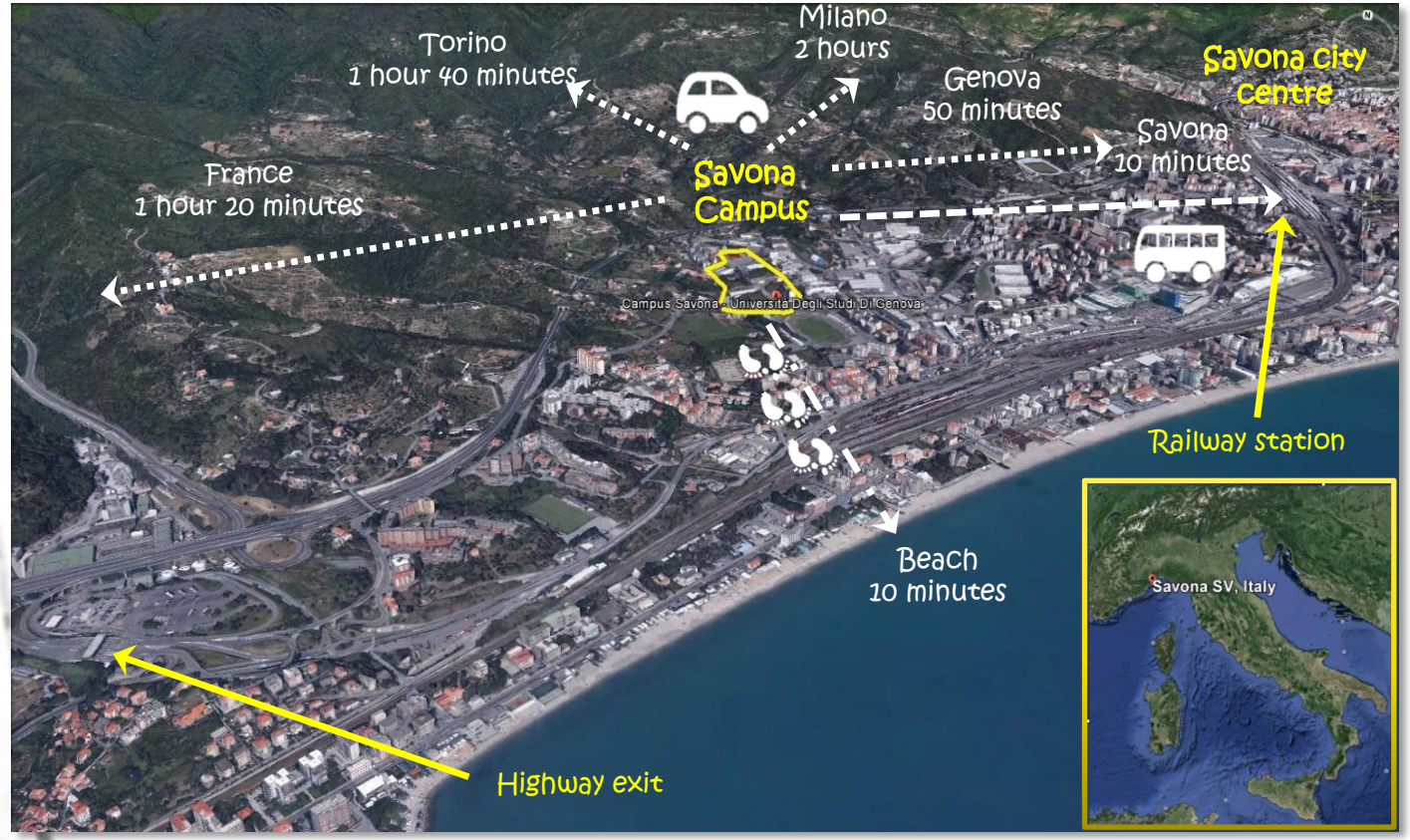
UNIVERSITÀ DEGLI STUDI
DI GENOVA

The University of Genoa Smart City Living-Lab

Prof. Federico Delfino
Savona Campus

UNIVERSITÀ DEGLI STUDI DI GENOVA

Savona Campus: where?



Savona Campus of the University of Genova

Via Magliotto, 2
I-17100 Savona (Italy)

CENS
Università degli Studi di Genova
Centro di Ateneo di Savona

Email: cens@unige.it
Website: www.cens.unige.it

UNIVERSITÀ DEGLI STUDI DI GENOVA

Savona Campus: growth to Sustainability

1930 - 1990

The area hosted a military compound of the Italian Army

1992

Urban regeneration process to host University of Genoa facilities

RESEARCH FOUNDATION cima OBSERVE TO PREDICT PREDICT TO PREVENT

2007

International Environmental Centre "CIMA Research Foundation"

2011

Italian Research & Innovation Cluster on Sustainable Energy

energia sostenibile POLO DI RICERCA E INNOVAZIONE

2011 - 2014

Project "Smart Polygeneration Microgrid"

MIUR

2015 - 2017

Project "Smart Energy Building"

MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE

2016

Entry into ISCN

ISCN International Sustainable Campus Network

2016 - 2017

Project "Energy Efficiency Measures"

REGIONE LIGURIA

2017-2019

Project "Smart City Demo Campus"

UNIVERSITÀ DEGLI STUDI DI GENOVA

Savona Campus: growth to Sustainability

ISCN
International Sustainable Campus Network

The SAVONA CAMPUS is ISCN MEMBER

Technische Universität Darmstadt TU Delft

- **Campus di Savona – Università degli Studi di Genova**
- Politecnico di Milano
- Università degli studi di Milano
- Università Milano Bicocca
- Politecnico di Torino
- Università degli Studi di Torino
- Università Ca' Foscari Venezia
- Università di Salerno
- Università di Siena

Technical University of Denmark

- University of Edinburgh
- University of Oxford

- Swiss Federal Institute of Technology (ETH Zurich)
- Ecole Polytechnique Fédérale de Lausanne

- Columbia University
- Harvard University
- Massachusetts Institute of Technology

KTH Royal Institute of Technology

National University of Singapore

- Federal University of Rio de Janeiro
- University of São Paulo

The University of Melbourne

- Peking University
- The University of Hong Kong

"Founded in 2007, the ISCN is a global forum for leading universities to exchange ideas and best practices for integrating sustainability into campus operations, research and teaching"

ISCN pillars:

- **WELLBEING**
- **CITY AND CAMPUS STRATEGIC RELATIONS**
- **HIGH PERFORMANCE BUILDINGS AND RESEARCH**
- **CAMPUS RENEWABLE ENERGY SYSTEMS**

ISCN AWARD 2017

The University of Genoa was one of the 5 finalists of ISCN award 2017 in "Building and Innovative Infrastructure" category.

https://www.international-sustainable-campus-network.org/news/496-iscn-2017-winners

UNIVERSITÀ DEGLI STUDI DI GENOVA

Energia 2020 Project

"Energia 2020" is an innovative project started in 2011 concerning with the Smart City & Sustainable Energy topics. It has been conceived, designed and developed by the University of Genoa with the final goal to make Savona Campus a Living Lab of the City of the Future

Total Value: 10.7 M€

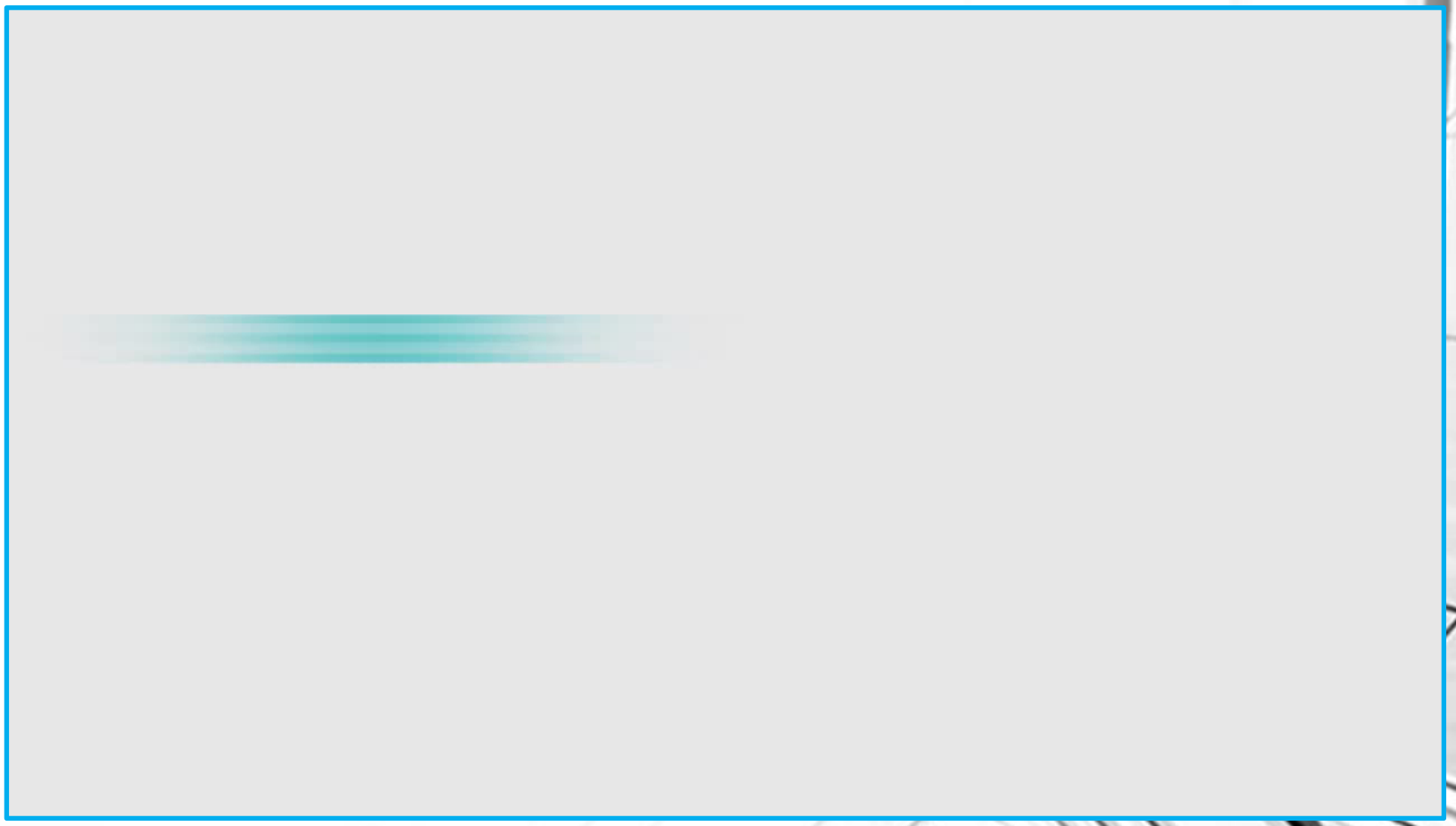
Energia 2020 is based on 4 main actions:

- ✓ **Smart Polygeneration Microgrid (SPM)** → "Intelligent" & Sustainable Microgrid feeding the electrical and the thermal loads of the Campus
- ✓ **Smart Energy Building (SEB)** → "Intelligent" & Active n-ZEB interacting in real-time with the SPM Energy Management System
- ✓ **Energy Efficiency Measures (EEM)** → Reduction of the Campus consumptions and the energy dispersions at the building level
- TO BE DONE **Smart City Demo Campus (SCDC)** → The Campus as a "test-bed" of state-of-the-art technologies for the City of the Future (the Campus as an independent "Energy Island" with high confort level for its population)

UNIVERSITÀ DEGLI STUDI DI GENOVA

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
- EEGI Label on March 2015 (www.gridplus.eu/node/172)
- Italian award on environmental innovation on April 2015 (www.premioinnovazione.legambiente.org)



EEGI
EUROPEAN ELECTRICITY GRID INITIATIVE
- SUPPORT -

INNOVAZIONE AMICA DELL'AMBIENTE

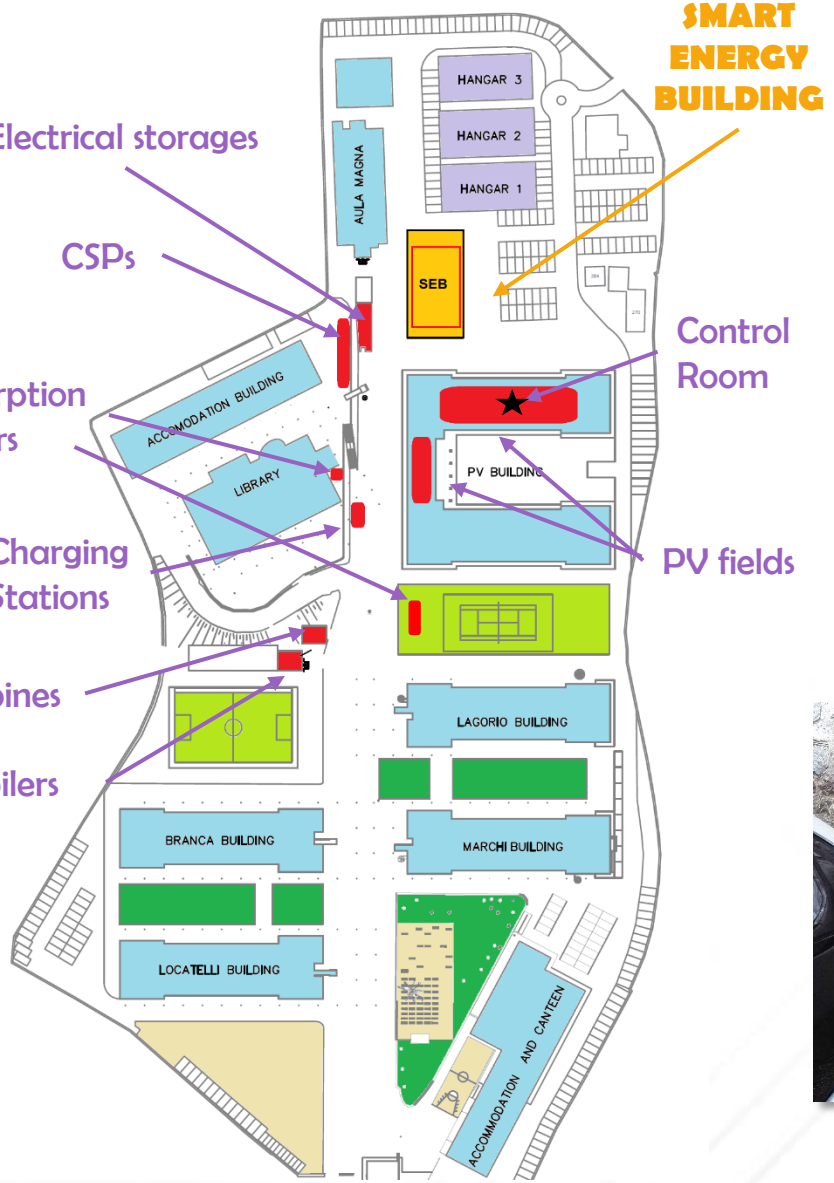
LEGAMBIENTE

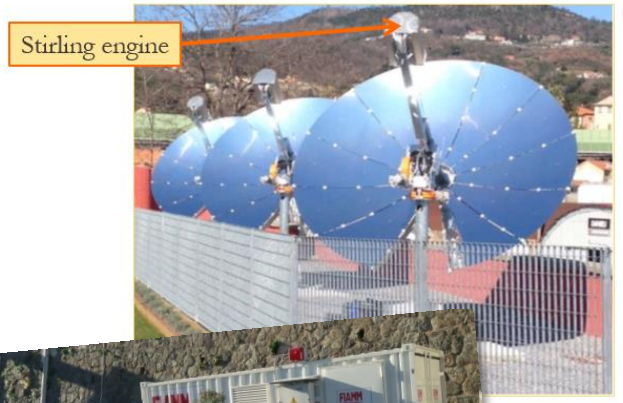
UNIVERSITÀ DEGLI STUDI DI GENOVA

SPM layout

Control Room

Trigeneration plants

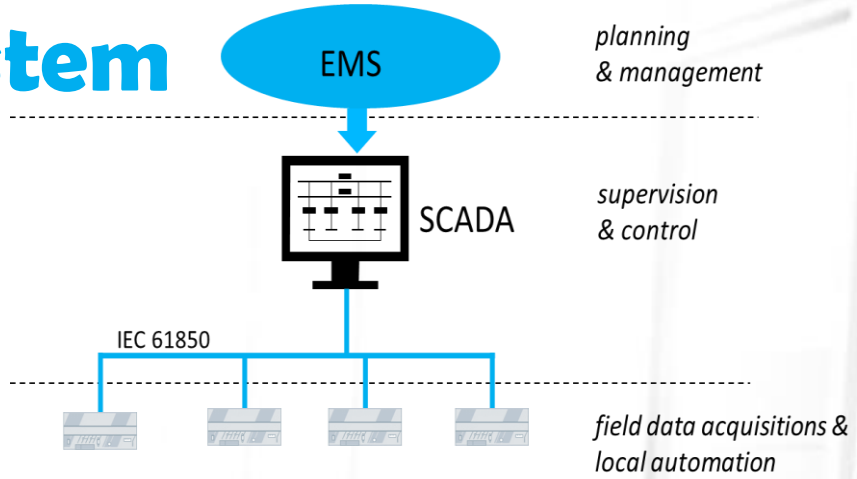




- Renewable power plants
- Storage systems
- E-mobility

UNIVERSITÀ DEGLI STUDI DI GENOVA

SPM 3-level planning & control system



Energy Management System (EMS)

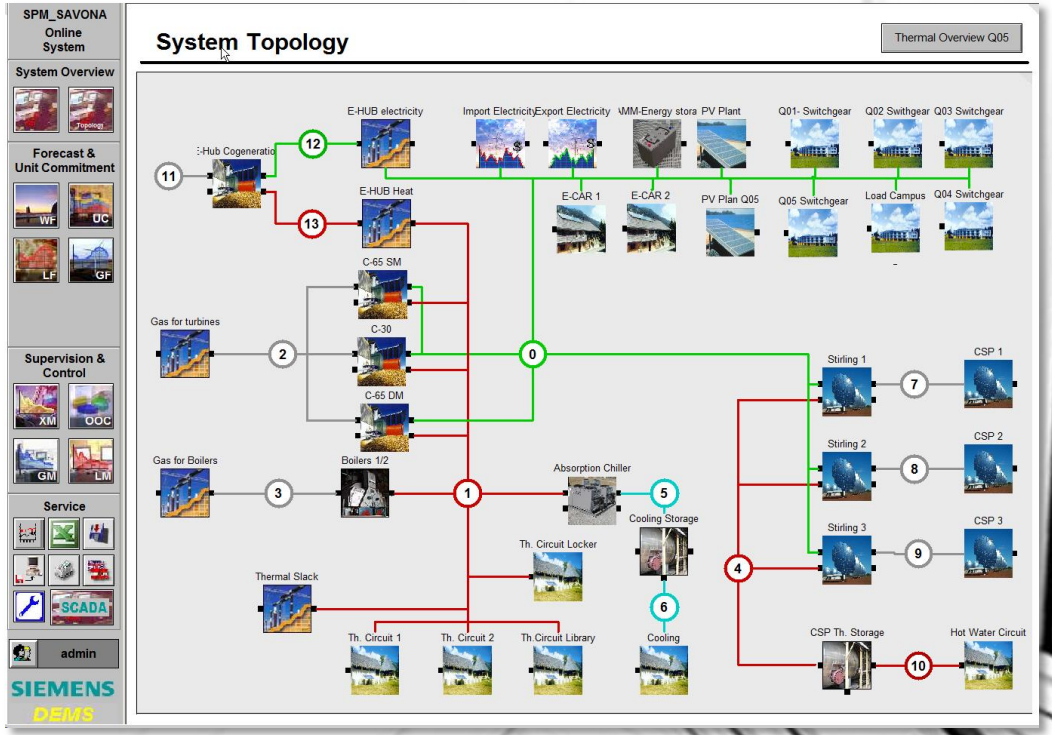
Optimization algorithm (time horizon: 24 hours, time interval: 15 min) – Objectives: reduction of daily operational costs & CO_2 emissions

Inputs:

- Cost functions
- Technical and environmental constraints (related to the performance of power plants)
- Savona Campus electrical and thermal load forecast
- Estimation of power production from renewable sources based on weather forecast and historical data

Outputs:

- Optimal scheduling of the production of fossil fuel power plants (microturbines and boilers) and electrical storage systems
- Such scheduling minimizes daily operational costs and emissions

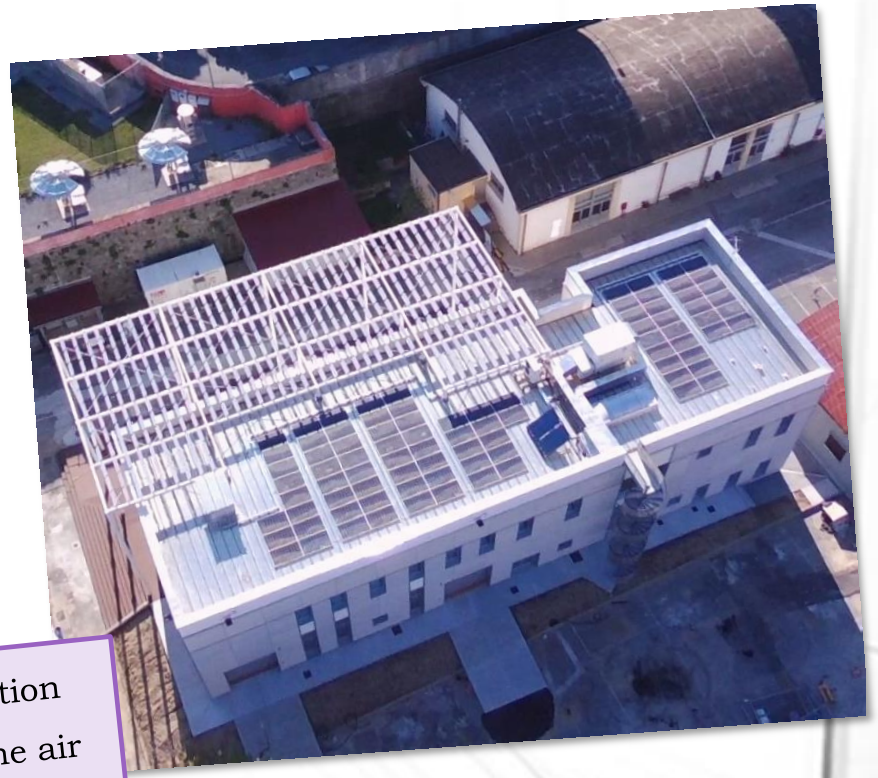


UNIVERSITÀ DEGLI STUDI DI GENOVA

Smart Energy Building

- 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
- Main technical peculiarity: Smart Building interacting with a Smart Microgrid as a Prosumer
- Surface: 1000 m^2

Energy Efficiency Class A+

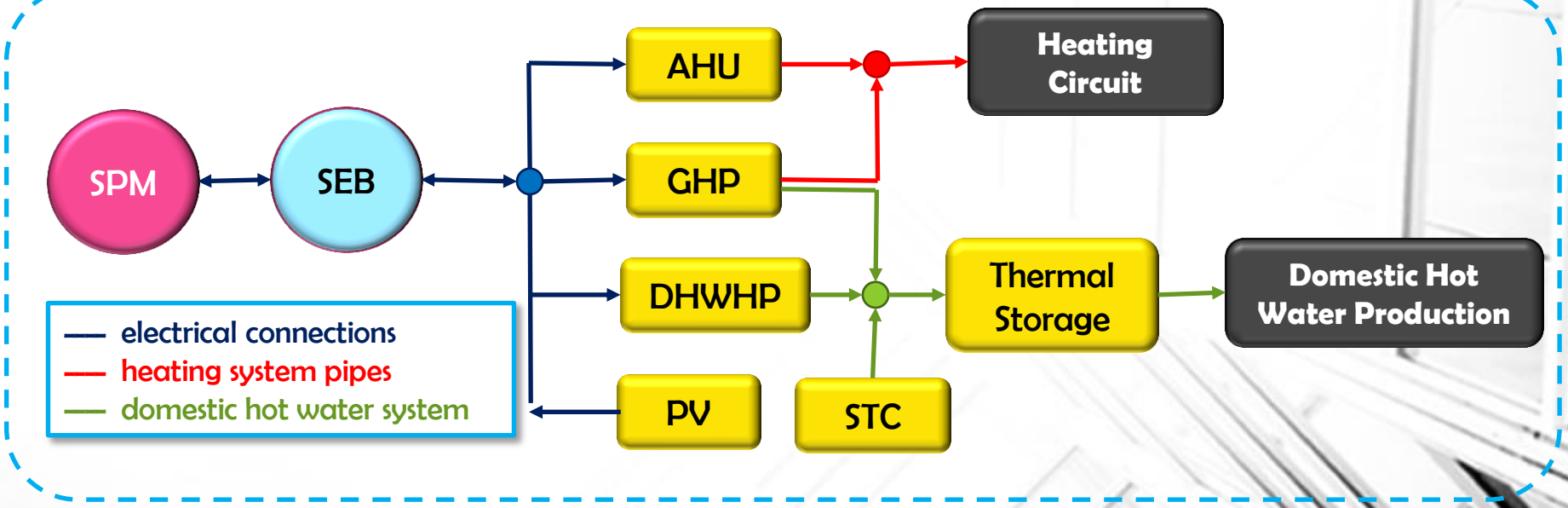


A complex regulation system controls the air conditioning and lights of SEB

UNIVERSITÀ DEGLI STUDI DI GENOVA

SEB: main technical features

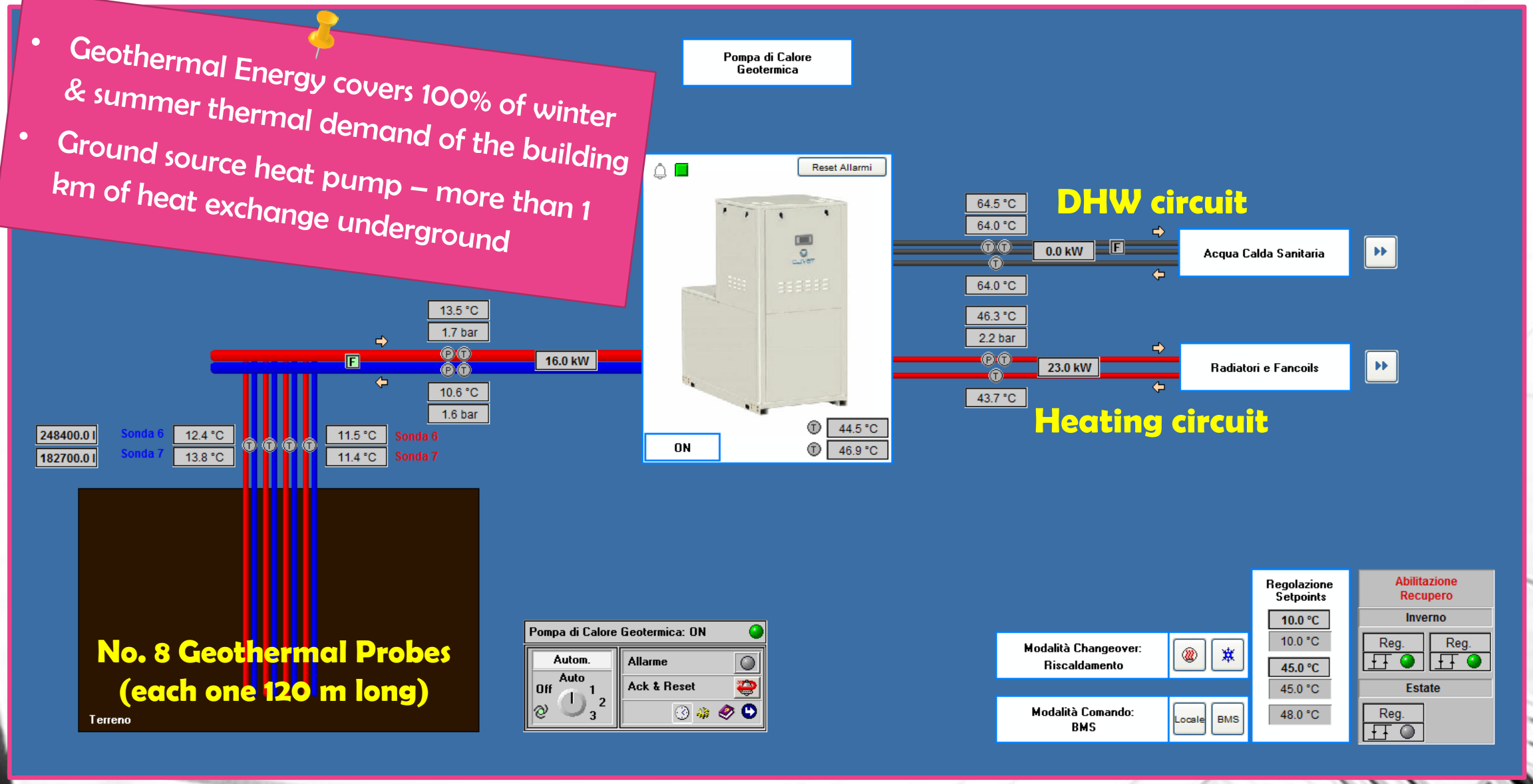
- High performance thermal insulation materials for building applications
- Geothermal heat pump (**GHP**) (45 kW_{th}, 8 probes)
- Solar Thermal Collectors (**STC**)
- Controlled mechanical ventilation plant, Air Handling unit (**AHU**)
- Domestic Hot Water Heat Pump (**DHWHP**)
- Photovoltaic field (**PV**) (23 kW_p)
- Extremely low consumption led lamps
- Rainwater collection system
- Ventilated facades
- Technological Gym



UNIVERSITÀ DEGLI STUDI DI GENOVA

SEB – Geothermal Plant

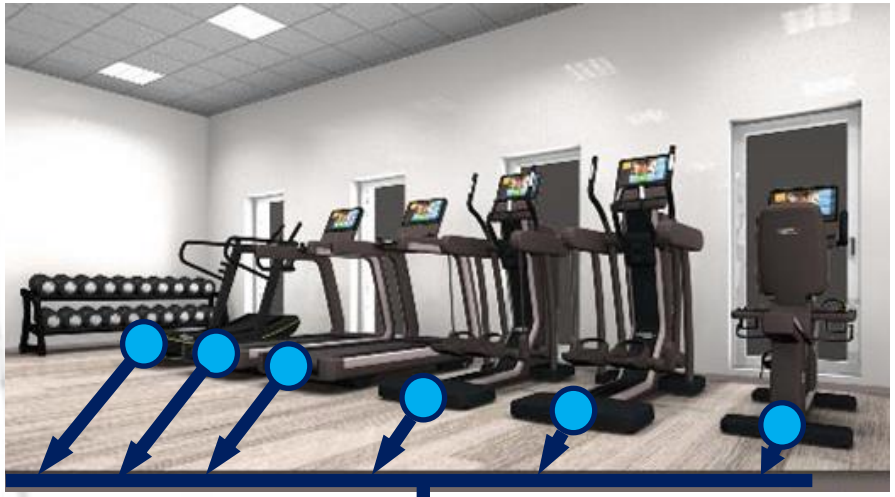
- Geothermal Energy covers 100% of winter & summer thermal demand of the building
- Ground source heat pump – more than 1 km of heat exchange underground

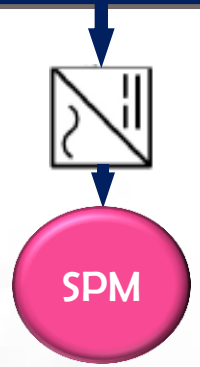


UNIVERSITÀ DEGLI STUDI DI GENOVA

SEB U-Gym

- The Gym as an Energy Harvesting system
- 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

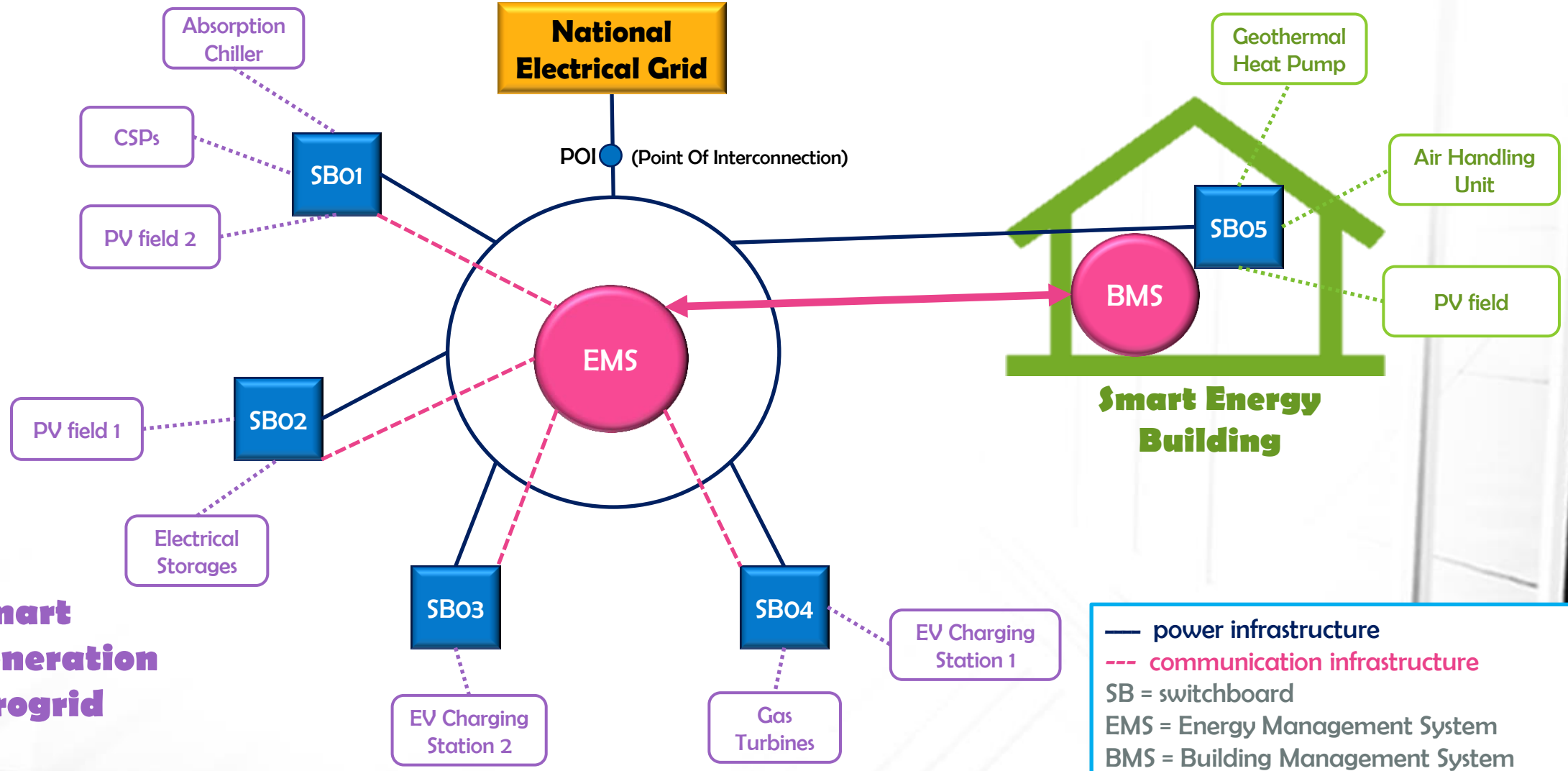




U-GYM

UNIVERSITÀ DEGLI STUDI DI GENOVA

«SMART CITY»
SEB - SPM power & communication connection



UNIVERSITÀ DEGLI STUDI DI GENOVA

Energy Efficiency Measures

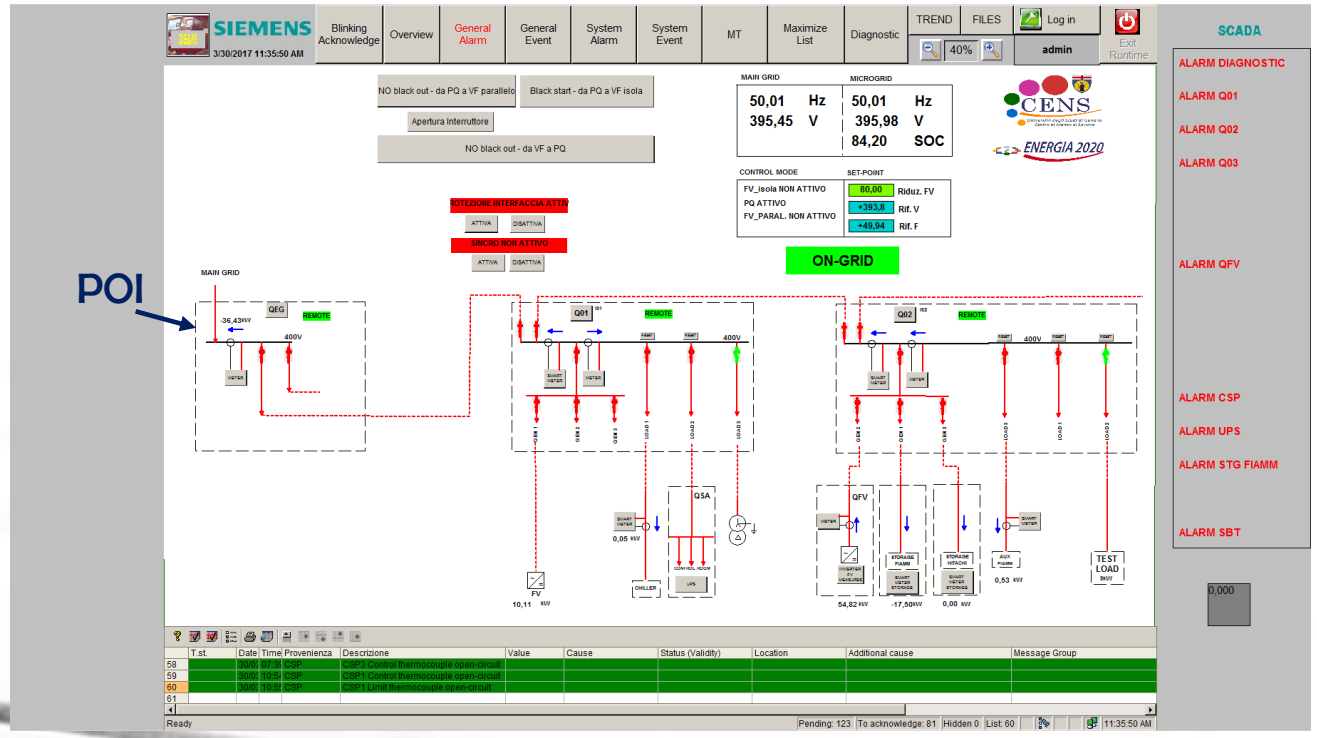
- Funded by: 65% Regione Liguria (North West Italian district), 35% UNIGE
- Value of the project: 2,3 M€
- Status: works started in October 2016, foreseen end date June 2017
- Main goal: to improve the cooling system of buildings using trigeneration (microturbines and absorption chillers) in order to increase indoor comfort; energy efficiency interventions to reduce the thermal dispersion of the buildings

Development of a platform to monitor and manage generation units (Heating, Ventilation and Air Conditioning) and loads (Lights, electrical appliances) in order to optimize energy flows, thus reducing primary energy consumptions and CO_2 emissions

UNIVERSITÀ DEGLI STUDI DI GENOVA

Smart City Demo Campus

- Funded by: the project is at the design stage, UNIGE is looking at fundraising opportunities
- Value of the project: 3 M€
- Status: to be done
- Main objective: to transform the Campus into a Living Lab of the City of the Future
- Cooperation with the Italian DSO (ENEL S.p.A.) to test the capability of the SPM and SEB infrastructures to operate disconnected from the National Grid, relying only on the supply of renewables + storage systems



Synoptic of the developed SCADA system section for the management of «on-grid», «off-grid» transition

The objective is to supply SEB, in islanding mode operation, using the PV fields (its own and that of the SPM) coupled with the storage systems

Experimental activity is now ongoing in order to shift the SPM + SEB infrastructures from the «grid-connected» mode of operation to the «Energy Island» one

UNIVERSITÀ DEGLI STUDI DI GENOVA

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

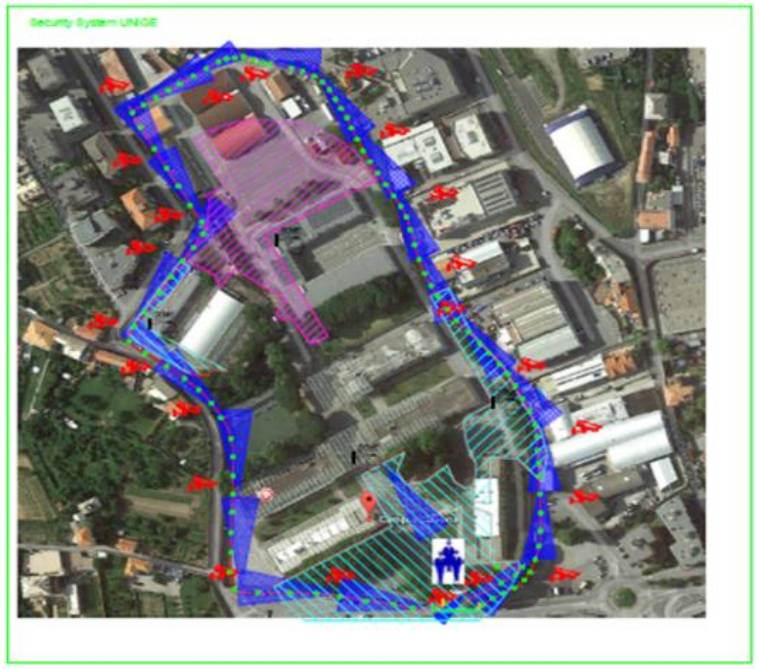
✓ DONE

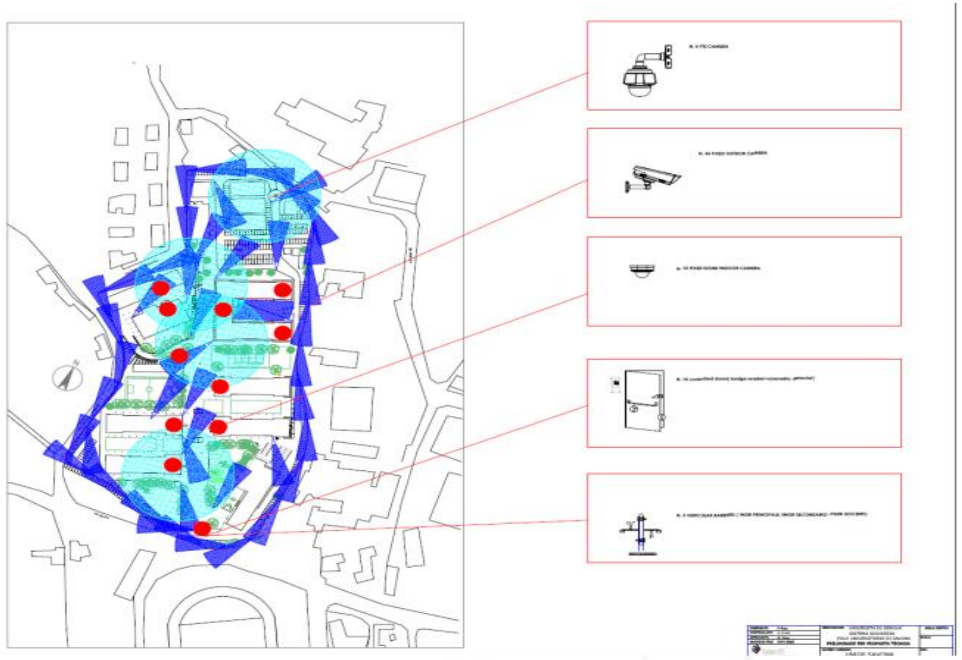
 IN PROGRESS

UNIVERSITÀ DEGLI STUDI DI GENOVA

Smart City Demo Campus

City Security (Physical & Cyber)





Technologies for citizens safety, environmental monitoring and cyber security

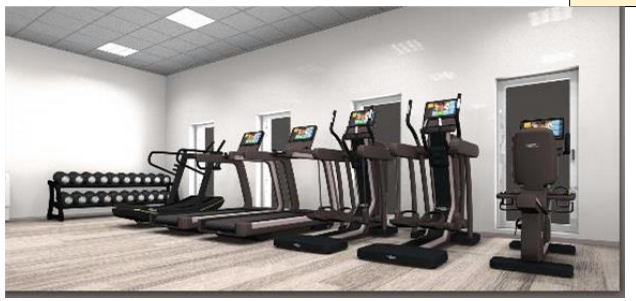
KASPERSKY lab

In partnership with Kaspersky Lab

Smart City Demo Campus

Health & Wellness for the citizens

U-Gym – «Human Energy»



Tennis Court

5-a-side Football Field

Fitness Trail

Functional Workout