XIV International Conference on Science Arts and Culture

WORKSHOP on GEOTHERMAL ENERGY Status and future in the Peri - Adriatic Area

25 - 27 August 2014
Veli Lošinj, Croatia

ECSAC
European Centre for Science Arts and Culture

AREA SCIENCE PARK INNOVATIVE SYSTEMS AND *OPEN-LABORATORIES* FOR THE DIFFUSION OF SMALL SIZE PLANTS BASED ON RENEWABLE ENERGY AND HIGH EFFICIENCY TECHNOLOGIES INCLUDING GEOTHERMAL APPLICATIONS

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AREA SciencePark

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- **Area Science Park key competences**
- **Experimental development projects**
- **LIDs demonstration plant in place**
- **Some project examples:**
  - LED public lighting
  - Cogeneration
  - Photovoltaics
  - Low enthalpy geothermal

Area Science Park Trieste – Where are we ?

Area Science Park Trieste

A national benchmark for technology transfer and a prestigious, multi-sectoral Science and Technology Park where research, development and innovation bear excellent results: this is AREA Science Park.

A place where top training, research and enterprise meet and become a key resource for the growth of the economy and employment opportunities in the territory.

Top quality services, extensive relations with academic and research institutes, highly qualified human resources, coupled with a marvellous location – in the farthest eastern corner of Friuli Venezia Giulia .

Area Science Park key competences

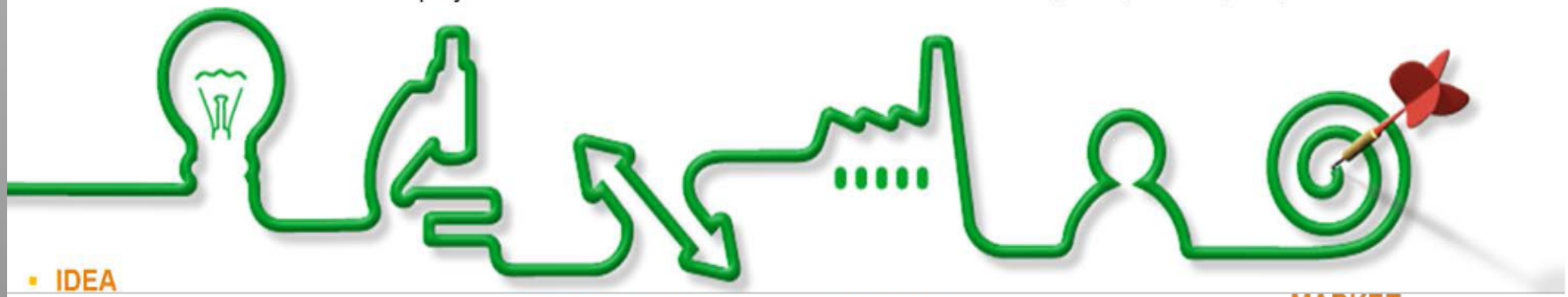
An exclusive environment which provides flexible solutions for tenancies, structures, instruments and support services for the development of activities based on knowledge and technology

RESEARCH

- To validate your idea scientifically
- To enhance exploitation of your research results
- To find efficient alternatives to solutions already implemented
- To find reliable partners in order to realize your international projects

PRODUCT/SERVICE

- To find new materials that improve product performance
- To improve the ergonomic design of what is produced
- To perform specific tests on a new product
- To improve product quality



IDEA

To come up with good ideas

- To ensure your idea is really unique and not already patented
- To find a good solution to your technical problem
- To defend your intellectual property
- To form a start-up using your innovative idea

DEVELOPMENT

- To enhance product development
- To elaborate new process or product engineering
- To promote your invention prototypes
- To discover new invention applications
- To turn your ideas into innovation projects

COMPANY

- To improve your business management
- To intervene where appropriate to boost your production efficiency
- To increase your productivity at a lower cost
- To identify other companies interested in collaboration

MARKET

- To identify new product markets
- To find potential buyers
- To recognise new business models and capture opportunities in advance
- To assist start-ups in finding potential investors

Experimental development projects Renewable energy and energy saving demonstration plants

- Develop and diffuse innovative solutions for energy efficiency and energy production from renewable sources and alternatives to fossil fuels

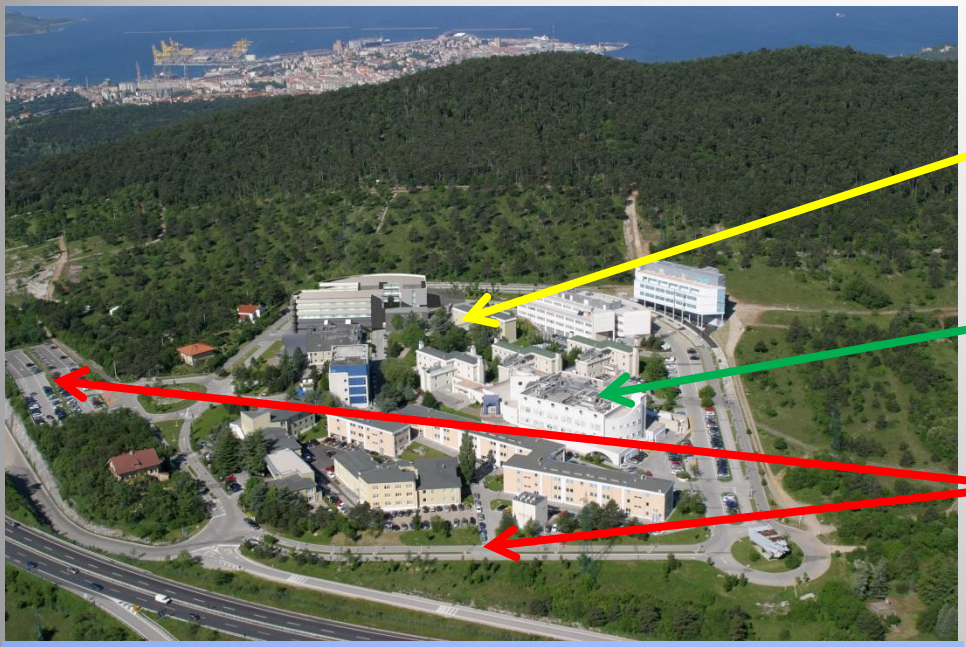
- Make available demonstration plants (LID) to be used as laboratories for technological development and industrial trials, in which universities and primary schools, research institutes and public administration can learn and compare the results of technical, environmental and economic effect of proposed changes

- Reduce energy management costs and at the same time radically cut harmful emissions in energy applications used in civil and industrial constructions

LIDs demonstration plant in place

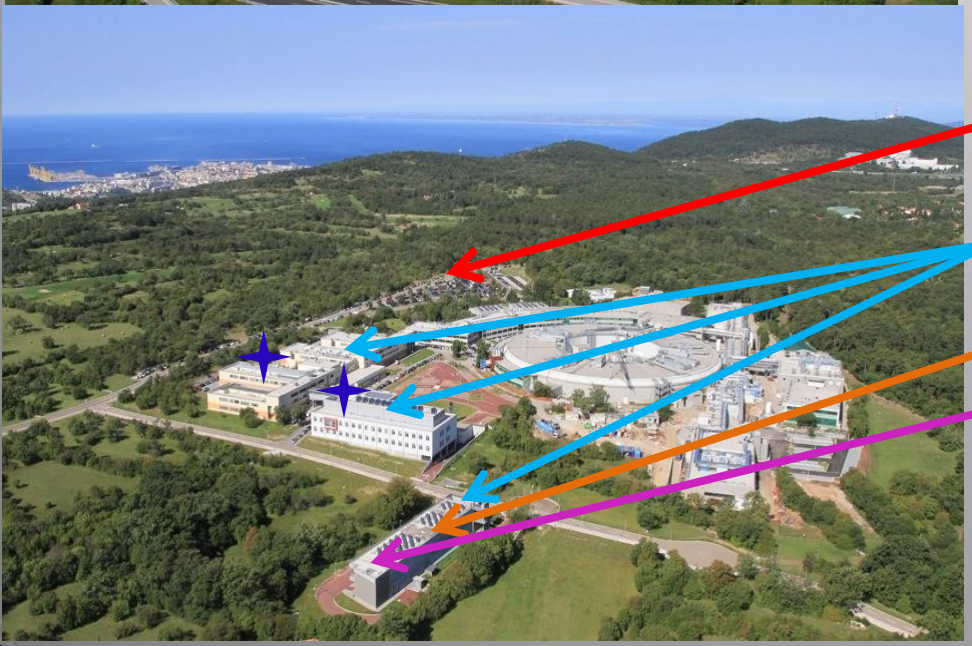
- Energy recovery from waste air exhaust
- Alternative Energy Demo Lab Facility (photovoltaics cogeneration integrated plant Internal Combustion engine fueled)
- LED based road lighting – n° 3 Light systems different based tecnologies
- Cogeneration plant CHP system – n° 2 micro gas turbines
- Experimental photovoltaic cell plant – n° 3 photovoltaic systems, with different construction technologies
- Active Building Insulation and Geothermal Heat Pump Plant
- Solar cooling new projects

LIDs LOCATION



Padriciano

- Active Building Insulation and Geothermal Heat Pump Plant
- Energy recovery from waste air exhaust
- LED based road lighting



Basovizza

- LED based road lighting
- Experimental photovoltaic cell plant
- Cogeneration plant CHP system
- Photovoltaics cogeneration integrated plant Internal Combustion engine fueled
- Solar cooling new projects

LED based road lighting – n° 3 Light systems different based tecnologies

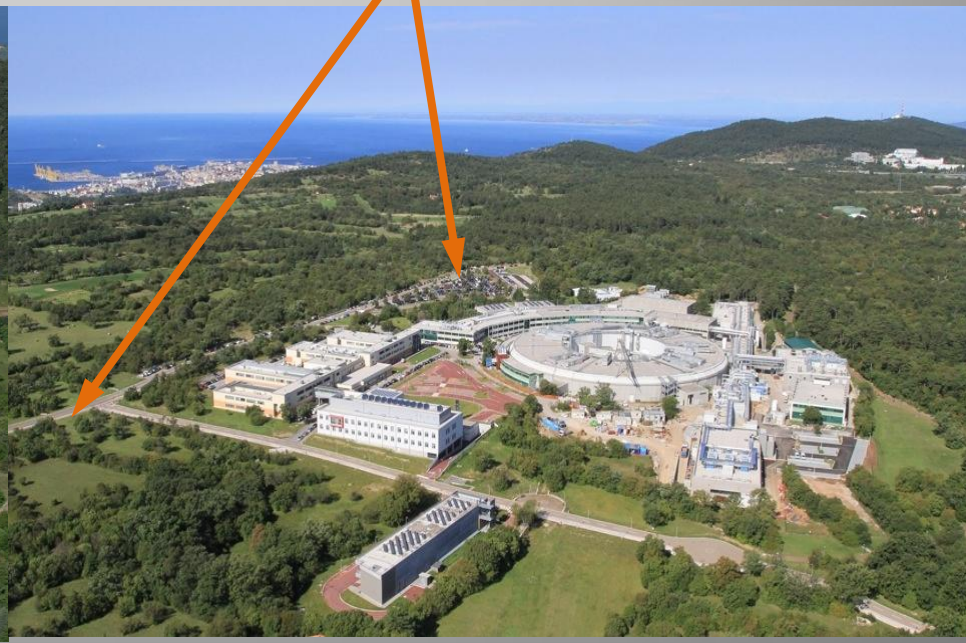
LID Location

N° 15 STREET LIGHTS

N° 65 STREET LIGHTS

Basovizza

N° 200 STREET LIGHTS



Overview of the experimental demo plant

➢Project description:

- ✓ Installed Pilot test plant
- ✓ Installed 3 different Led road light systems with the most promising technologies
  - n°15 led street light 30W - City Design Lotus 3 - matrix system + fv monocristalline module power
  - n° 70 led street light 34W - Siteco lantern led - matrix system
  - n°200 led street light 48W - Ibt Lighting Dogma 46 - chip array led system
- ✓ Advanced monitoring system of performance

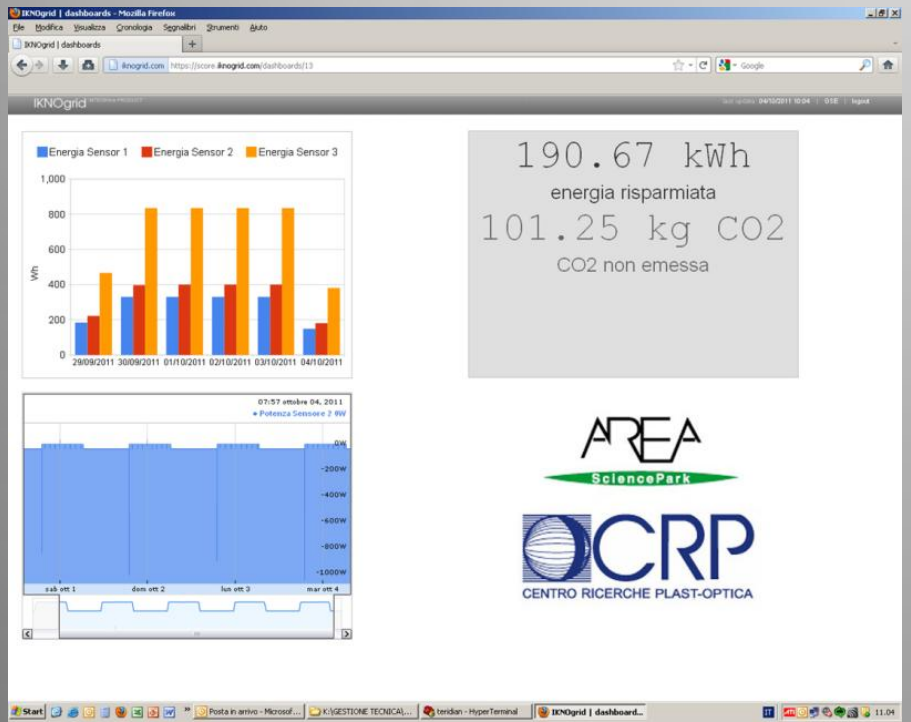
➢Aims and objectives:

- ✓ Field study and trials of the best LED available technologies, coupled to systems of measurement of energy consumption and performance monitoring, the quality of the illumination, the reliability of the devices, the complete customization of the functions of the system in use, by giving evidence in real time through the use of a dedicated software.
- ✓ drastic reduction of the energy bill, CO_2 emissions and light pollution

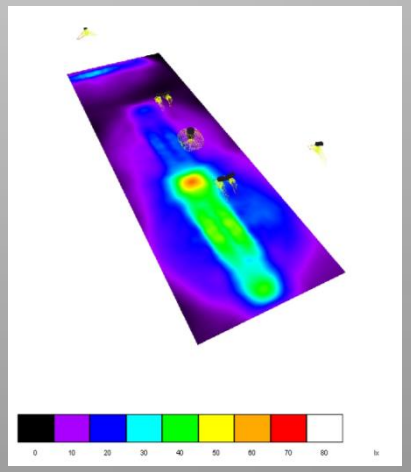
Pilot plant to test and misure the results before final project

N°6 Pilot streetlights

- Road lumen measurament to fix project data
- Monitoring and control system study
- Determine best Lamp type technology even with in - lab test
- Color Temperature test
- Evaluate real energy savings



Radio Data System



Campus Padriciano

N° 70 LED STREET LIGHTS

MATRIX SYSTEM

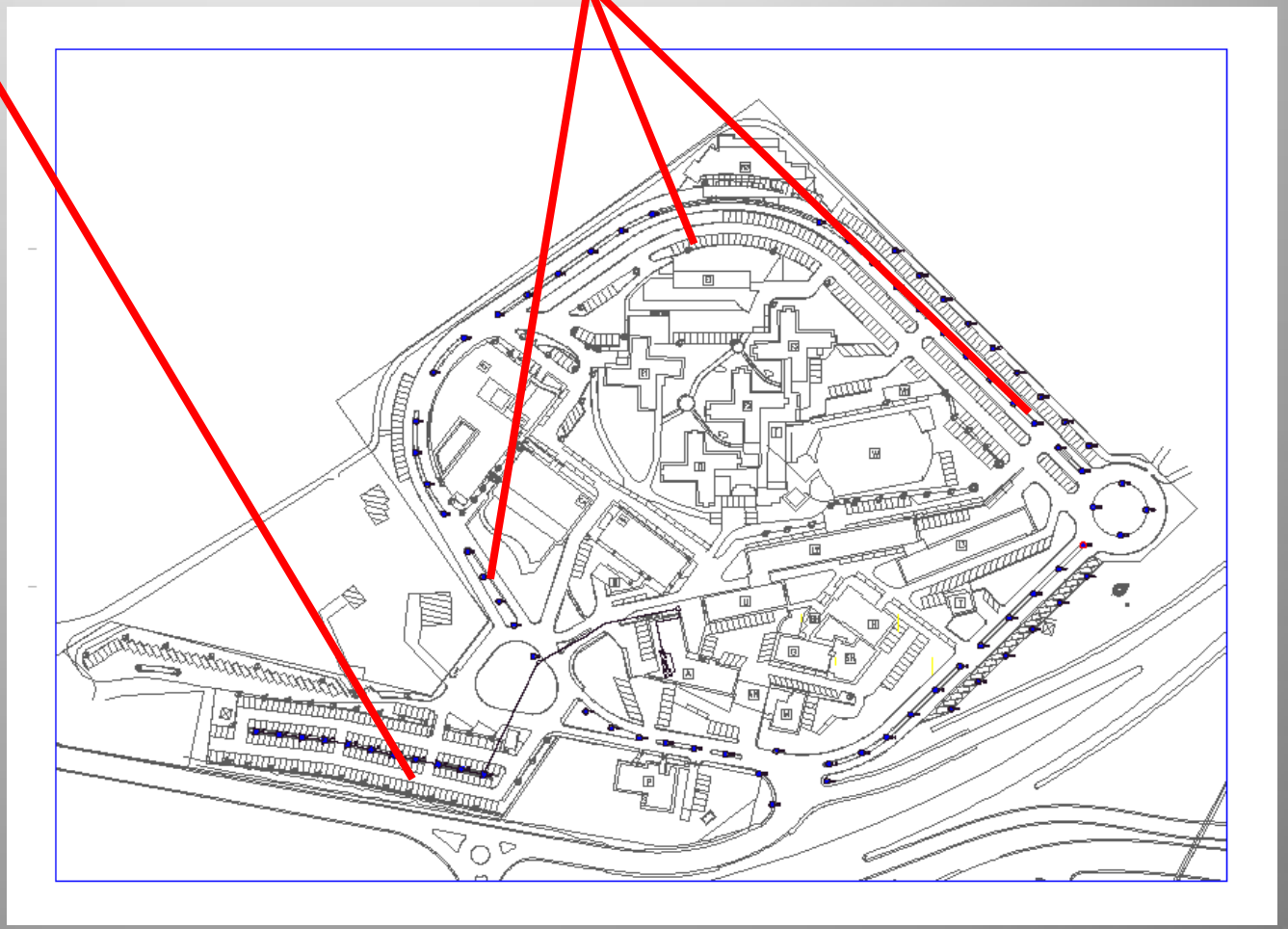
MODEL : Lantern LED (Siteco)

N°15 LED STREET LIGHTS

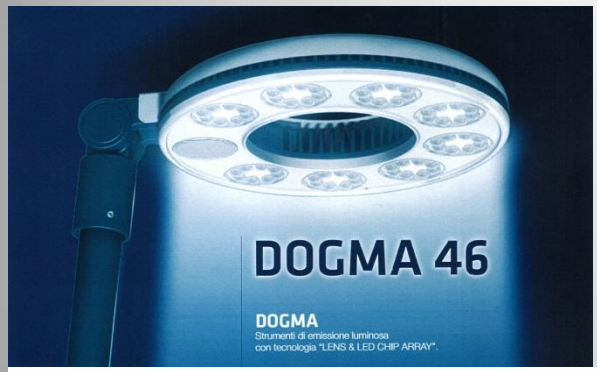
MATRIX SYSTEM + FV MONOCRISTALLINE MODULE POWER

5 DAYS ENERGY STORAGE

MODEL : City Design Lotus 3



Campus Basovizza



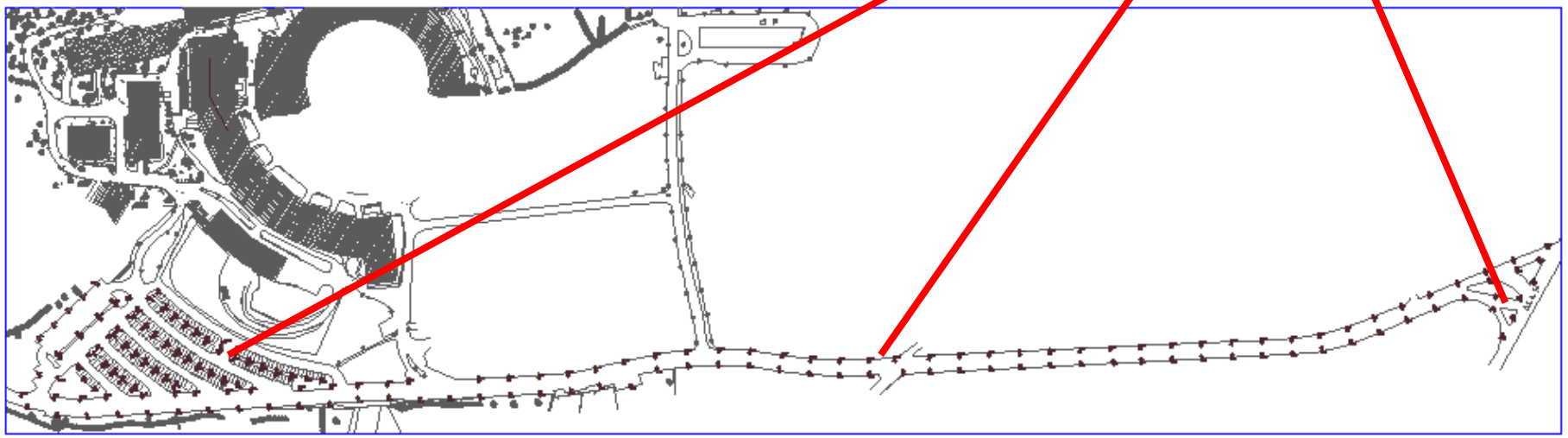
Lato AC	Lato DC
Tensione = 229,831 V	Tensione = 54 V
Corrente = 0,199 A	Corrente = 0,351 A
Potenza attiva = 43,056 W	Potenza = 37,9 W
Fattore di potenza= 0,944	Numero LED = 36

Efficienza alimentatore= 88 %

N°200 LED STREET LIGHT

‘’CHIP ARRAY LED’ SYSTEM

MODEL IBT Lighting Dogma 46



Led monitoring and Remote Control

➢ Power line carrier remote control systems

- The special control and monitoring system is based on the **power line carrier (PLC**) technology (i.e no need for additional wiring) to control the light flux of dimmable LED fixtures up to 990 lights max distance of 1.5 km.

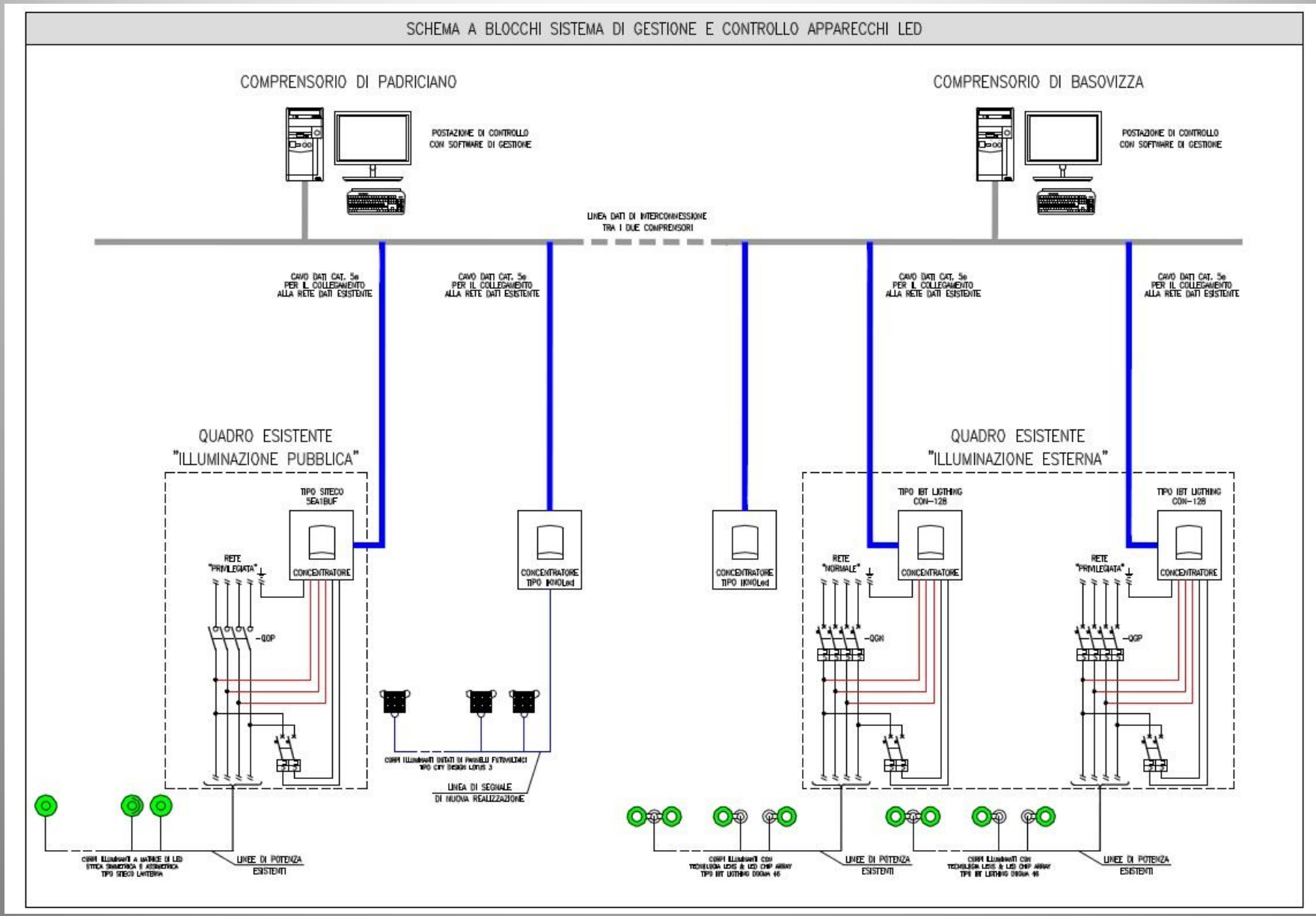
➢ System monitoring

- The electronic system detects the fixture's operation parameters and takes all the appropriate maintenance measures to ensure long life.
- The system also records power ON-OFF times, the number of hours the lamp stays ON and the total absorbed energy and detect: supply voltage, power and current rates and Led critical Temperature

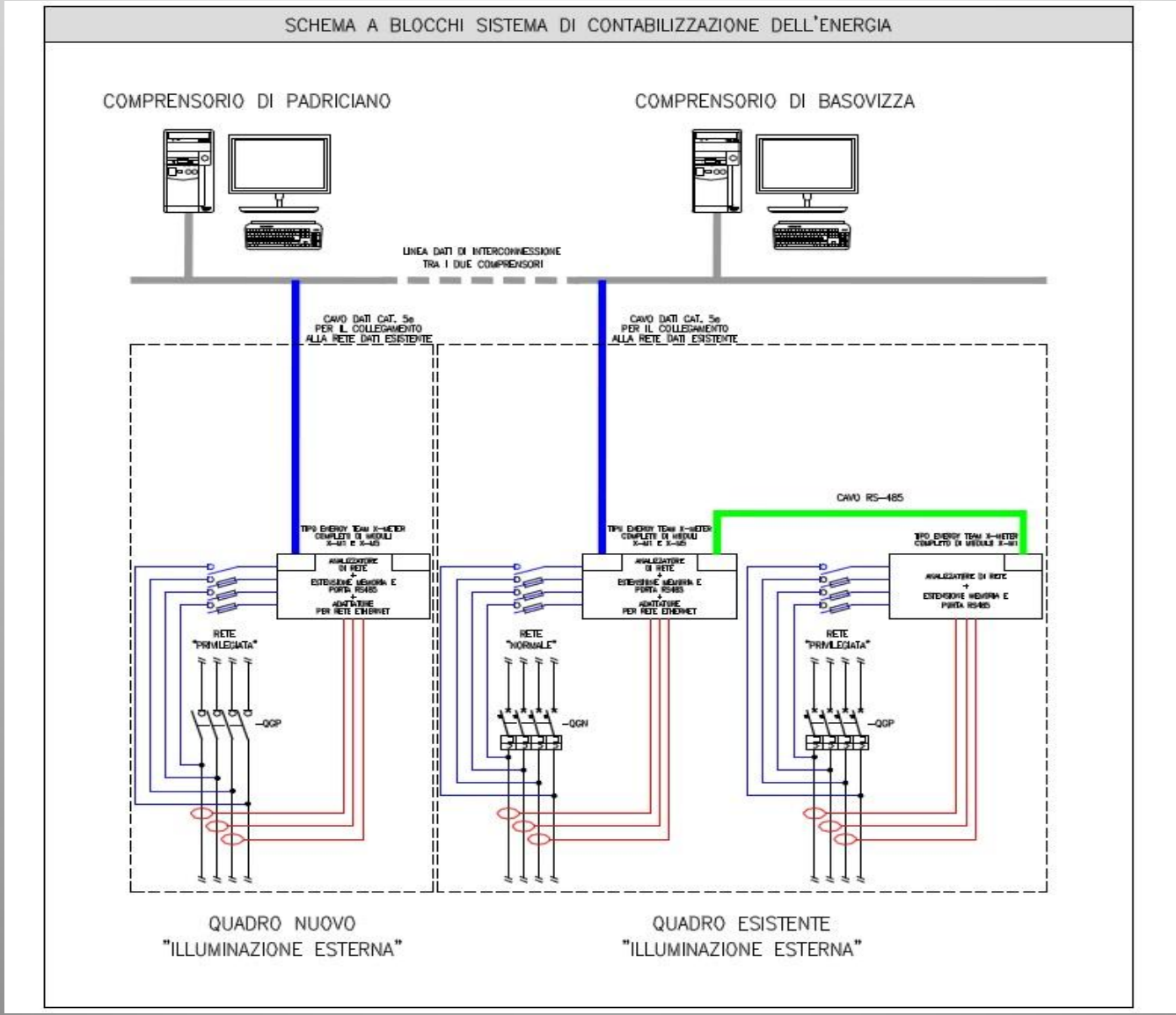
➢ Remote control is used to:

- change the fixture's parameters after installation, to create advanced dynamic settings and to monitor the lighting fixture in real time.
- turn off some lights and/or reduce the luminous flux meet the need to save energy resources during the timeslots and/or periods of low pedestrian and vehicular traffic, generating economic and environmental benefits
- receive information on the status of the lamp fixture (on/off) and/or on failures directly from each lighting point;
- send commands directly to each lighting point to run the fixture at full/reduced power and to gradually adjust (dim) the luminous flux emitted by the fixture

Led monitoring and Remote Control



Power System monitoring and Remote Control

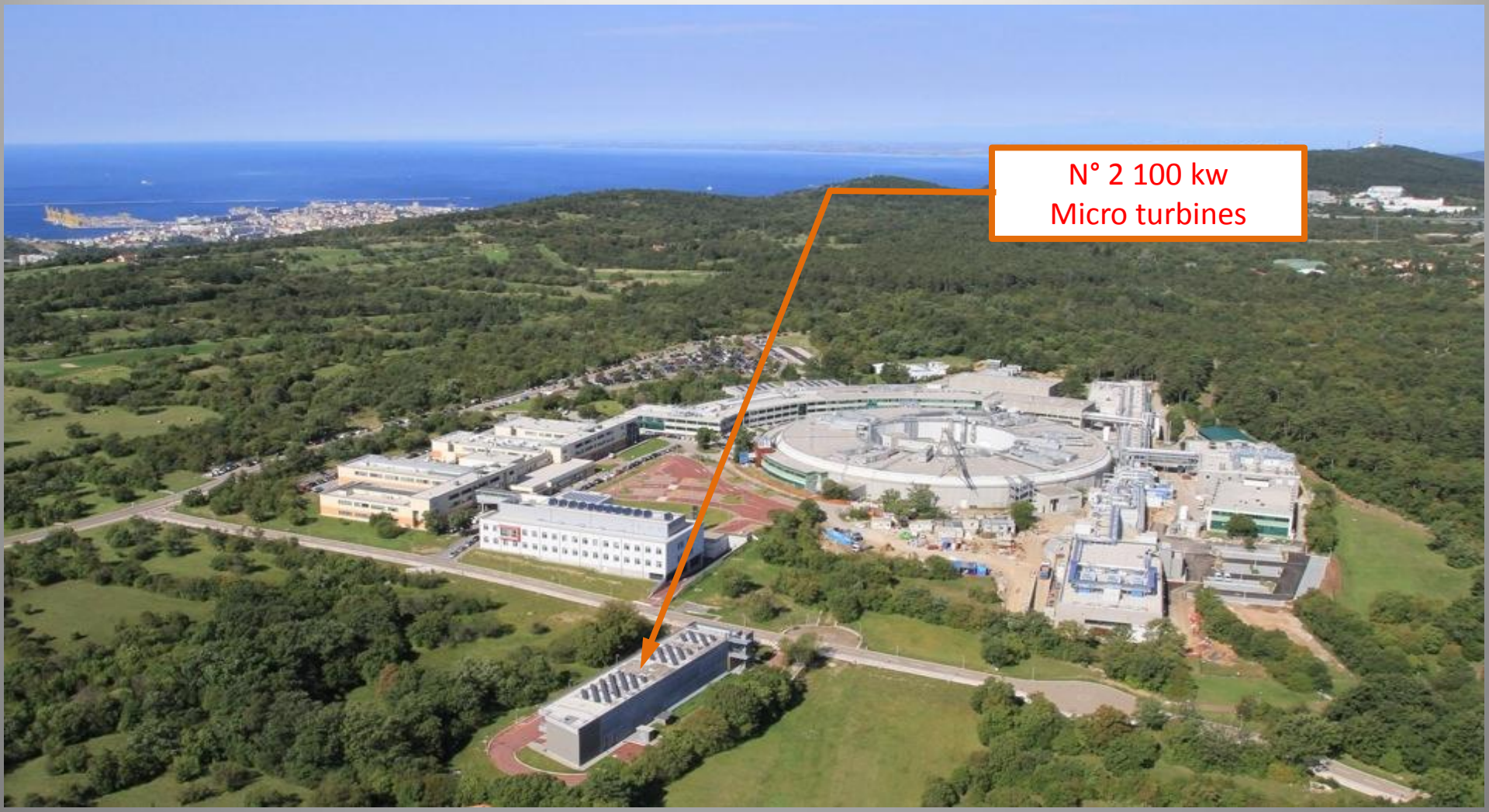


The main advantages of this technology can be listed as follows

- drastic reduction (measured to 45% in one year) of the energy bill due to the high luminous efficiency;
- elimination of routine maintenance costs and long lamp life ;
- high-speed switching and instant issuance of the luminosity with the total elimination of flicker;
- ability to manage and monitor the systems remotely by centralized systems;
- reductions in CO_2 emissions in the order of 40-45% of the power consumption of traditional lighting systems;
- reduction of '"light pollution" by allowing a lighting directed without loss and without IR and UV components;
- reduction in the use of highly toxic substances such as mercury and relative risks of environmental pollution

Cogeneration plant CHP system – n° 2 micro gas turbines

LID Location Basovizza



Overview of the experimental demo plant

➢ Project description:

- ✓ Installation of CHP cogeneration plant system (Combined Heat Power) in the new HVAC power station of the Basovizza campus of AREA Science Park
  - n°2 microturbine 100kW electric/167 kW thermal – Turbec T100 – natural gas fueled
  - n°1 additional fuel tank fo sperimental gas test

➢ Aims and objectives:

- ✓ Encourage the expansion of cogeneration and distributed generation energy plant systems in civil and industrial buildings. Distributed Generation (DG) is the use of small-scale power generation technologies located close to the load being served.
- ✓ Estimating the turbine performance with LHV (Low Heating Value) gases in order to verify the installation of micro turbine in the emerging/3rd world countries
- ✓ reduction of the energy bill, CO_2 emissions and pollution

Main technical data

Dimensions (CHP)

– 900x1810x2527/3652 mm (WxHxL)

Weight

– 2650 kg

Site working conditions

– 0°C to +40°C

– Ur≤80%

Intake conditions

– -25°C to +40°C

– Ur≤100%

Gas requirement

– Da 6 a 8.5 bar (g) (senza compressore)

– Da 0.02 a 1 bar (g) (con compressore)

– 0 °C to +60 °C

Fuel consumption

– 333 kW (Circa 34,5 m3/h)

Electrical Production

– Power: 100 kW

– 3 phases 400 (480) VAC ± 10%

– 50 (60) Hz ±5%

– Adjustable power factor

– Electrical efficiency30%

Heat Production (hot water)

– 167 kW (Circa 144.000 kcal/h)

– Efficienza termica 48% (acqua in ingresso a 50°C ed in uscita a 70°C)

Exhaust gases

– 55°C

acoustic emission level

– 70 dBA (ad 1 metro)

Main Technical data

Combustion chamber pressure:

– 4.5 bar (a)

Turbine inlet temperature:

– 950ºC (1742ºF)

Turbine outlet temperature:

– 620 – 650ºC

Exhaust temperature :

– 55ºC (131ºC)

Rotation speed: 70 000 rpm

Gas characteristics :

– Press: 6 – 8.5 bar (a)

– Temp: 0°C to +60°C

– Wobbe index: 43 – 55 MJ/mn³

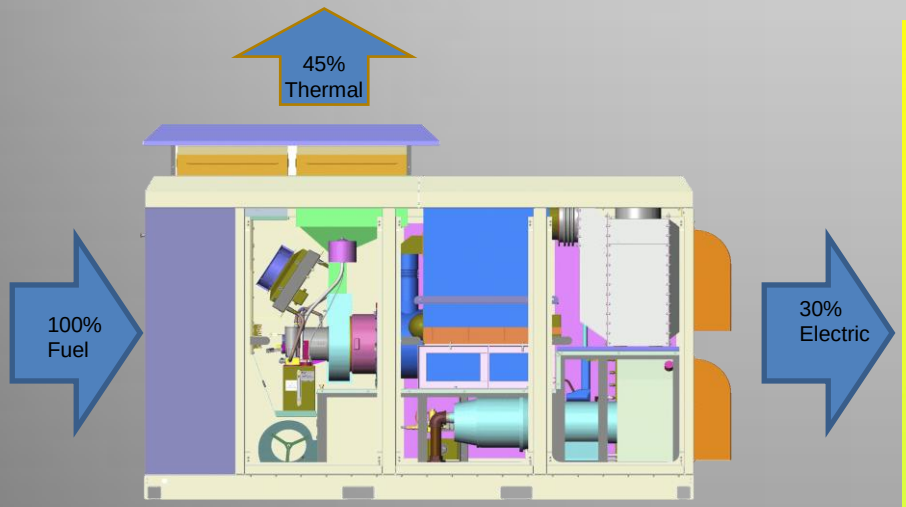
– gas flow : Circa 34,5 m3/h)

Pollutant Emissions @ 15% O2 and @ 100% load:

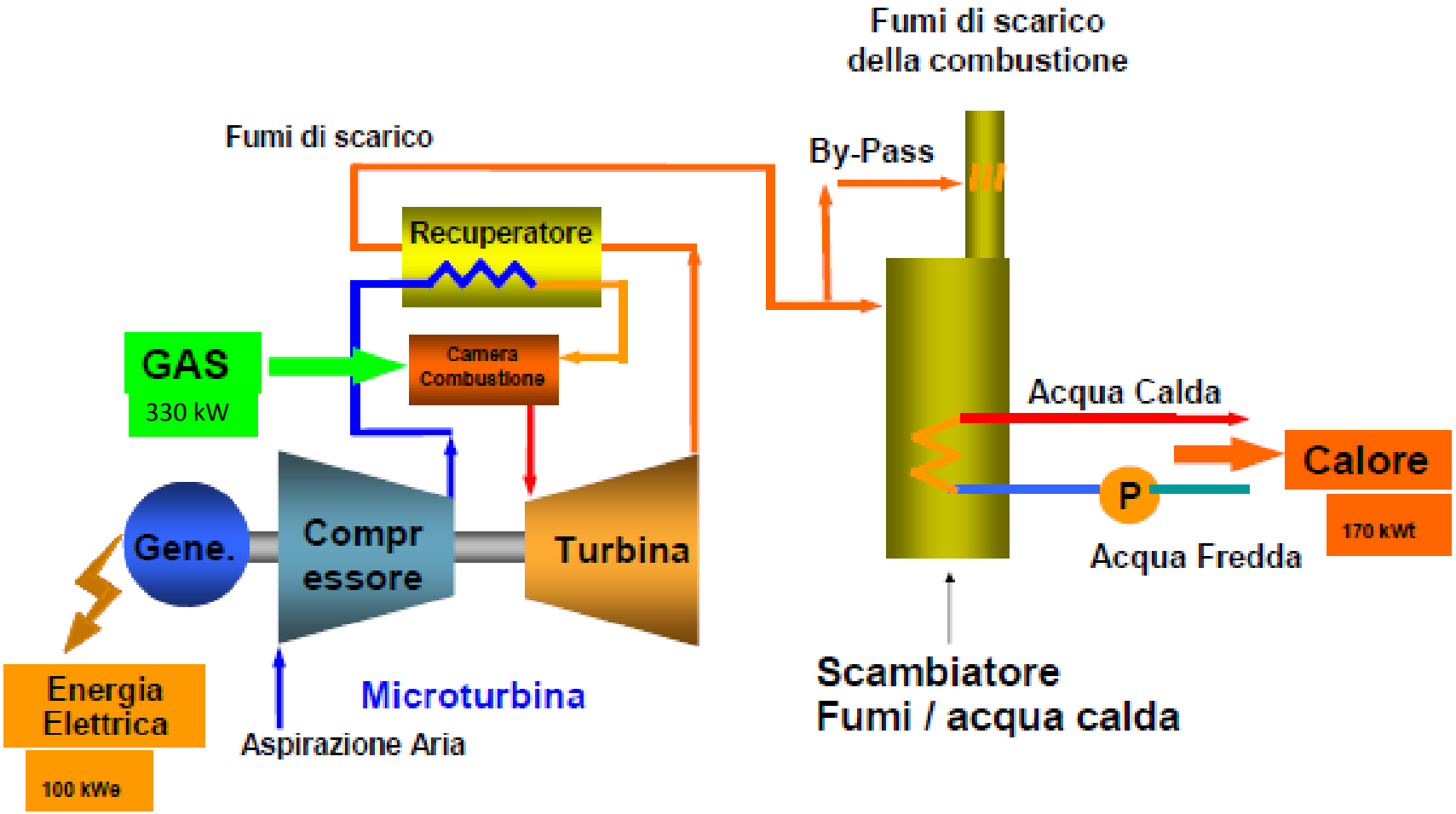
– NOx <15 ppm v (<32mg/MJ fuel)

– CO <15 ppm v (<18mg/MJ fuel)

– UHC <10 ppm v

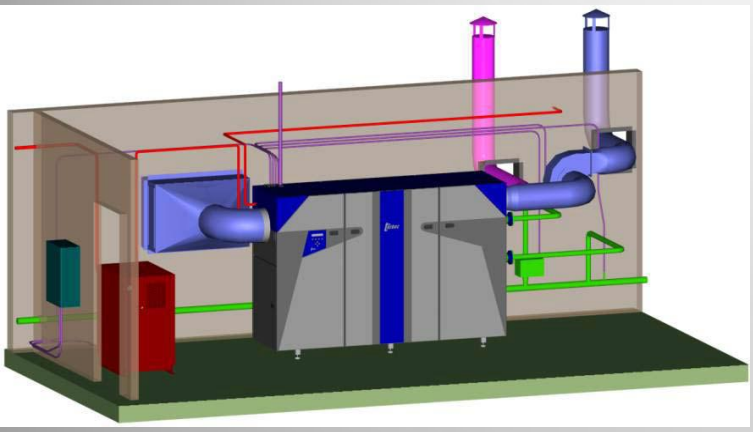


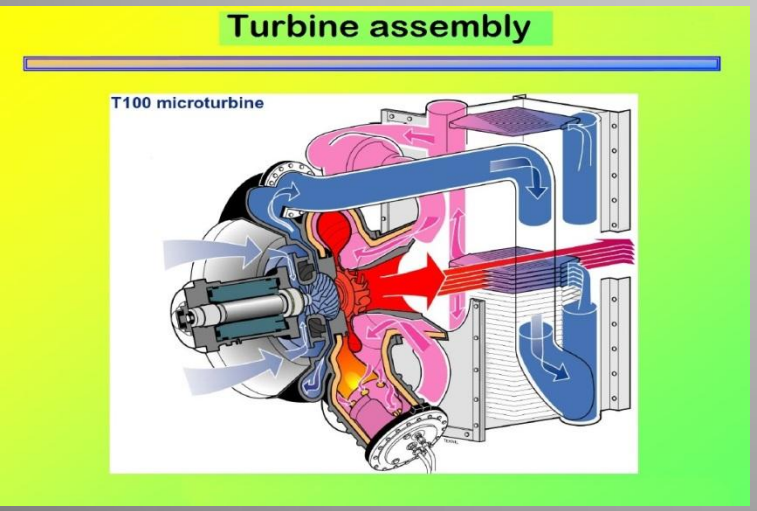
Technology: How Micro Turbines Work



Ciclo cogenerativo di una microturbina a gas

Lab and turbine assembly



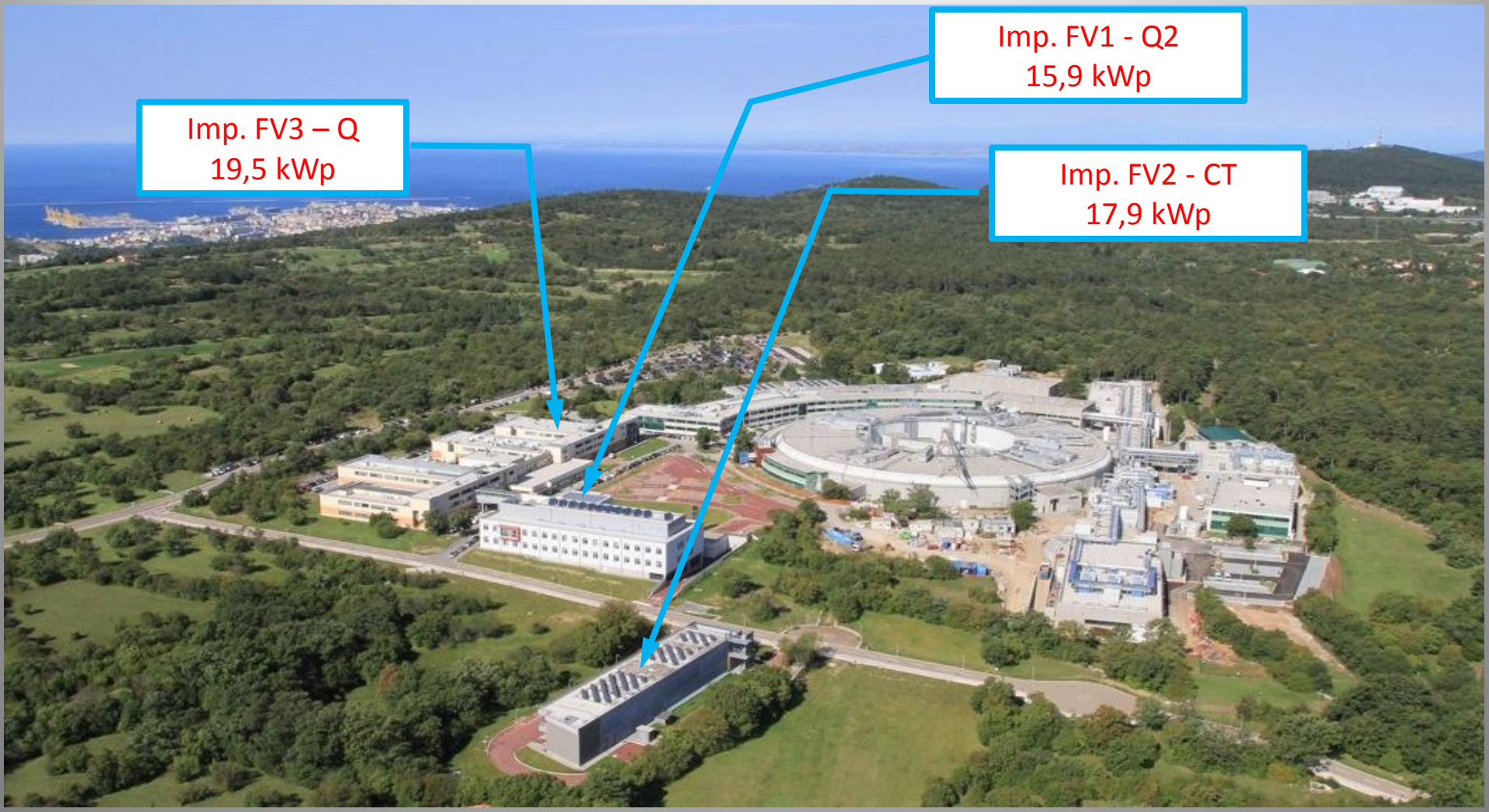


Advantages include one or more of the following:

- These technologies can meet a variety of consumer energy needs including continuous power, backup power, remote power, and peak shaving.
- They can be installed directly on the consumer's premise or located nearby in district energy systems, power parks, and mini-grids.
- Load management
- Reliability
- Power quality
- Fuel flexibility
- Cogeneration
- Deferred or reduced T&D investment or charge
- Increased distribution grid reliability/stability

Experimental photovoltaic cell plant – n° 3 photovoltaic systems, with different construction technologies

LID Location Basovizza



Overview of the experimental demo plant

➢ Project description :

- ✓ Installed 3 different PV cell plants systems with the most promising technologies:
  - 15.9 kWp - Sunpower - silicon monocristalline - efficiency (%) 19,3
  - 19.5 kWp - MiaSolè – rigid panel thin film CIGS - efficiency (%) 17,4
  - 17.9 kWp - Sanyo - HIT (Heterojunction with Intrinsic Thin Layer) efficiency (%) 13,1
- ✓ Monitoring advanced system of performances

➢ Aims and objectives:

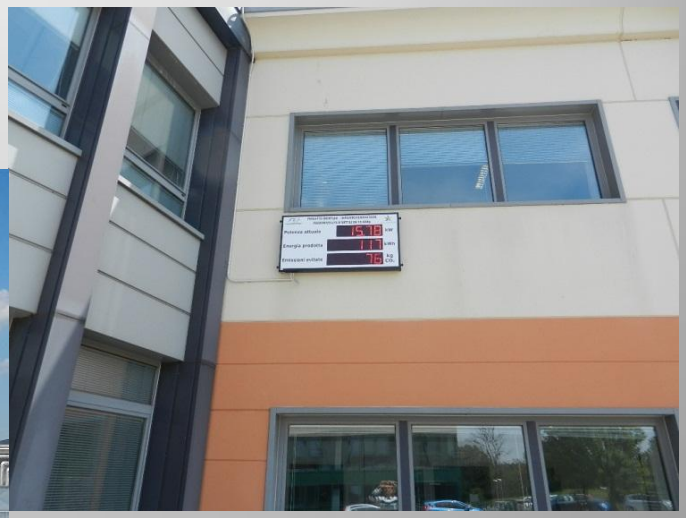
- ✓ Comparative study of three photovoltaic systems, with different construction technologies, to determine the actual productivity and energy efficiency under “real environmental conditions” and identify the most competitive solution for small sized PV plants (< 20 kW)
- ✓ Install a data acquisition and processing system to constantly monitor the performance of tested technical solutions
- ✓ Energy cost and pollution reduction

Pv cell plant assembly

15.9 kWp - Sunpower - silicon monocristalline

Pv cell plant assembly

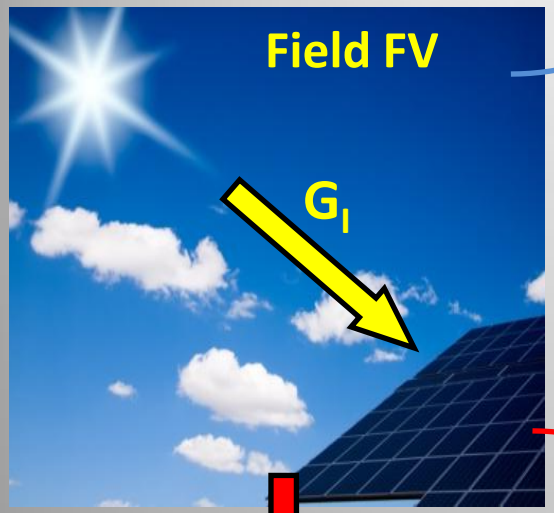
19.5 kWp - MiaSolè – rigid panel thin film CIGS



Pv cell plant assembly

17.9 kWp - Sanyo - HIT (Heterojunction with Intrinsic Thin Layer)

Data acquisition and processing system to constantly monitor the performance of tested technical solutions



T_{am}, S_W

Piranometer

T_m

V_A, I_A, P_A

V_U, I_U, P_U

Mains Load

Electrical parameters:

Direct current

- string current
- inverter inlet voltage

Alternate current

- inverter outuput voltage
- inverter outuput current

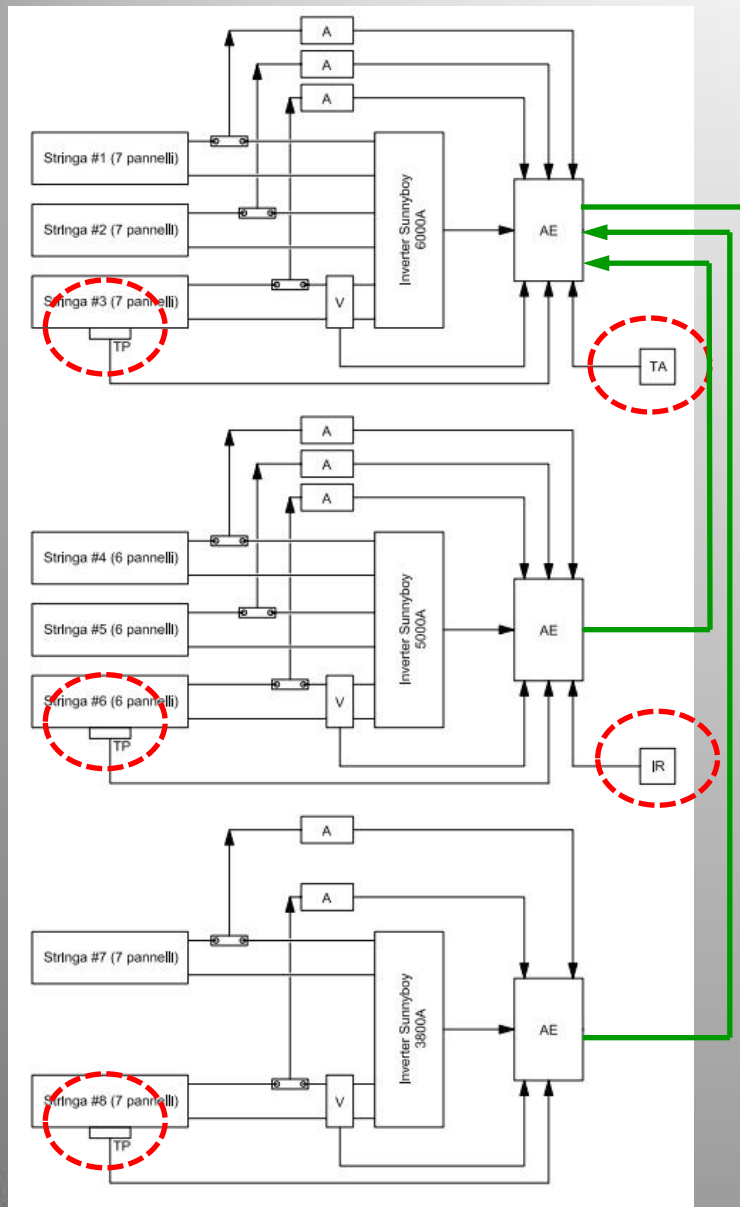
Pv panel parameters:

- Solar irradiation (on the panel)
- PV panel temperature

Enviroment parameters :

- Horizontal Solar irradiation
- Air temperature
- Wind velocity

Data acquisition and processing system to constantly monitor the performance of tested technical solutions

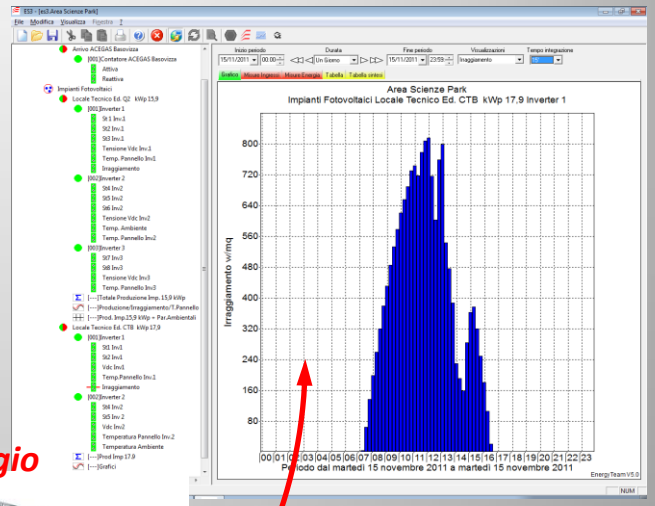


IR = solar sensor

TP = pv panel temperature

TA= air temperature

ethernet



PC monitoraggio

Comparative study of 3 Pv plants system to determine:

- productivity and energy efficiency
- alarm failure
- electrical production

Active Building Insulation and Geothermal Heat Pump Plant

LID Location Padriciano

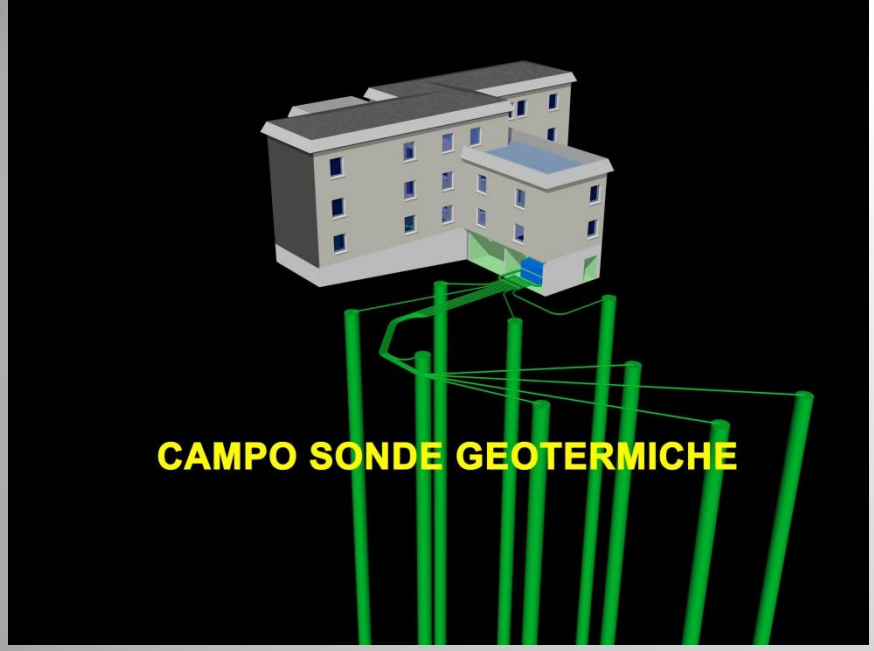
Overview of the experimental demo plant

➢ Project description:

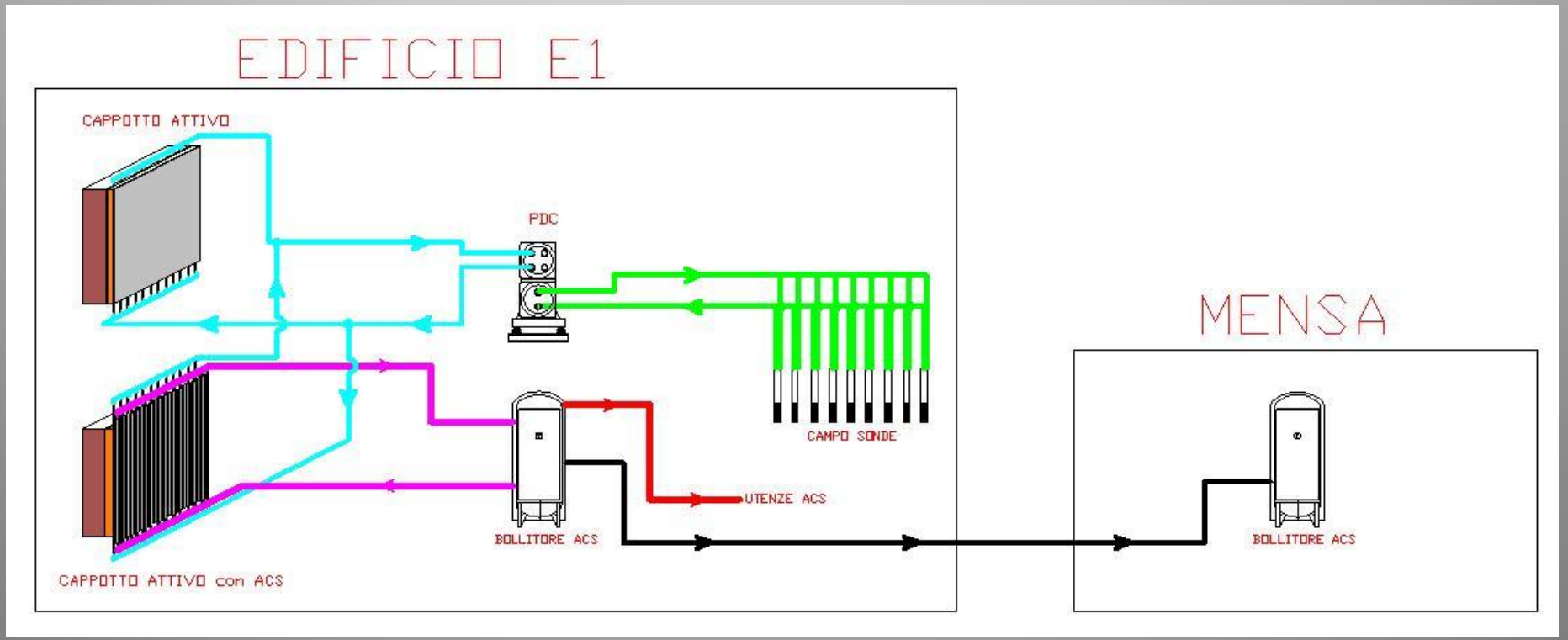
- Climatization system based on **geothermal heat pump, solar collectors** and on **radiating and insulating external layer :**
  - **PVC radiation tubes + 16 cm polystyrene insulation layer + protective coating**
  - **Geothermal heat pump and vertical heat exchangers**
  - **Energy performance monitoring system**
  - **Solar flat collectors**

➢ Aims and objectives

- Test the feasibility of vertical GHE on the Karst plateau
- Develop and build an innovative climatisation system to be used in case plant refurbishment/ energy requalification in poorly insulated buildings.
- Energy cost and pollution reduction

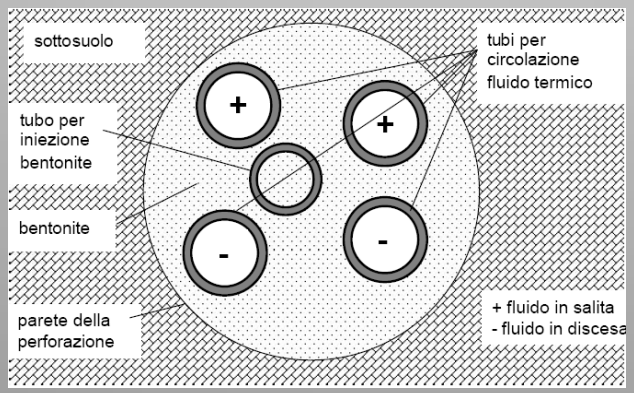


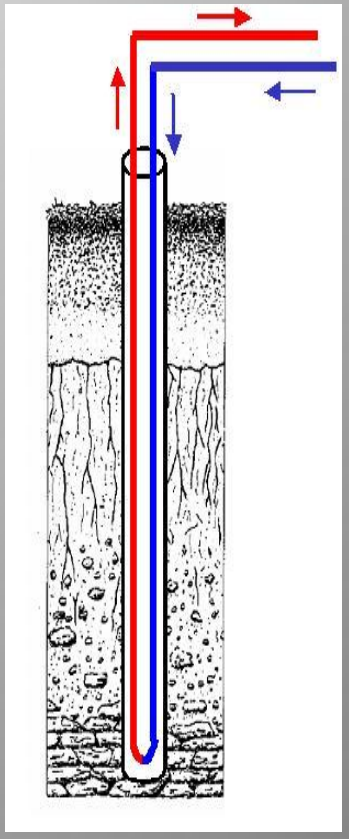
Active Building Insulation and Geothermal Heat Pump Plant Functional sketch



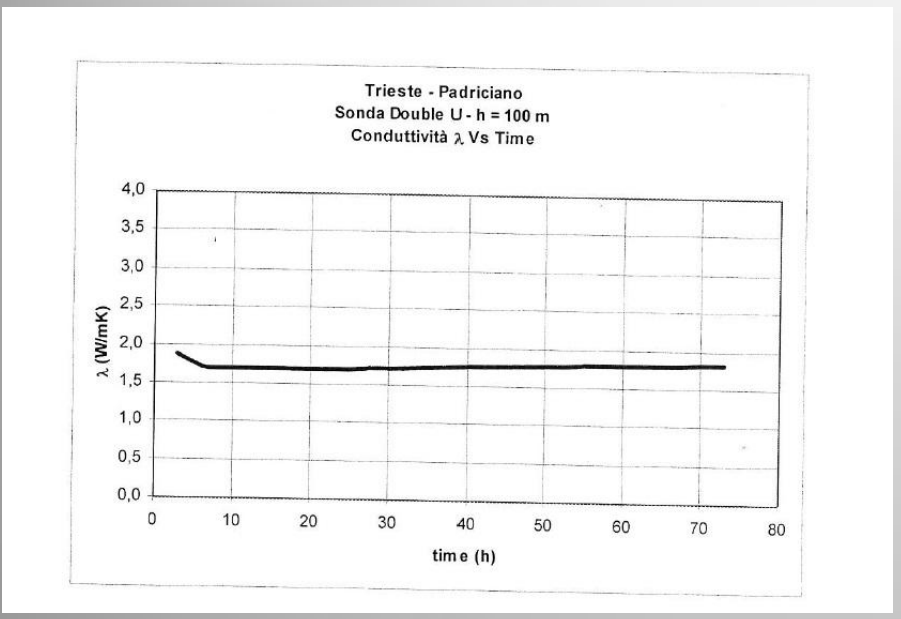
Vertical borehore geothermal heat exchangers

- **Can we use vertical GHE on the Karst Plateau ?**
- Detailed preliminary geophysical investigation
- Not deeper than 100 m





Ground response test results



- **GRT (line source theory model)**
- Rock conductivity λ = 1,83 W/mK
- GHE Th. Resistance R = 0,135 mK/W

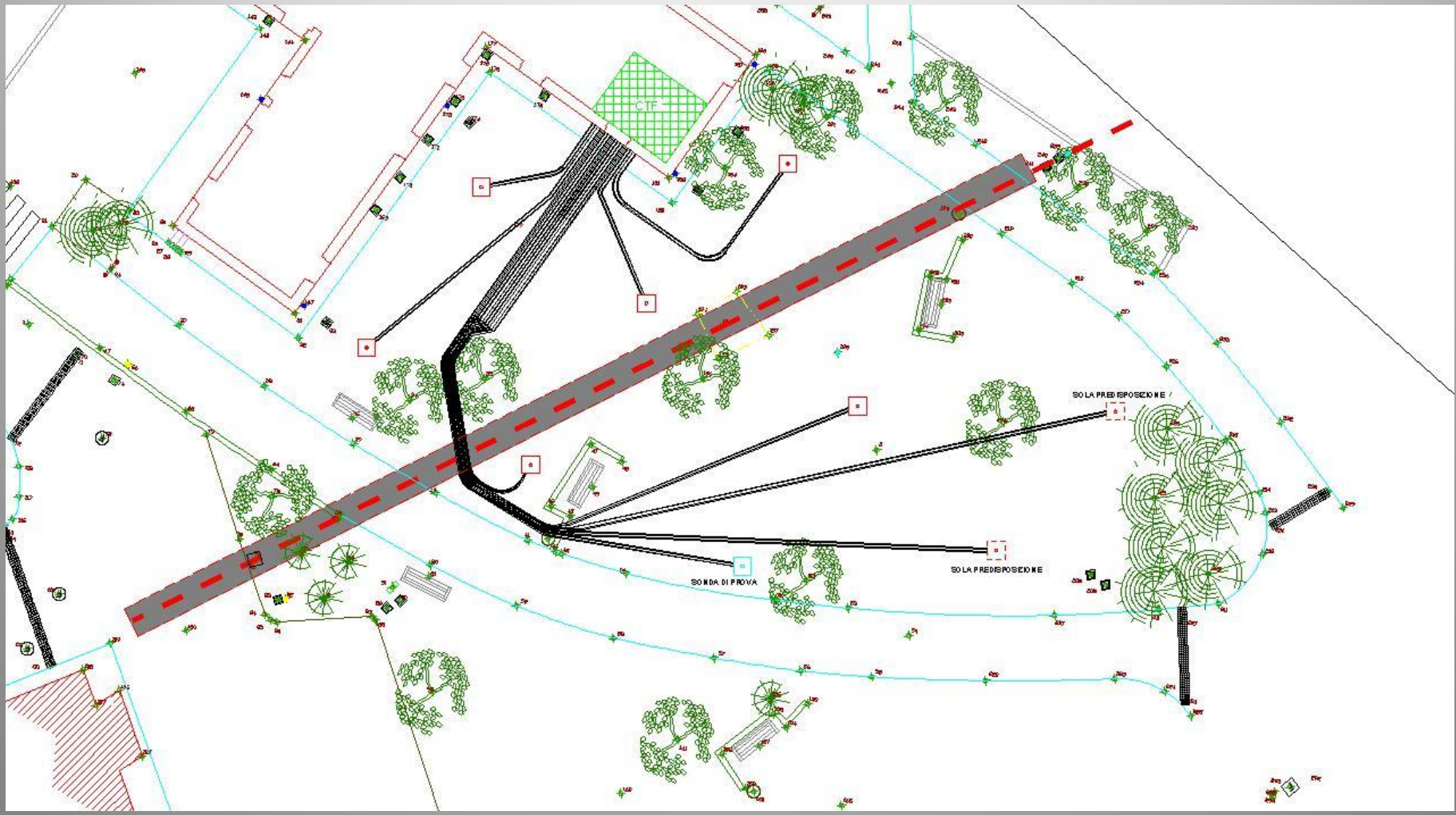
- **<u>Case n. 1</u>**
- 5 x 100 GHEs
- Twater in/out: 32 / 0 °C
- SPF = 4
- Pmax (W/S) = 43,95 / - 70,25 W/m

- **<u>Case n. 2</u>**
- 8 x 100 GHEs
- Twater in/out: 27 / 5 °C
- SPF = 5
- Pmax (W/S) = 29,30 / - 42,15 W/m

Results comparison with technical literature

Tipo di materiale	Conduttività termica [W/(m K)]	Potenza specifica assorbita (W/m) (F_{sonda} = 13 cm)
Loose rock(dry)	<1,5	20
Gravel, sand (dry)	0,4	<20
Clay, silt (wet)	1,7	30-40
Water saturated rock	1,5-3,0	50-65
Sandstone and conglomerates	2,3	55-65
Solid limestone	2,8	**45-60**
Gneiss	2,9	60-70
Basalt	1,7	35-55
Granite	3,4	55-65

Borehole heat exchangers field



AREA has focused solar cooling technologies (< 50 kWf) and strived for getting adequate funds to scale up its LID concept. This action turned up in two EU funded projects aiming at newly established international network of Open Labs focused on Solar Cooling Technologies, namely

- **Adriacold** - Diffusion of Cooling and Refreshing Technologies using the Solar Energy Resource in the Adriatic Regions
  www.area.trieste.it/opencms/opencms/area/en/projects_en/Adriacold.html

- **Emilie - Enhancing** Mediterranean Initiatives Leading SMEs to Innovation in building Energy efficiency technologies
  www.emilieproject.eu/eng/the-project.aspx

Thank you for your kind attention and we invite you to visit us in Trieste!

Trieste, 26 agosto 2014