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Energy costs division and plants modification in a large research complex: the experience of Padova National Research Council (CNR) area

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Executive summary

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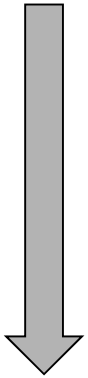
- The IGI (Istituto Gas Ionizzati) in agreement with Reserch Area, did a proposal to solve some criticalities of existing plants, in order to save energy and improve costs repartition criteria;
- Proposal was discussed involving Research Area, IGI-RFX and all the involved CNR Institutes; a final technical assessment was defined;
- Project was funded by Central CNR Administration for 83 k€;
- Works were carried out by IGI-RFX (on behalf of Reserch Area) with a final expense of 54 k€;
- The payback of this project is less than one year, with an overall costs saving for energy of around 100 k€ per year;
- Remaining amount was dedicated to centralized plants of Reserch Area (replacements of some parts to improve maintenance and reliability aspects and to allow further energy saving).

IDEA

Apr 2013



Jun 2014

End of works

Location of CNR area of Padova

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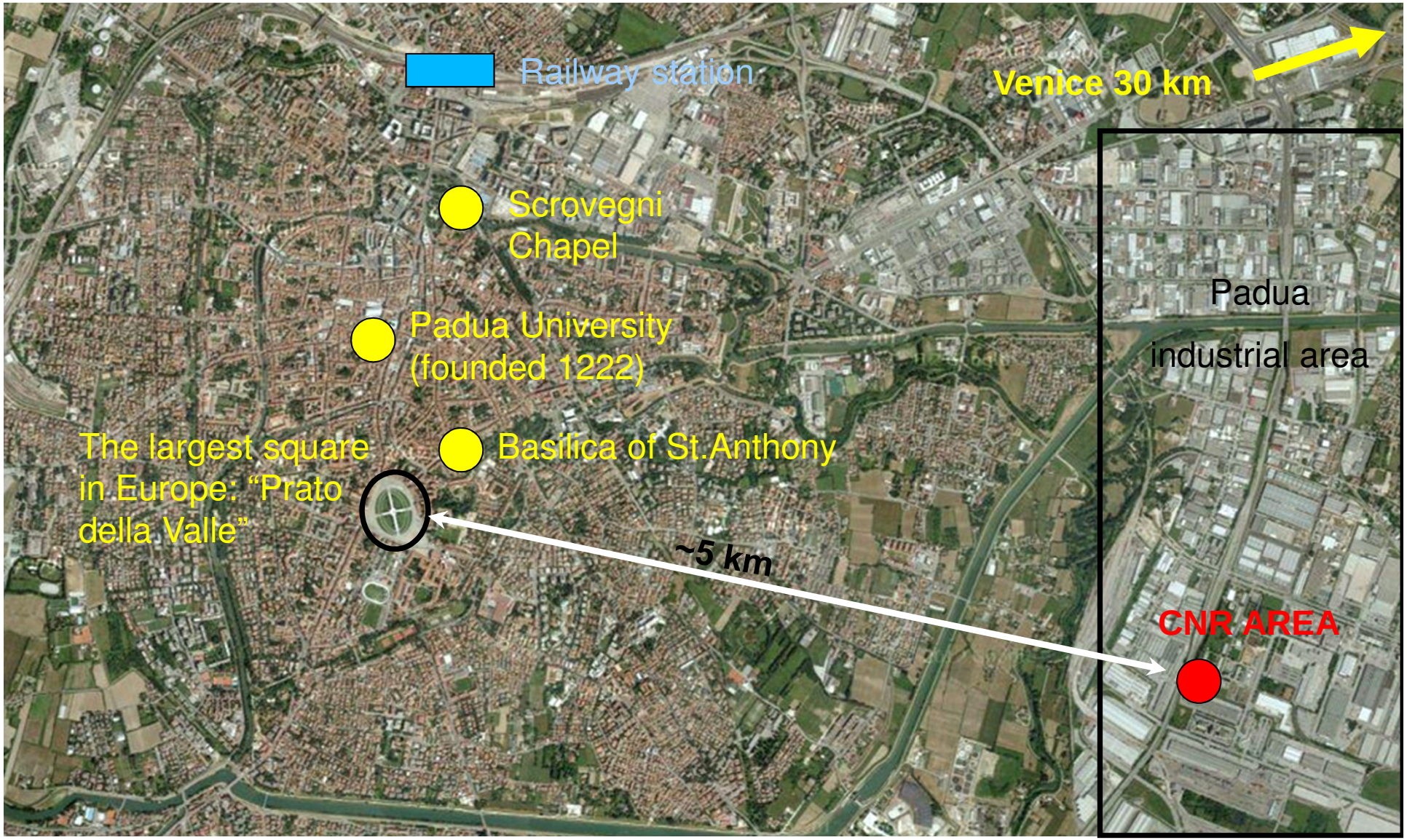

Introduction

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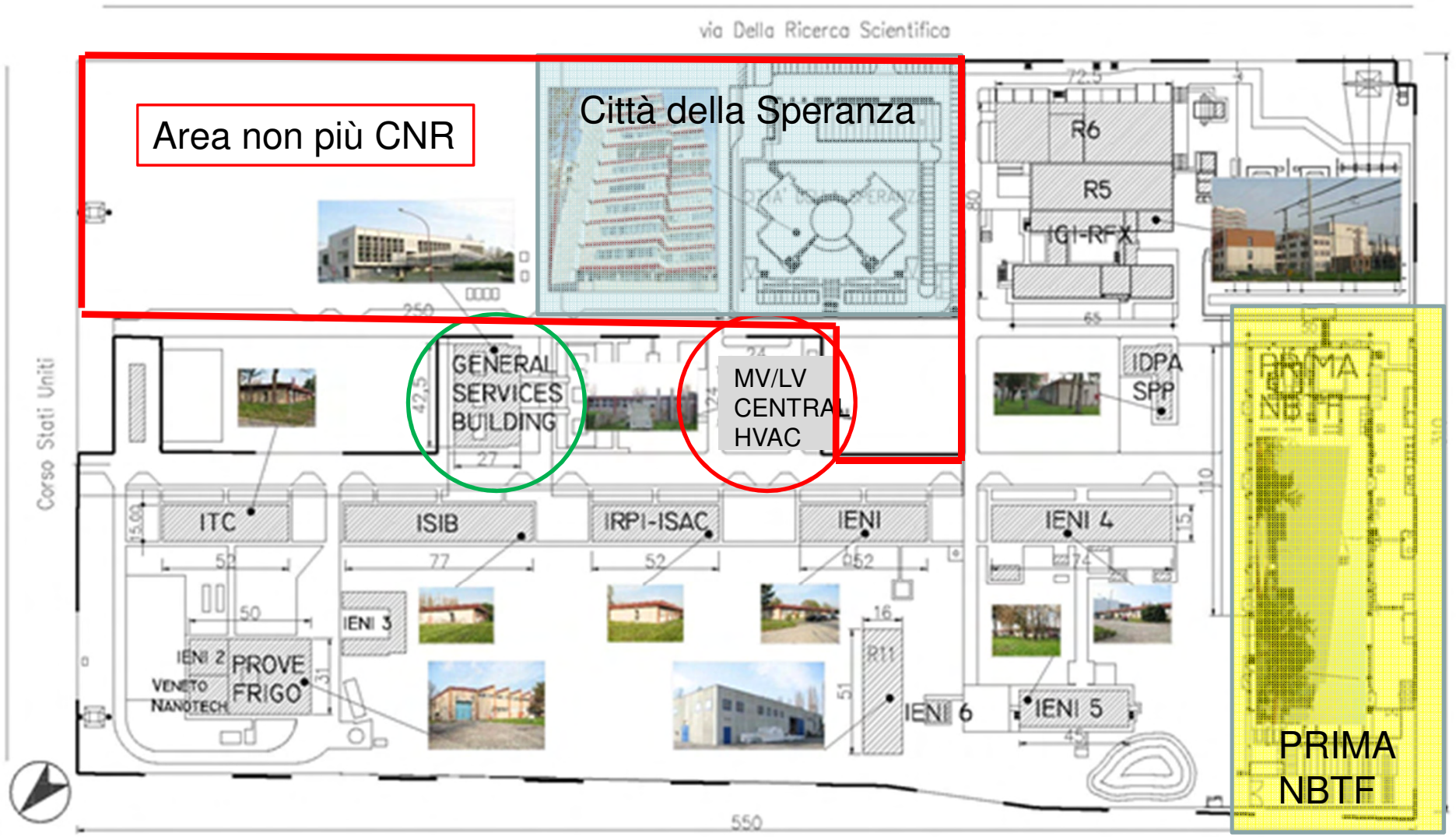
Area overview

Overall extension: 170,000 m² in the Padova industrial area (South-East);

- Many buildings built in 1970s;
- IGI-RFX built in 1980s
- Recent construction of Città della Speranza (2012) and PRIMA NBTF (2013);
- Future realization of a new laboratories building
- 20,000 m² of buildings served by centralized plants (except the last two ones)
- 227,000 m³ of methane and around 5130 MWh (except RFX experiment) the energy consumption in 2014

The current area aspect



New buildings (2012-14) supplied by independent electrical and HVAC plants

New centralized plants of PRIMA-NBTF (Sept. '15)

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2 chillers x 700 kW

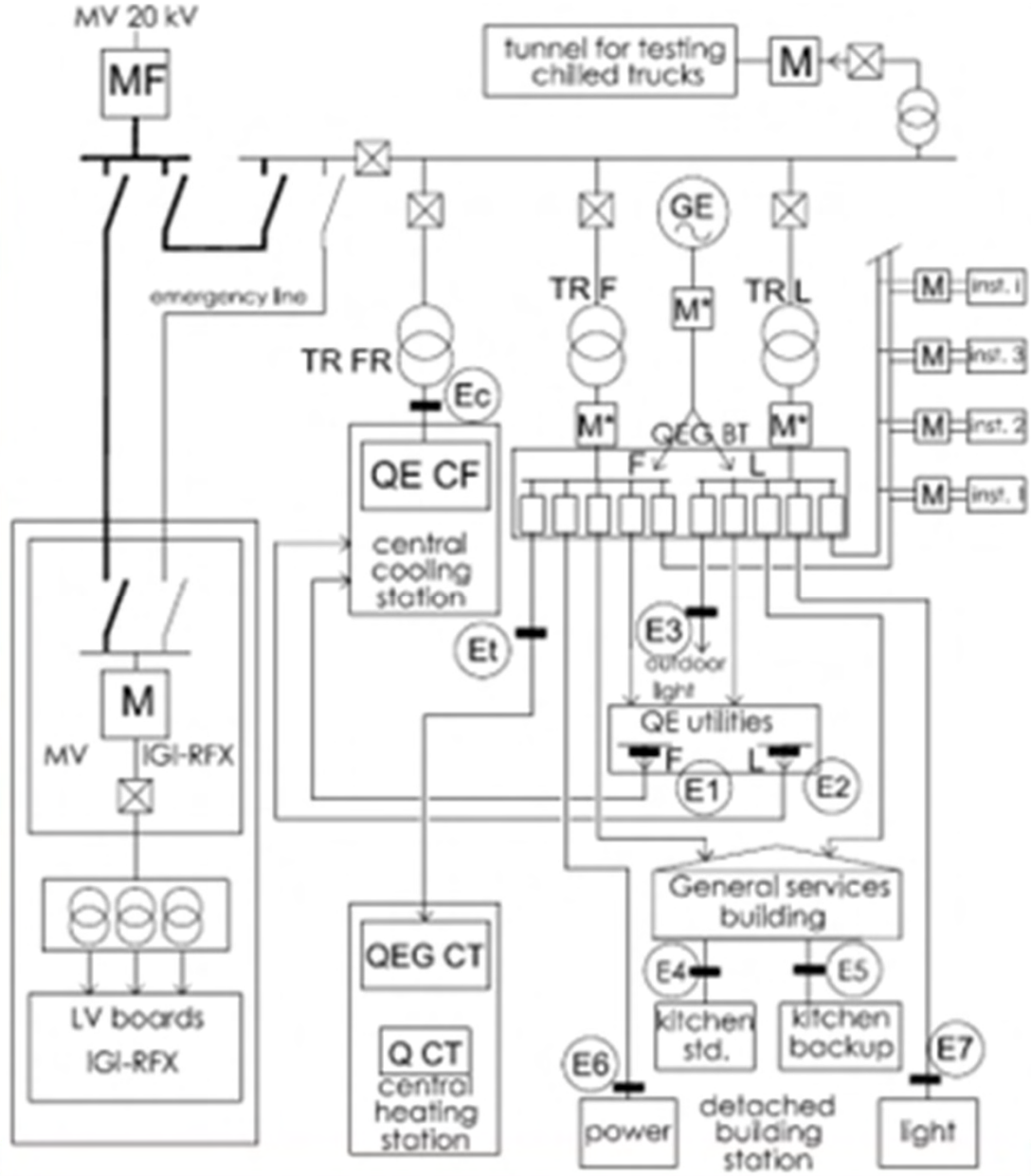
2 boilers x 350 kW

PRIMA is the test facility for the Neutral Beam Injector to be later installed on ITER site (worldwide project to demonstrate the feasibility of nuclear fusion for elec. energy production, www.iter.org). IGI is the host research Institute.

Pumps room for HVAC plants

Electrical plant scheme

- A MV supply (20 kV) is distributed to internal users;
- 800 kVA are for cooling plant, 1050 kVA for other uses, 630 kVA for ITC test facility;
- Only ITC and IGI-RFX has MV supply (other bldgs LV supply);
- MV supply for Cooling Central station;
- Energy meters (M) are installed except for the common services (e.g. centralized cooling and heating stations, general services building, outdoor light,..)



District cooling and heating scheme

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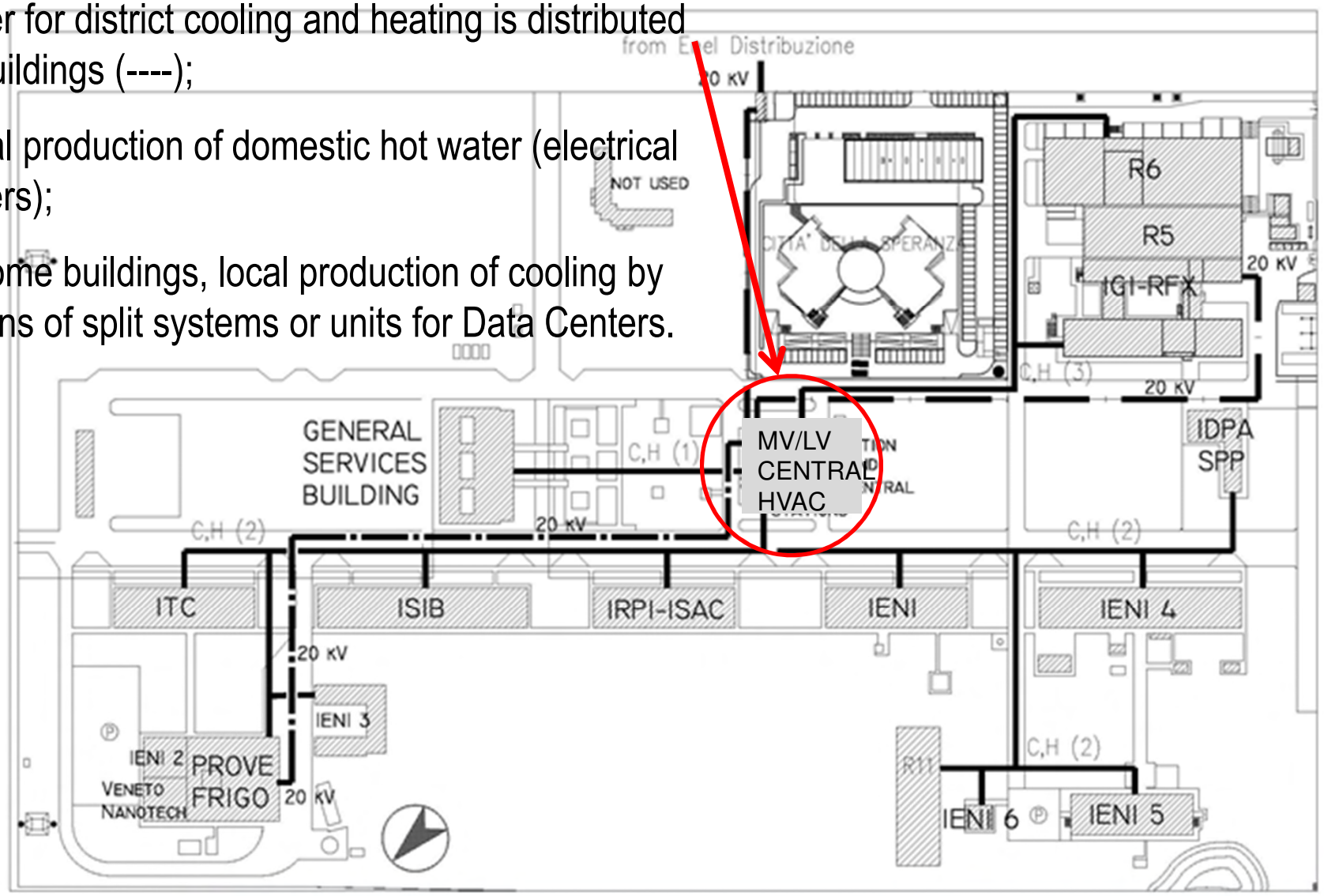
- A centralized production of chilled water and hot water for district cooling and heating is distributed to buildings (----);
- Local production of domestic hot water (electrical boilers);
- In some buildings, local production of cooling by means of split systems or units for Data Centers.



Critical aspects

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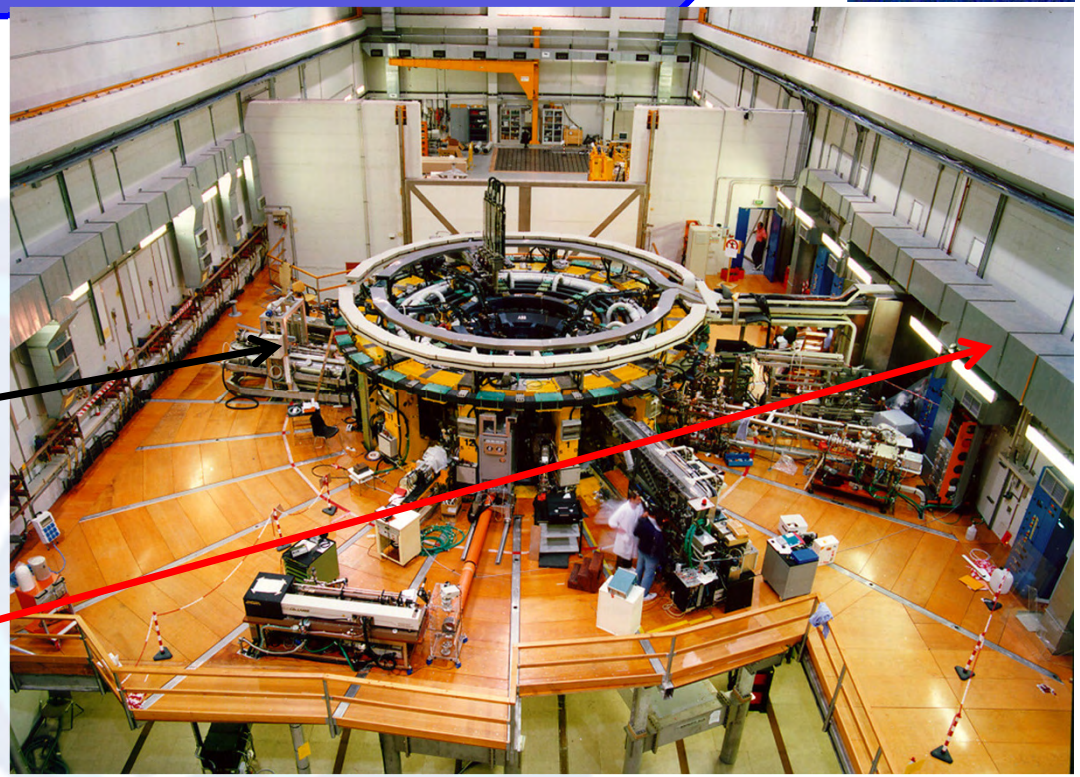
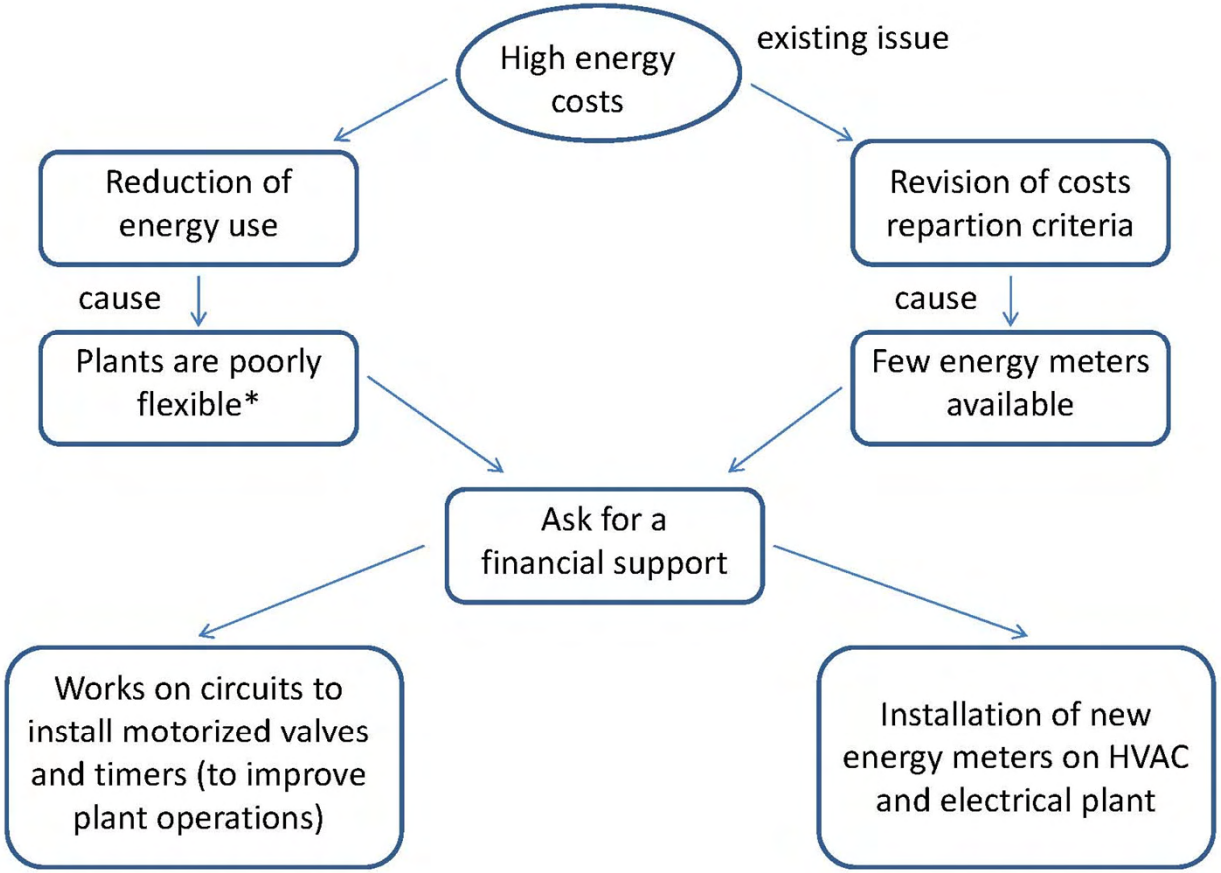
- CNR buildings (except IGI-RFX) have same plant types (primary air and fan-coils); buildings contain offices and small laboratories;
- IGI-RFX hosts a fusion machine (magnetically confined, the largest RFP in the world) with precise requirements for T and RU control (wide use of fully air conditioned rooms);
- Hot water is only required by IGI-RFX during summer (for air heating, to control RU);
- Chilled water is only required by IGI-RFX during winter (for data center and experimental devices).



Overview of critical aspects



*Circuits are not fully separated. Due to different requirements of indoor climate, IGI-RFX requires use of central plants also overnight and during weekends, when other Area Institutes could reduce energy use.

Study of solutions and implementation

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The availability of around 80 k€ permits to investigate alternative solutions:

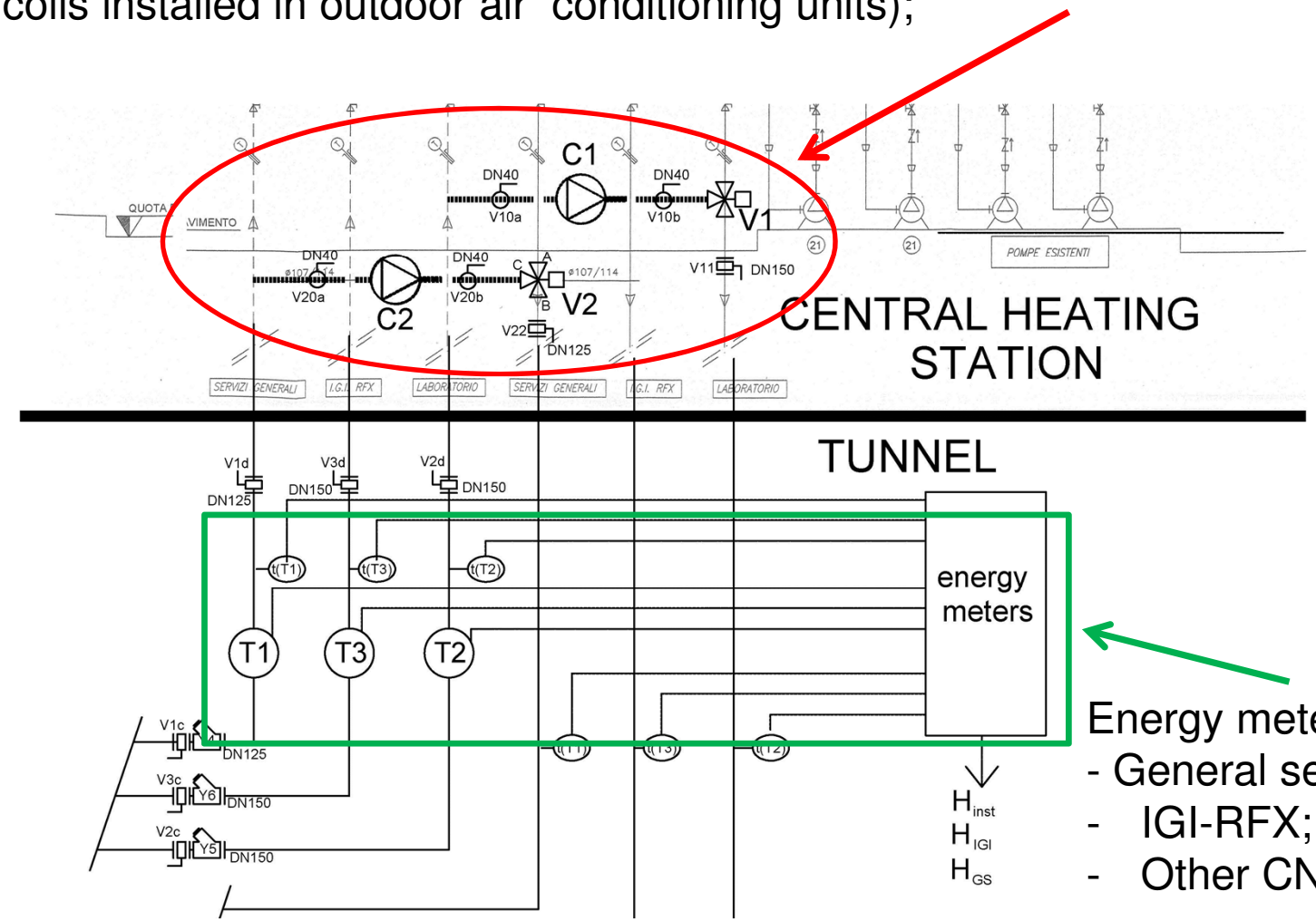
- to save energy;
- to improve the billing system (administrative aspect);
- to make the buildings users aware about own energy consumption (no best practice in energy use without knowledge… !)

The plant modifications are related to:

- Cooling and heating stations: installation of motorized valves and anti-freeze circulators; installation of energy meters;
- Electrical plants: installation of energy meters;

Modification of heating system

Anti-freeze circulators and motorized valves to maintain (when necessary) water circulation in the net without heat dissipation (IGI-RFX is always supplied due to coils installed in outdoor air conditioning units);



Energy meters for:
- General services building;
- IGI-RFX;
- Other CNR buildings

Modification of cooling system

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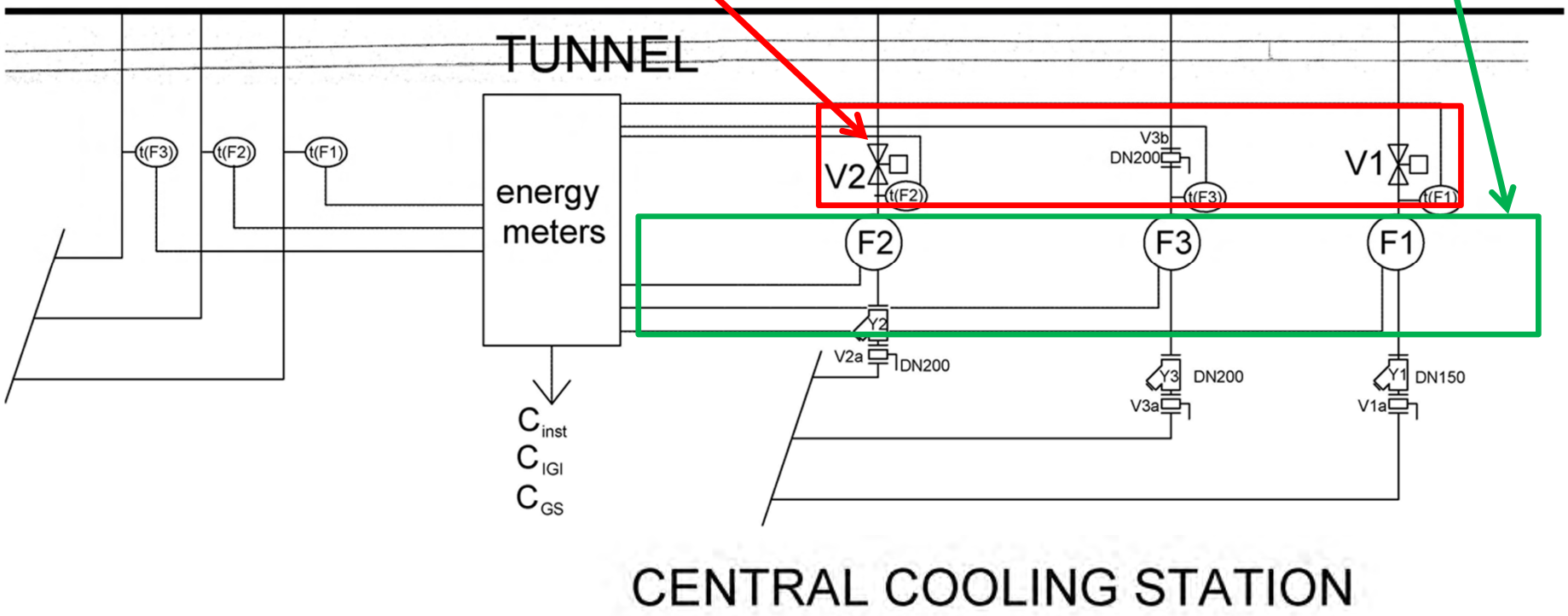
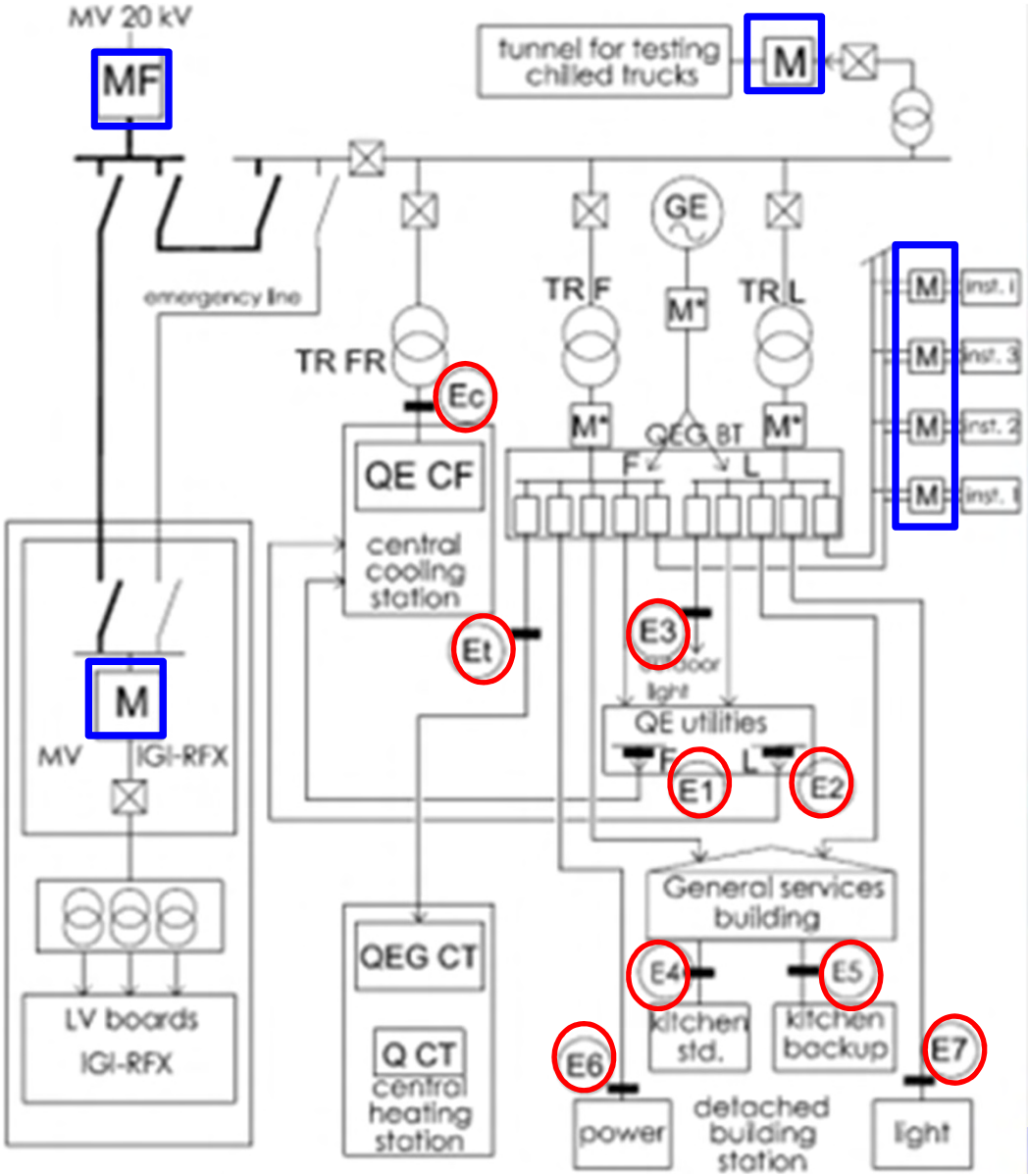
Two-ways motorized valves to avoid chilled water circulation in the net during holidays or weekend (IGI-RFX can be independently supplied)

Energy meters for:
- General services building;
- IGI-RFX;
- Other CNR buildings



Improvement of billing system on LV net



Nine new energy meters (red) added to the existing ones (blue) allow precise repartion of electrical costs of shared and common services (like central cooling and heating, general service building, outdoor lighting etc.)

Analysis of first results: cooling energy

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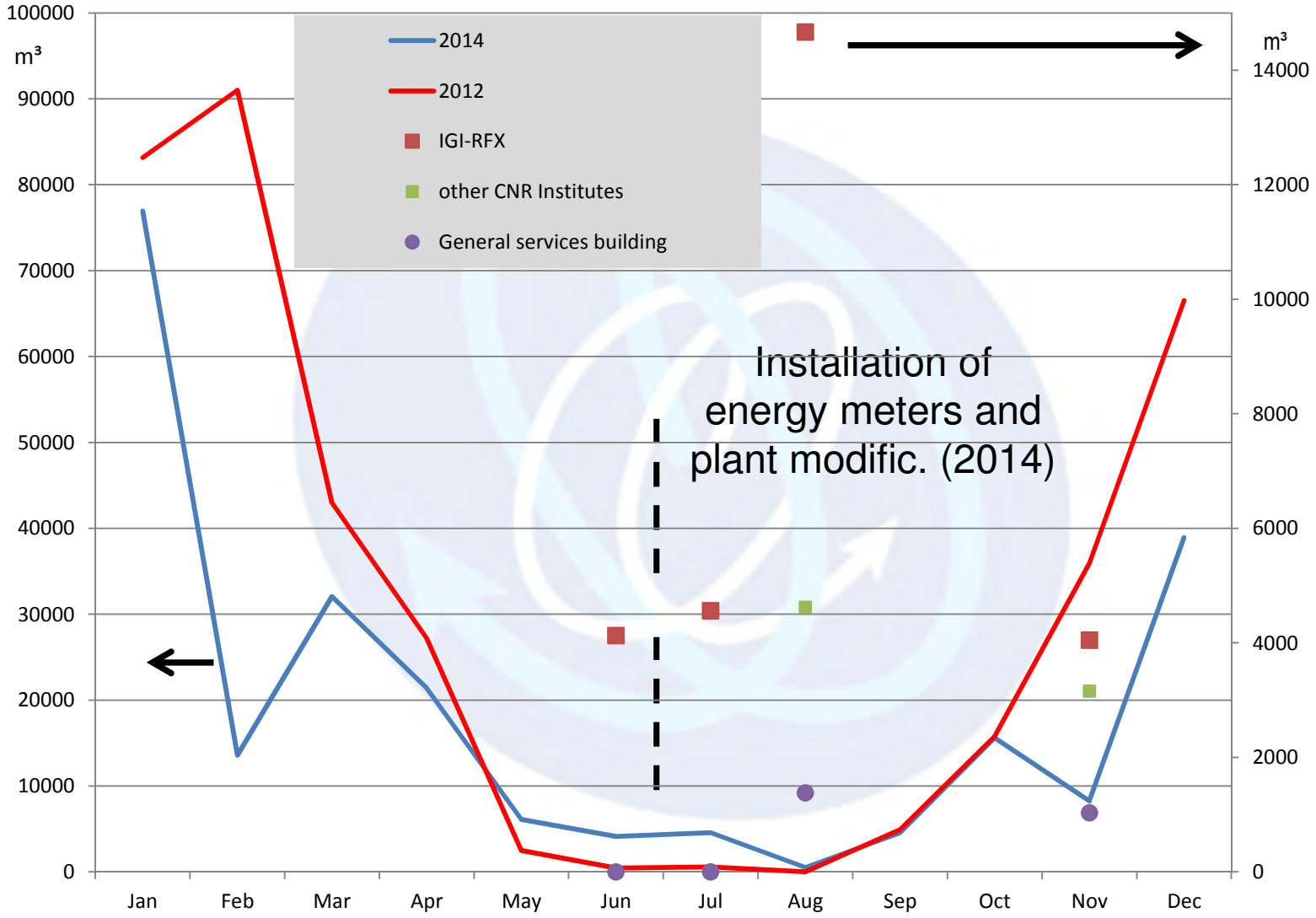
TABLE III cooling energy consumption: daily average

2014		C_{inst}	C_{GS}	C_{IGI}
from	**to**	MWh/d	MWh/d	MWh/d
1/7	**28/7**	5.19	0.45	7.13
28/7	**3/11**	1.11	0.31	6.85
3/11	**1/12**	0.00	0.00	3.08

TABLE IV specific cooling energy consumption: daily average per volume

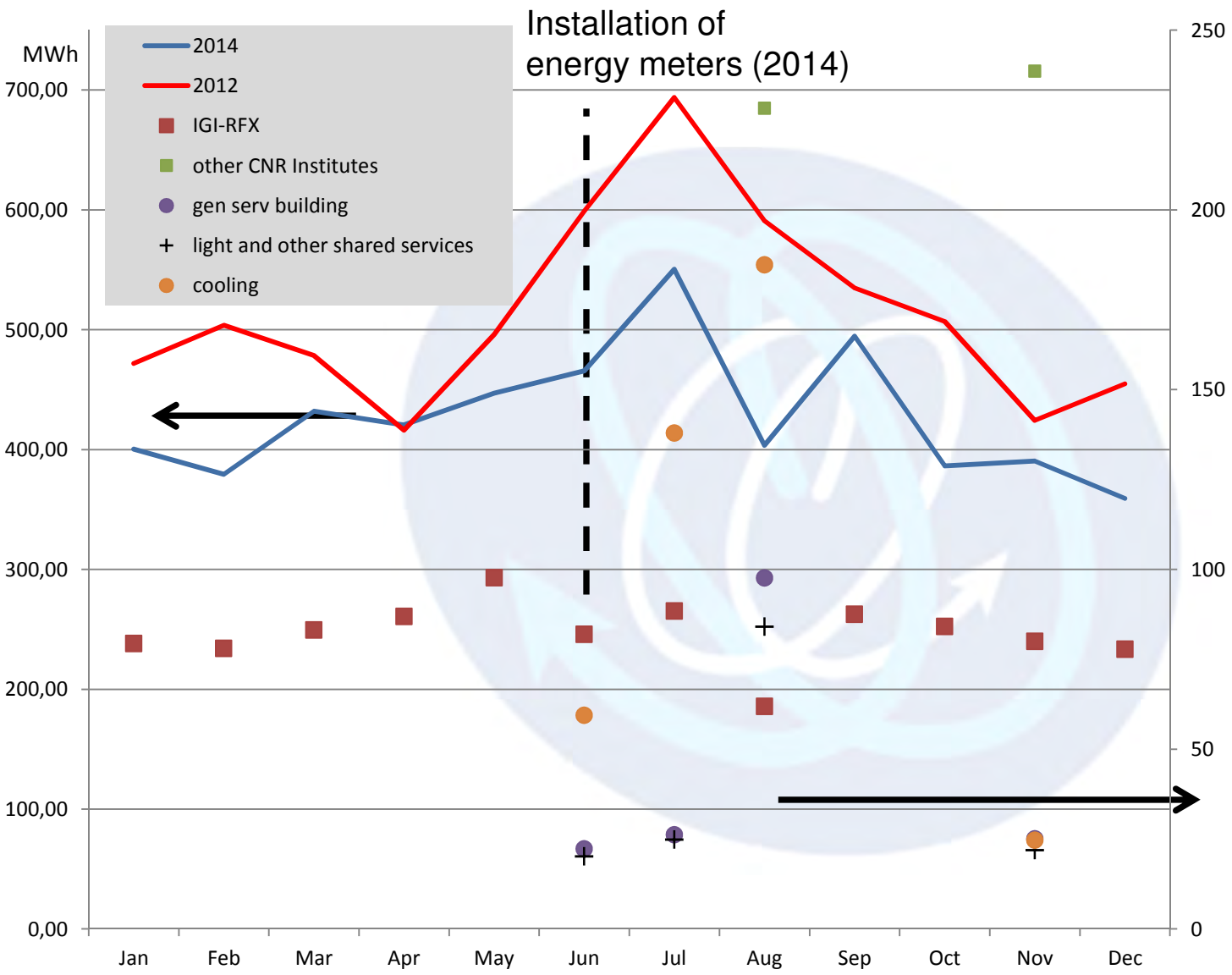
		C_{inst}	C_{GS}	C_{IGI}
volume	m^3	27500	9000	42000
from	**to**	kWh/m^3	kWh/m^3	kWh/m^3
1/7	**28/7**	0.19	0.05	0.17
28/7	**3/11**	0.04	0.03	0.16
3/11	**1/12**	0.00	0.00	0.07

Analysis of first results: thermal energy



Gas consumption distributed among the three users (2012-4)

Analysis of results: electrical energy (2014)



Low values of overall EER of central cooling station (EER around 3 in May 2015)

Results of works

- A not neglibible energy saving was observed during first year of modified plants operations;

- at least a 10% of energy saving was detected; another 5 % is expectable from the knowledge of consumed energy, that should push people to adopt better practice in buildings use;

- ~30 k€ already used to improve energy efficiency of existing centralized plants;

- analysis of acquired data is important to plan control improvement, future plant modifications and/or revamping.

Research area future changes

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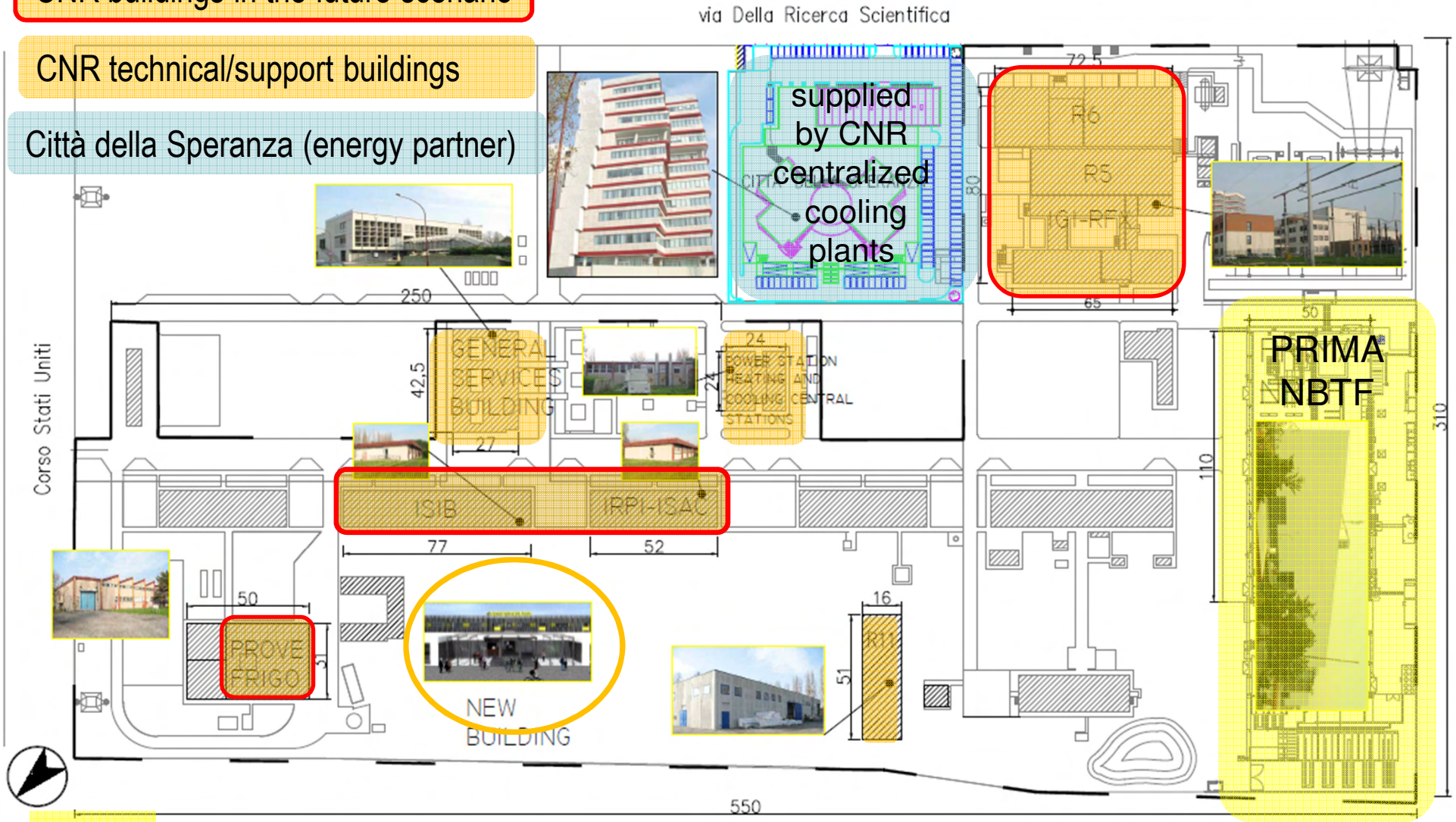
CNR buildings in the future scenario

CNR technical/support buildings

Città della Speranza (energy partner)



PRIMA is supplied by independent electrical and HVAC plants

Future perspectives and conclusions

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- Construction of a new CNR building (offices and laboratories: high efficiency building) to replace existing obsolete buildings (except general services, IRPI-ISAC,ISIB,prove frigo and IGI-RFX);
- Renovation of centralized plants: installation of ground source heat pumps (3 x 400 kW) to satisfy most amount of energy requirements; existing chillers and boilers to fulfill the energy peaks only;

- New link with “Città della speranza”

to supply chilled water for 300 kWf (Cds has a defect of cooling power);

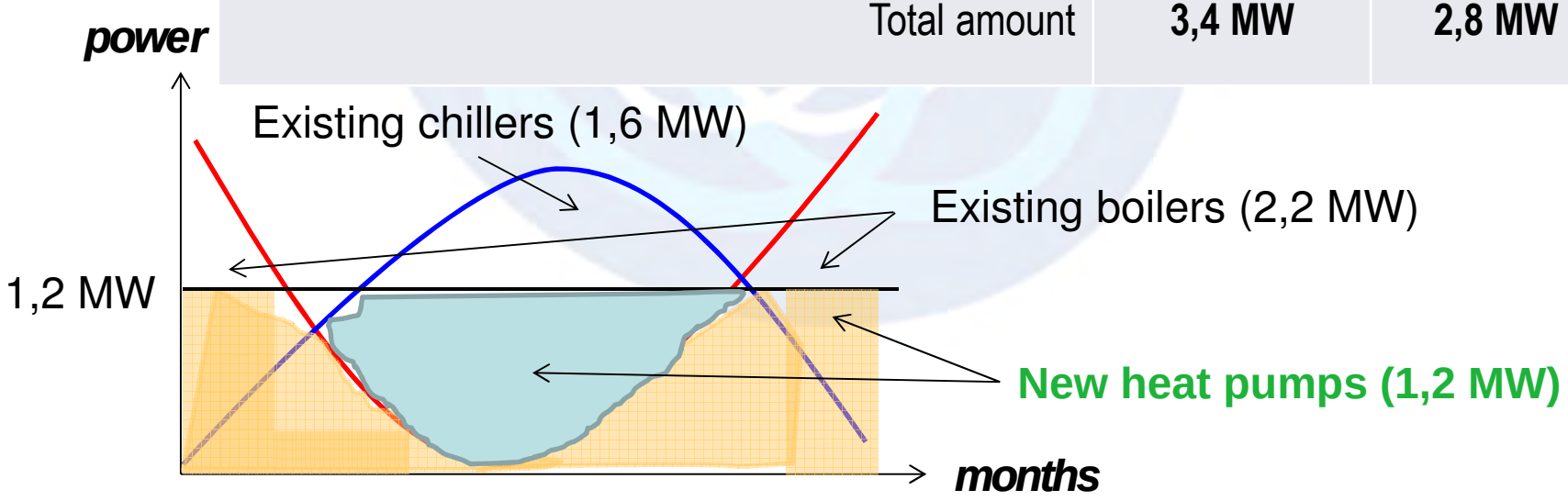
- The new situation leads to an high efficiency research area, keeping the concept of district heating and cooling but improving energy production performance with the best current technology.

Some additional concepts

Installed power (2014)	Heating (boilers)	Cooling (chillers)
CNR	3,6 MW	2,2 MW
Città della speranza	1,1 MW	0,7 MW

expected payback:
6 years !!!

Required power (2017)	Heating	Cooling
CNR new building	0,3 MW	0,6 MW
CNR (ISIB+IRPI/ISAC+IGI/RFX+prove frigo)	1,7 MW	1,2 MW
Città della speranza	1,1 MW	1,0 MW
Total amount	**3,4 MW**	**2,8 MW**



Grazie per l'attenzione !

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