	
Plant Automation	3	
From Materials Handling and Logistics	1	

## Double Degree EM3ES

Roadmap (Study  
Programme) for MCI  
students

[http://www.en2.unige.it/  
/double-degree-em3es/](http://www.en2.unige.it/double-degree-em3es/)

[http://www.en2.unige.it/  
/syllabus-en2/](http://www.en2.unige.it/syllabus-en2/)

Environmental Engineering Branch	
Groundwater, Advanced Water Engineering and Reuse	4
Life Cycle Assessment	1
Chemical Engineering Branch	
Advanced Industrial Chemistry	2.5
Advanced Catalysis	2.5
EM3ES semester 3 for MCI students (at Unige)	
Models and Methods for Energy Engineering (86662)	6
Energy and Buildings (86655)	6
Fuel Cells and Distributed Generation Systems (86660)	6
Solar and Geothermal Energy (80043)	6
<i>1 elective course among those available at Unige below</i>	6
EM3ES semester 4 for MCI students (at Unige)	
Hydro, Wind and Micro-gas Turbines (86661)	6
Energy Laboratory (80081)	6
Power Systems Modeling and Control (65887)	6
Power Systems Management (86638)	6
<i>1 elective course among those available at Unige below</i>	6
EM3ES semester 5 for MCI students	
Master Seminar	5
Jointly supervised Master Thesis	25
<b>TOTAL</b>	<b>150</b>

Elective Courses at Unige	
Remote Sensing (80048) (semester 3)	6
Project Management for Energy Production (86666) (semester 3)	6
Advanced Propulsion Systems (86665) (semester 4)	6
Power Systems Simulation and Optimization (86667) (semester 4)	6

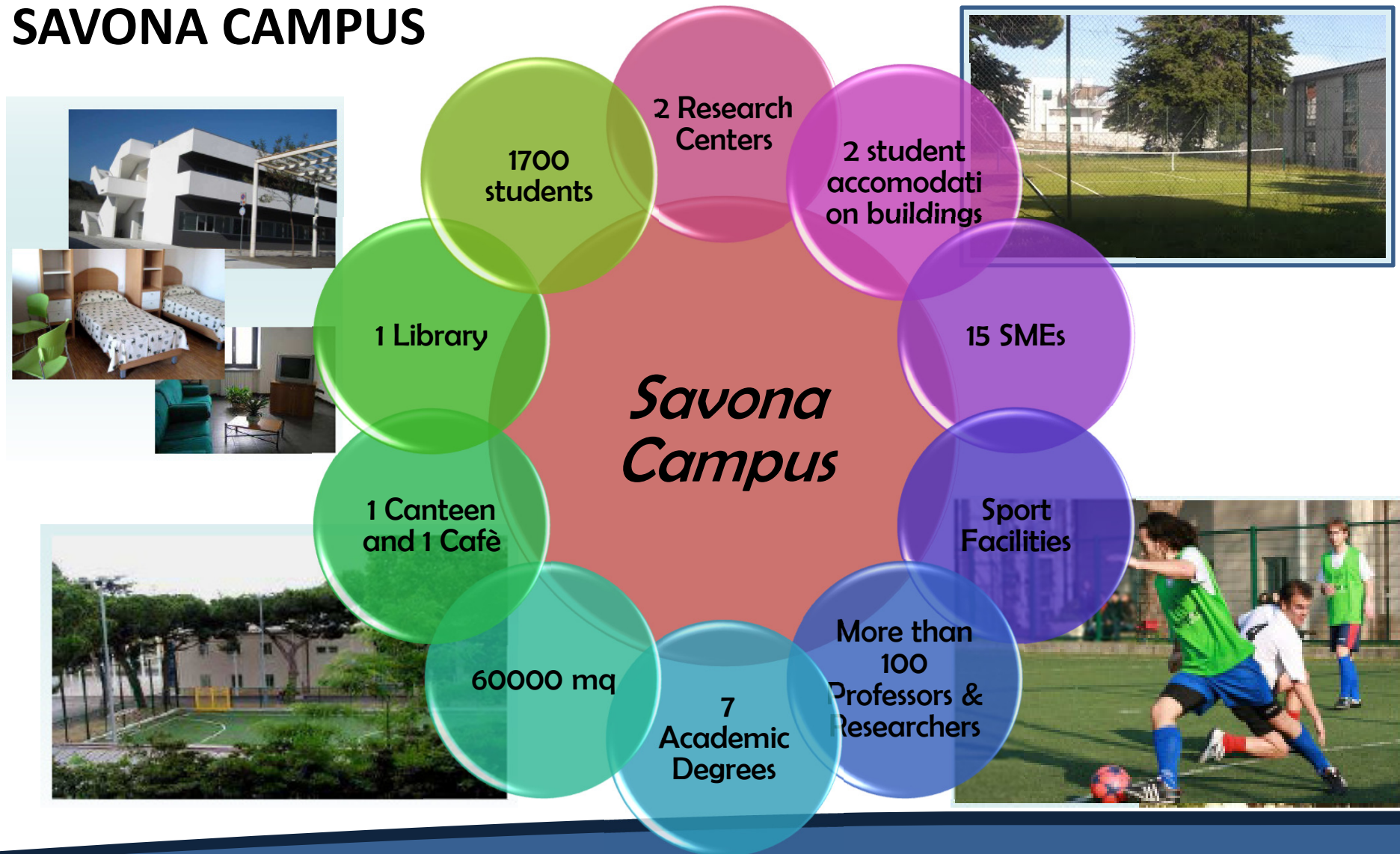


UNIVERSITÀ DEGLI STUDI  
DI GENOVA



# Unige Savona Campus: teaching facilities and its Polygeneration Smart Grid

## SAVONA CAMPUS

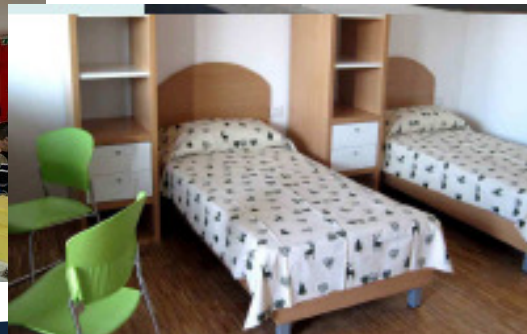




## SAVONA CAMPUS

The University of Genoa set its modern Campus in Savona and in the last few years, public and private funds have been invested to improve its infrastructures, sport facilities, hall of residence, library and an auditorium.

Courses at Savona Campus:



## SAVONA CAMPUS, Courses

B.Sc. in Mechanical Engineering  
M.Sc. Digital Humanities – Communication and  
New Media  
M.Sc. Energy Engineering  
M.Sc. Management Engineering  
M.Sc. in Engineering for Natural Risk Management

B.Sc. Nursing  
B.Sc. Sport Science and Health

B.Sc. Communication Sciences  
M.Sc. Valorizzazione dei Territori e Turismi  
Sostenibili

<http://www.cens.unige.it/en/courses-in-the-savona-campus/>





## SAVONA CAMPUS: LIBRARY

Linked to the University of Genova and National Information systems for libraries, the library provides to students an important support at the Campus. It offers a wide space for internet connection and reading of scientific texts. Multi-medial support is also provided inside the building.

Library air conditioning is provided by a TriGeneration system and Absorption Chiller



From left: Prof. Marco Rupprich  
and Aldo Giovannini (MCI  
Innsbruck) at Campus Library





## SAVONA CAMPUS: Companies

Different companies are located at the Campus and they offer training activities for students after the Master Degree and during thesis development.

Palazzina Locatelli	Palazzina Branca
ACROTEC COS(OT) ELIOS Fondazione CIMA IPS ISIA MESA NOEMALIFE STUDIOSIT	AIFO AITEK ASL2 - POLO FORMATIVO CANOVATECH LOGNESS SHINY SPES



The collaboration favors the integration of research activities with professional needs, increasing job opportunities.

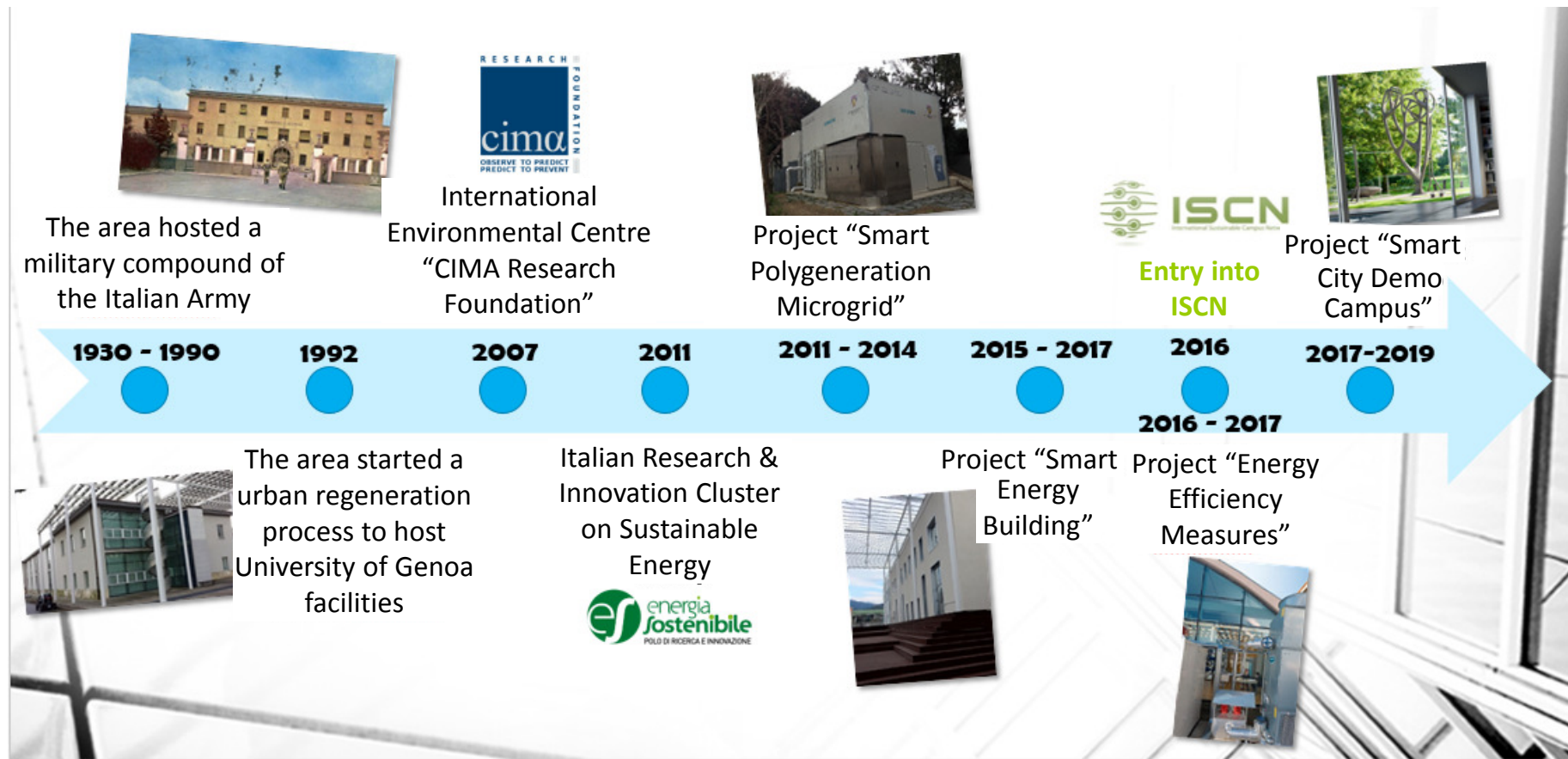
## SAVONA CAMPUS: Research

Several Departments and Research Centers are present in the Campus as well as research laboratories that provide support to training activities.



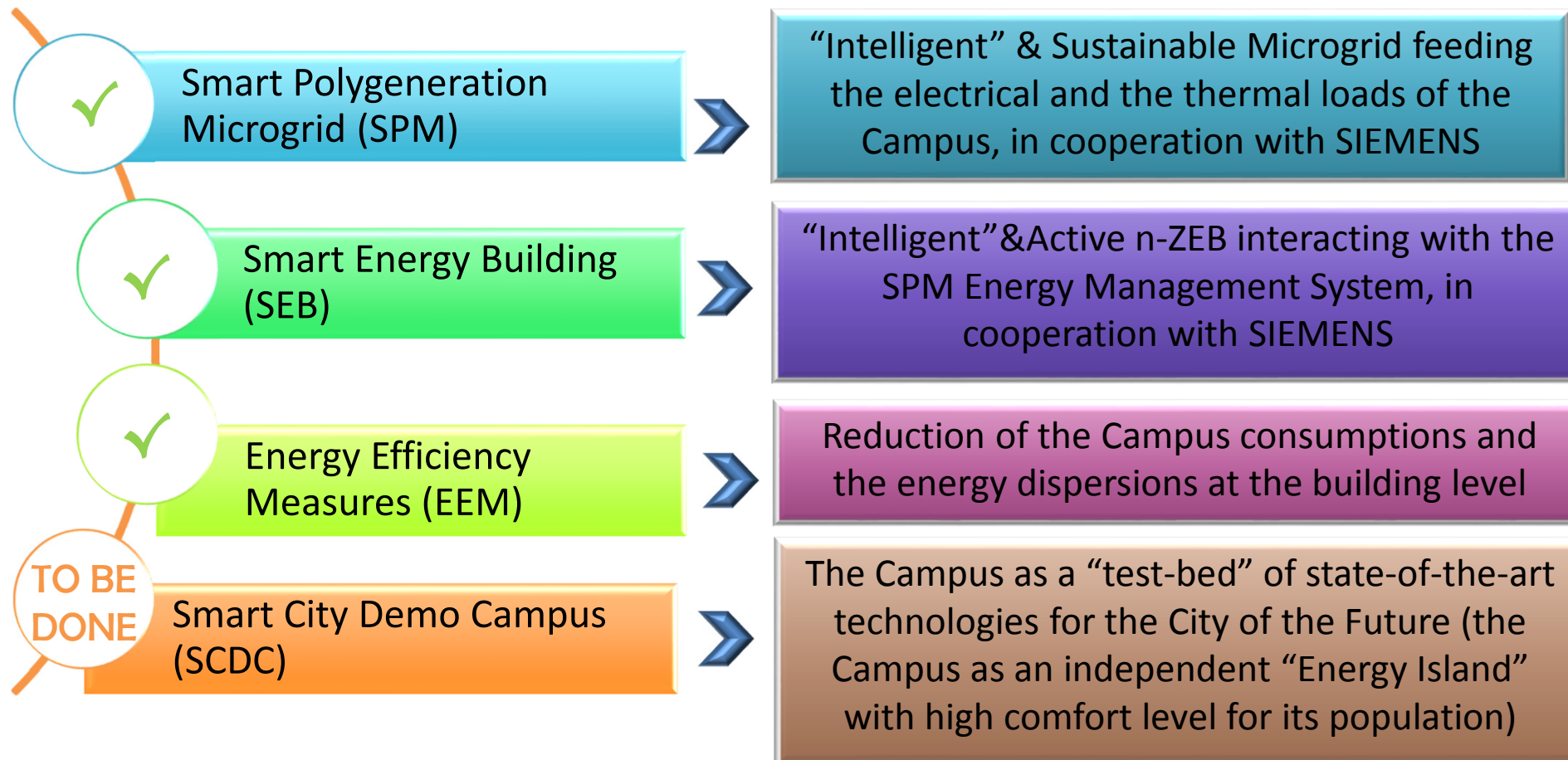
Palazzina Delfino	Palazzina Lagorio	Palazzina Marchi
<i>CRT - DIE</i> <i>DEUIM</i> <i>DITEN-DIBRIS</i> <i>DICCA</i> <i>DIFI</i> <i>DIME</i> <i>Lab. Informatico</i> <i>Lab. Chimico CESISP</i> <i>Lab. Gestionale DIME</i> <i>Lab. SCL/DIME</i> <i>Lab. DITEN/CANOVATEC</i>	<i>DIBRIS</i> <i>Laboratori DIBRIS</i> <i>PRAI-FESR</i> <i>Lab. Multimediale</i> <i>Sc. Comunicazione</i> <i>Lab. Audiovisivo</i> <i>Sc. Comunicazione</i> <i>Lab. "E-Learning &amp; Knowledge Management"</i> <i>Lab. "MISS-DIPTM"</i> <i>Consorzio SIRE</i>	<i>Fondazione CIMA</i>

## SAVONA CAMPUS: growth to sustainability





## SAVONA CAMPUS: ENERGY 2020 project



[www.energia2020.unige.it/en/](http://www.energia2020.unige.it/en/)

**Total Value: 10.7 M€**

## SMART POLYGENERATION MICROGRID

Funded by: Italian Ministry of Education, University and Research

Value of the project: 2.4 M€, Status: in operation since February 2014

1st low voltage Smart Microgrid in Italy



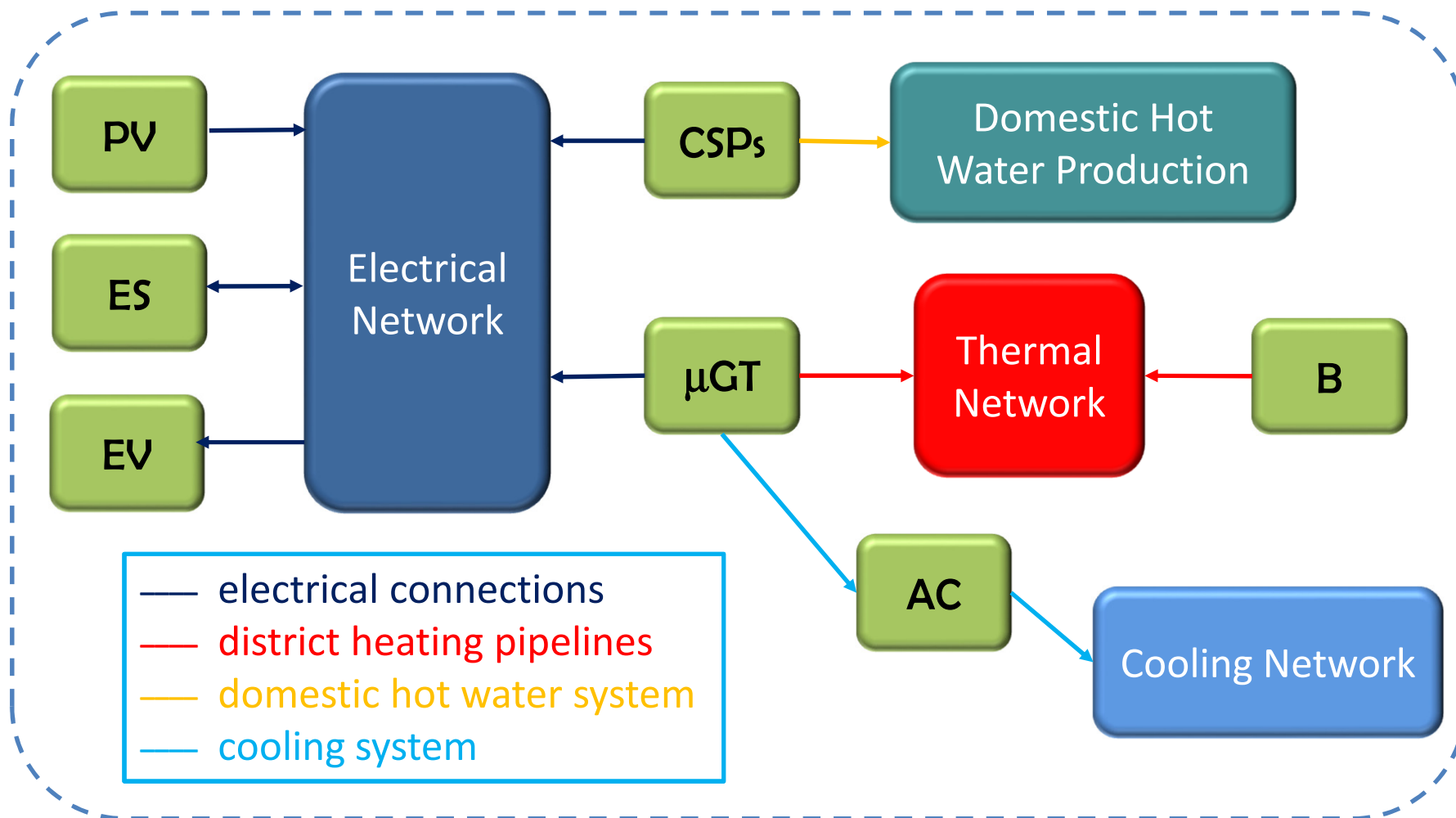
Poly grid video

## SMART POLYGENERATION MICROGRID

3-phase low voltage (400 V line-to-line) “intelligent” distribution system coupled with a thermal network, composed by:

- 3 micro-cogeneration gas turbines ( $\mu$ GT) fed by natural gas ( $160 \text{ kW}_{\text{el}}$  -  $290 \text{ kW}_{\text{th}}$ );
- 2 photovoltaic fields (PV), 396 modules ( $95 \text{ kW}_{\text{el}}$ );
- 3 concentrating solar power systems (CSP) ( $1 \text{ kW}_{\text{e}}$  -  $3 \text{ kW}_{\text{th}}$  each) equipped with Stirling free piston engines;
- 2 absorption chillers (AC) (200 kW) employed to refrigerate two buildings during the summer;
- 2 electrical storage systems (ES) (Na-NiCl<sub>2</sub>,  $140 \text{ kWh}_{\text{el}}$  and Li-ions,  $25 \text{ kWh}_{\text{e}}$ );
- 2 electrical vehicle (EV) charging stations;
- 2 gas boilers (B) ( $450 \text{ kW}_{\text{th}}$  each).







UNIVERSITÀ DEGLI STUDI  
DI GENOVA

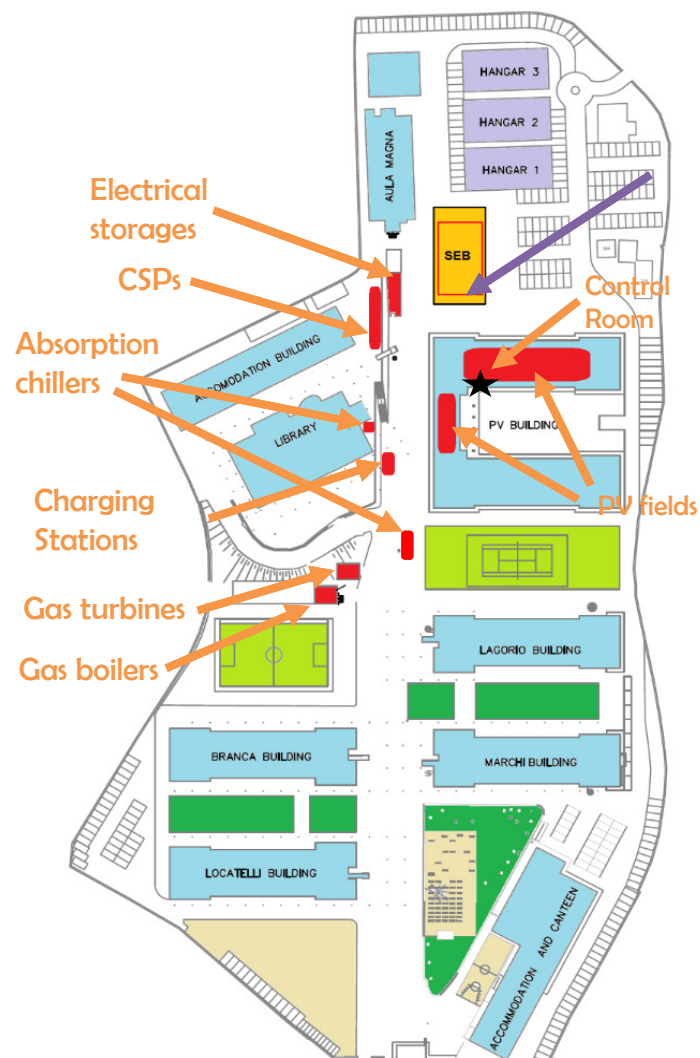
# The Double Degree EM3ES and the MSc in Energy Engineering at Univ. Genova, Italy



Control Room



Trigeneration  
plants



- Renewable energy plants
- Storage systems
- E-mobility



## SMART ENERGY BUILDING (SEB)

Funded by: 90% Italian Ministry for the Environment and the  
Protection of Land and Sea, 10% UNIGE

- Value of the project: 3 M€
- Status: in operation since February 2017
- Smart Building interacting with a Smart Microgrid as a Prosumer.
- Surface: 1000 m<sup>2</sup>
- NZEB building with geothermal heat pump

Energy  
Efficiency  
Class A+



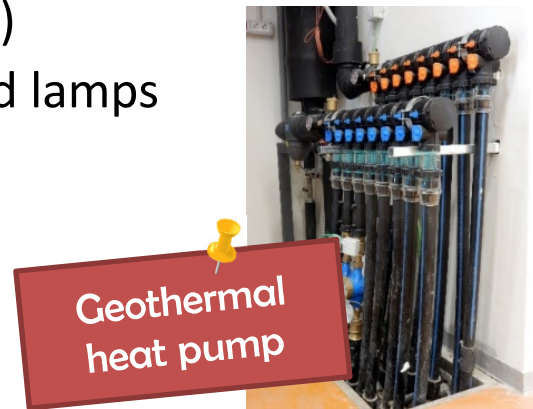
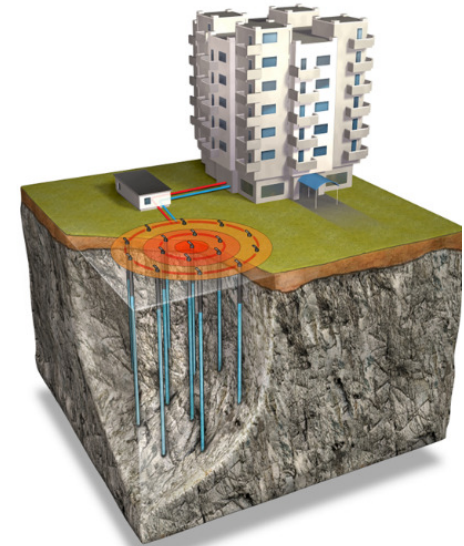
A complex regulation system  
controls the air conditioning and  
lighting of SEB





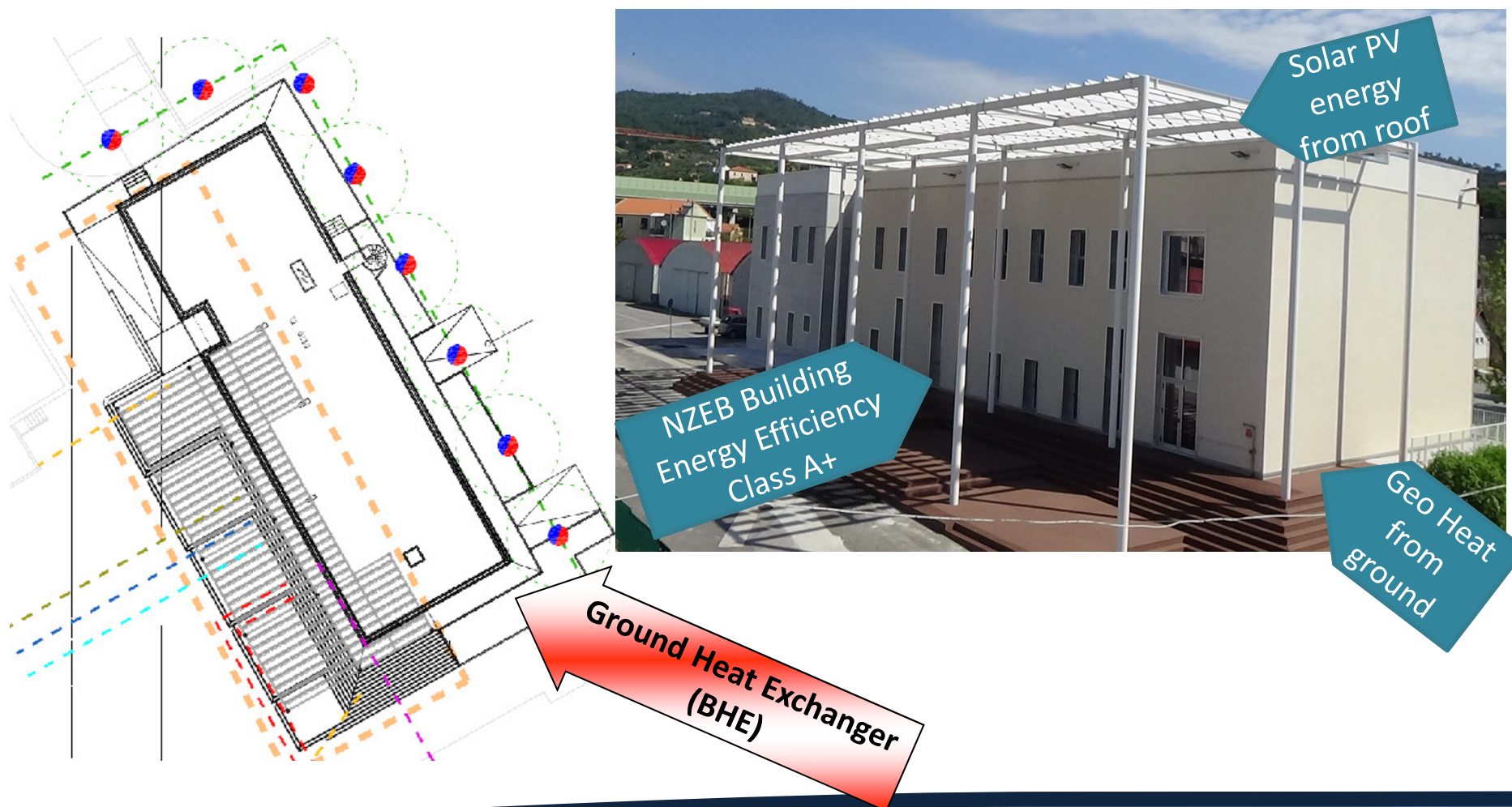
## SEB: main technical features

- High performance thermal insulation materials for building applications
- Geothermal heat pump (GHP) ( $45 \text{ kW}_{\text{th}}$ , 8 borehole heat exchangers)
- Solar Thermal Collectors (STC)
- Controlled mechanical ventilation plant, air handling unit (AHU)
- Domestic hot water heat pump (DHWHP)
- Photovoltaic field (PV) ( $23 \text{ kW}_p$ )
- Extremely low consumption led lamps
- Rainwater collection system
- Ventilated facades
- Technological Gym

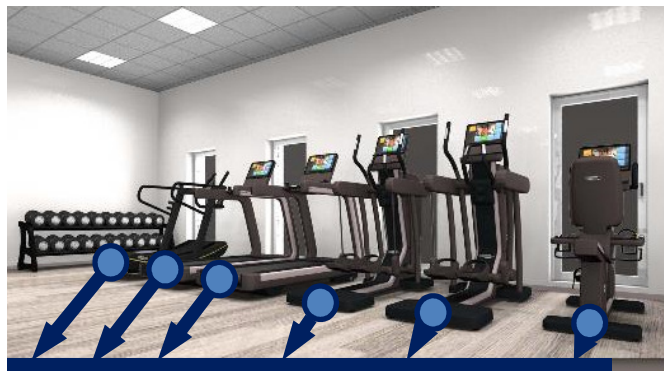




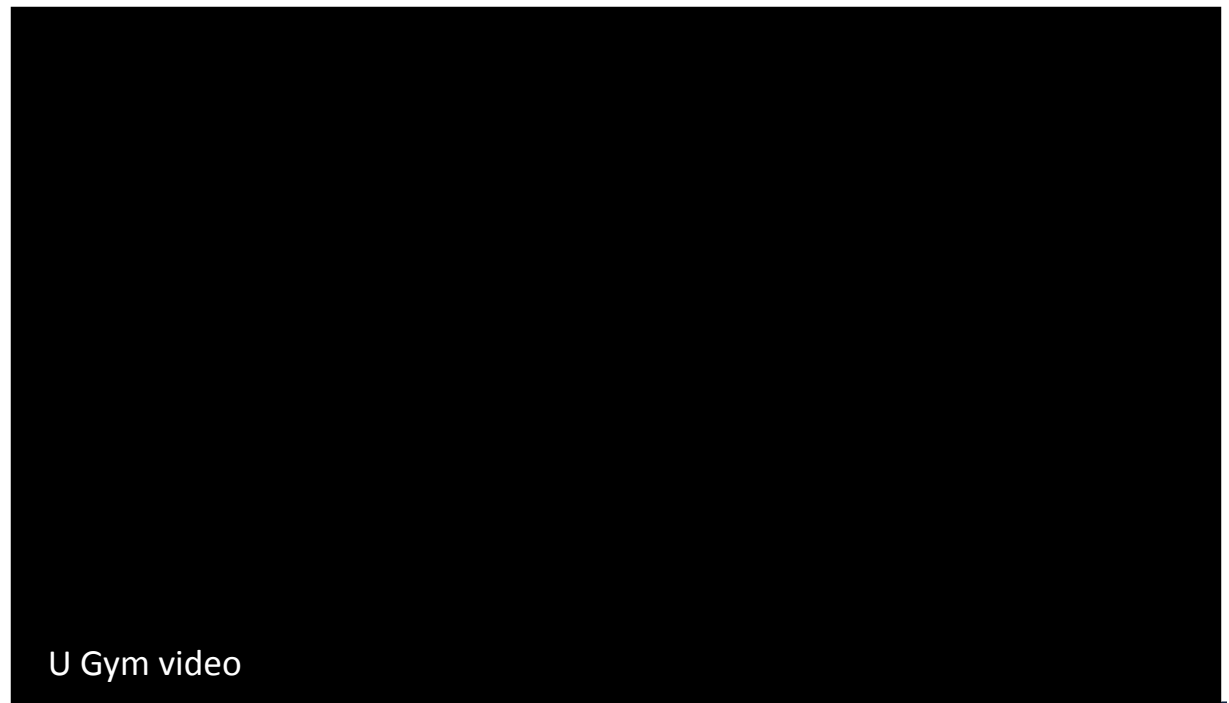
## SEB: main technical features



The Gym as an Energy Harvesting system, offered to Students and Unige Staff.  
Elliptical machines, tapis roulant and bikes are electrically equipped in order to transform the human energy of people working out into electricity for the SPM.



## SEB: U-Gym



U Gym video

## SMART CITY DEMO CAMPUS **Urban district → Campus**

- Green and sport areas



- Bar and Restaurants



- Lightning



- Offices



- School




- Residences



## SMART CITY DEMO CAMPUS The action lines

- Smart Grids and Polygeneration Microgrids ✓
- Renewables & Storages ✓
- Smart Buildings ✓
- Smart Public Lighting ✓
- Smart Waste & Environment ⚠
- Health & Wellness for the Citizens ⚠
- Broad Band: Digital City iper-connected TO BE DONE
- City Security (Physical & Cyber) TO BE DONE
- Water & Sailing Sport Centre TO BE DONE

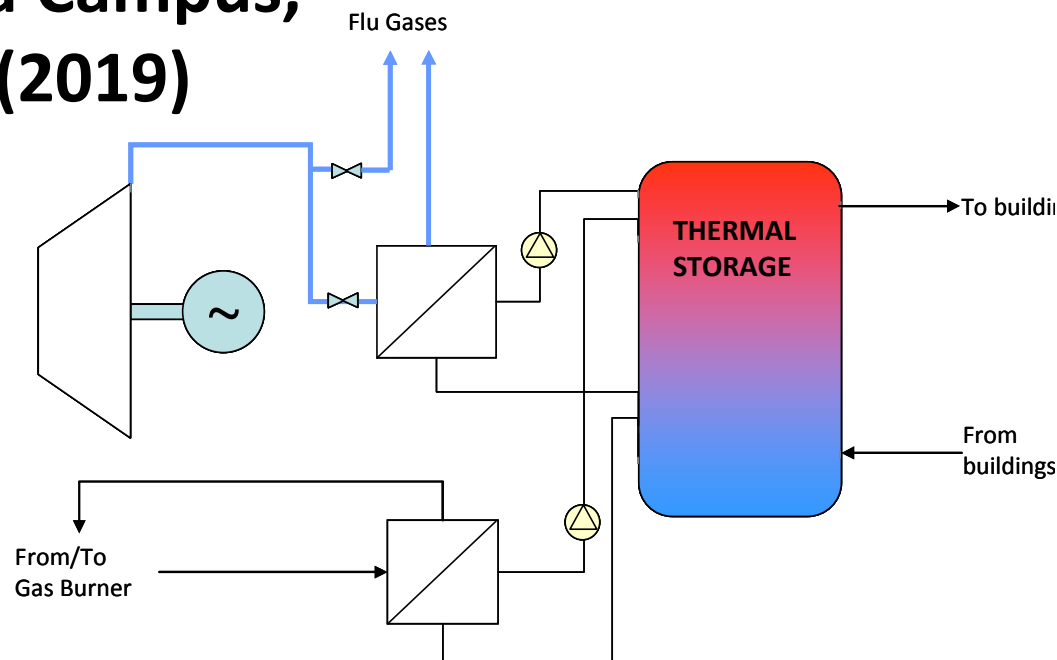


The objective of the project is  
to transform Savona Campus  
into a “Living-Lab” of the city  
of the future



## Current Research at Savona Campus, Microgrid Thermal Storage(2019)

Smart Polygeneration Microgrid (SPM) at Savona Campus is equipped with several power units, including Cogenerative Gas Turbines, Capston C65 type (65 kWel, 112 kWth).

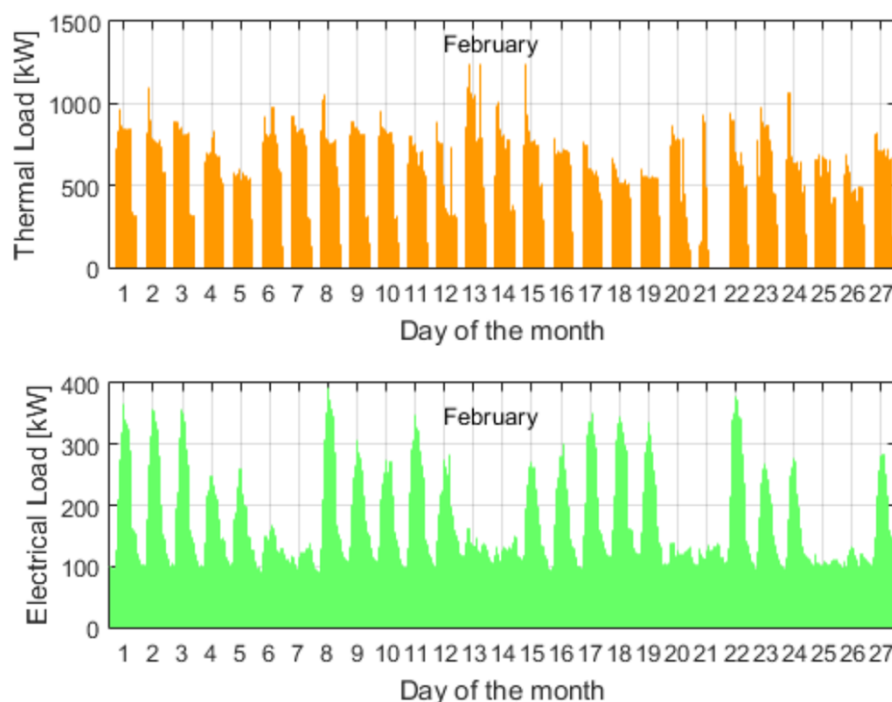


Electricity production is typically 24/24h while cogeneration depends on heat demand, which in turn is scheduled currently for daily operations (5.30am to 11.00 pm).

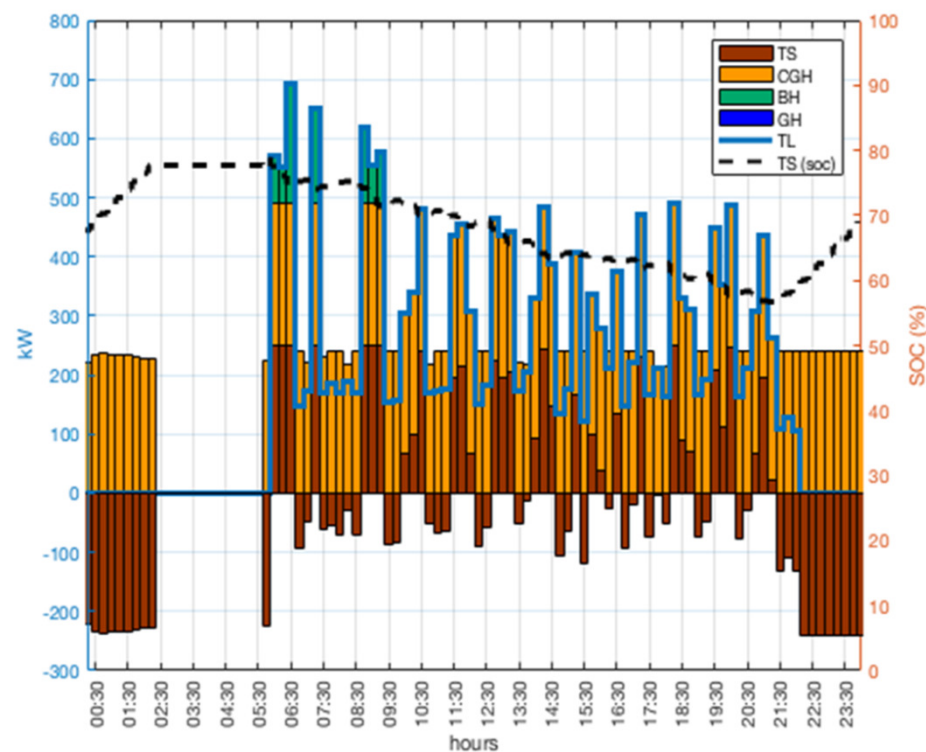
Thermal storage has been considered since SPM commissioning. Recent modelling efforts (2018) yielded to a complete simulation of one year consumption and production of energy (heat and electricity, hourly basis) for assessing best storage volume for shortest payback



## Polygeneration Microgrid Thermal Storage, simulations



*Input Data for TS model: heat and  
electricity demand*



*Energy transfers from Turbines, storage, boilers  
in a typical day*



# Thank You for your attention

*for further information and enrolling:  
<http://www.en2.unige.it/double-degree-em3es/>*