



in collaboration with:



SAPIENZA
UNIVERSITÀ DI ROMA



6° UNICA GREEN Workshop

TOWARDS CARBON NEUTRAL UNIVERSITIES

2-4 May 2016, University of Rome "Tor Vergata «

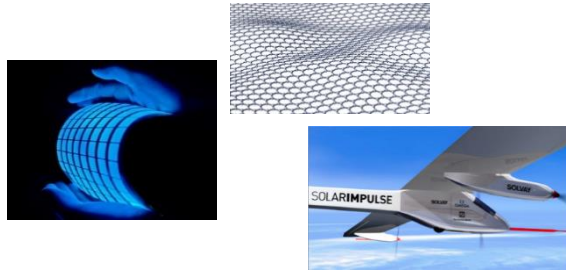
COLLABORATION STRATEGY OF THE 3 LARGE UNIVERSITIES IN ROME

Francesco Asdrubali
University of Rome " Roma TRE"

The United Nation objectives toward Sustainable Development



Possible actions



- Diffusion of Renewable Sources

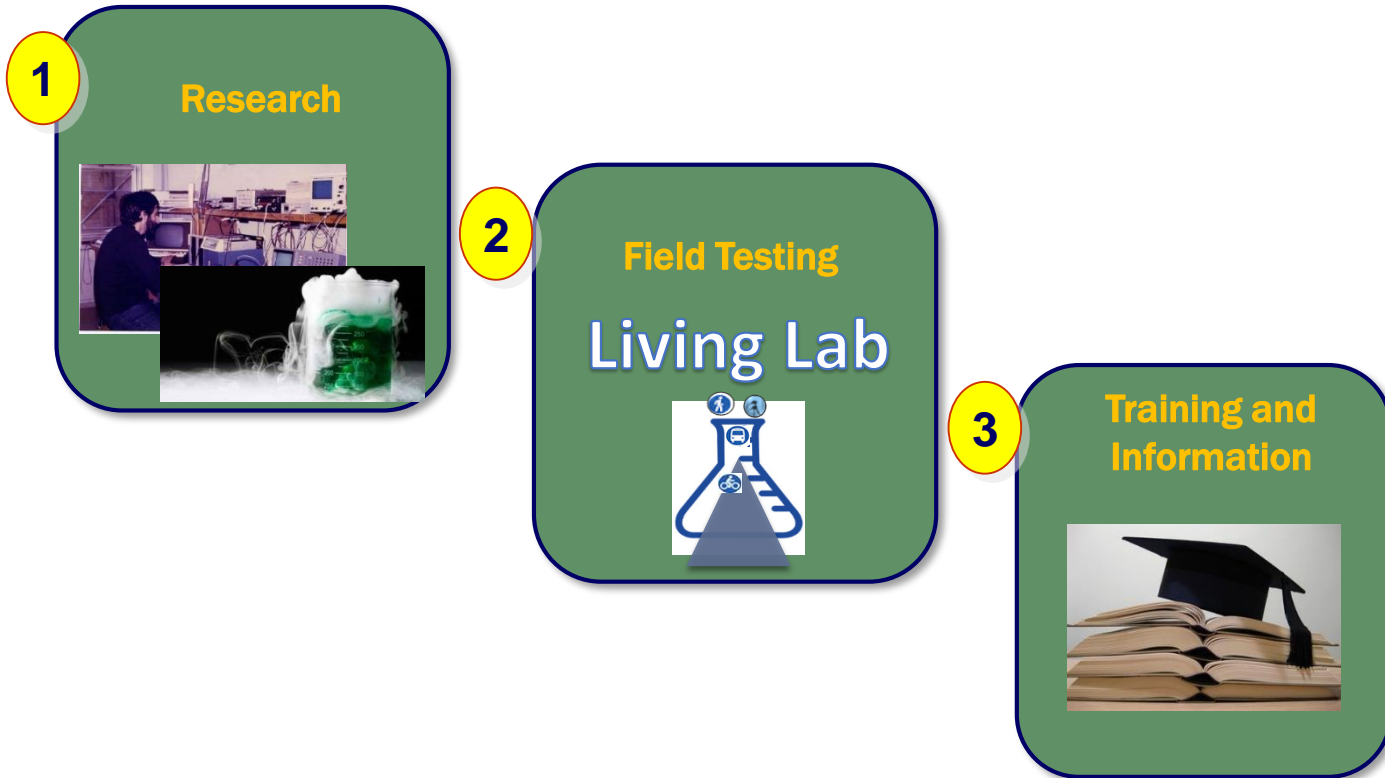


- New Technologies



- New behavioral models

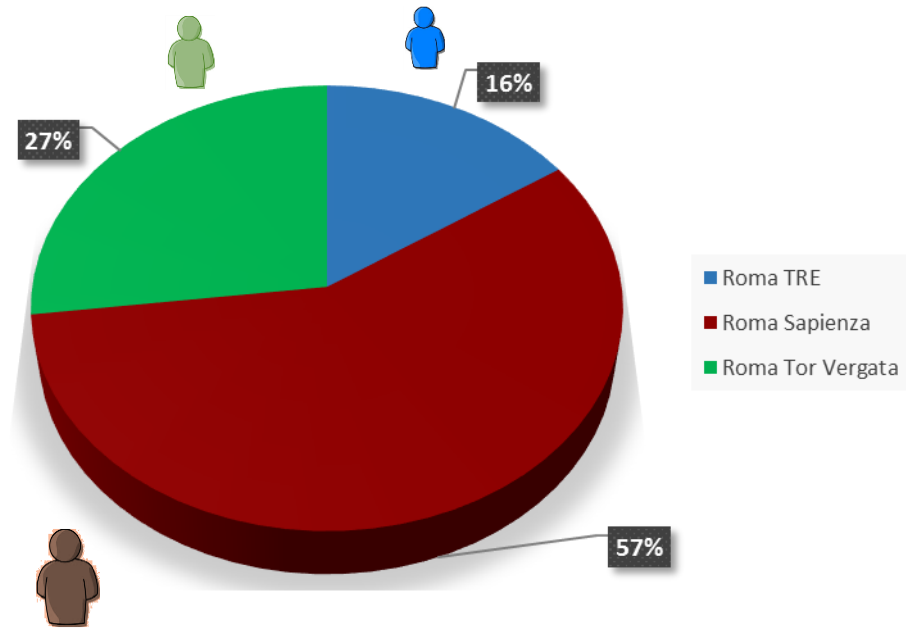
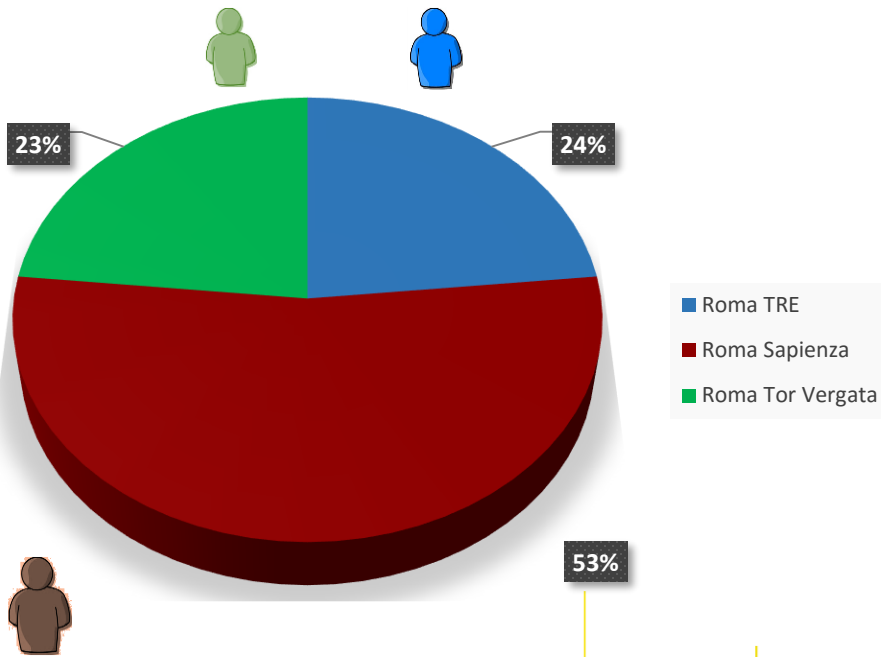
Which is the role of Universities?



The Potentiality of the three main public Universities in Rome

☐ Students: 170,000

☐ Staff (Faculties, Technician and Administration) : 9,500

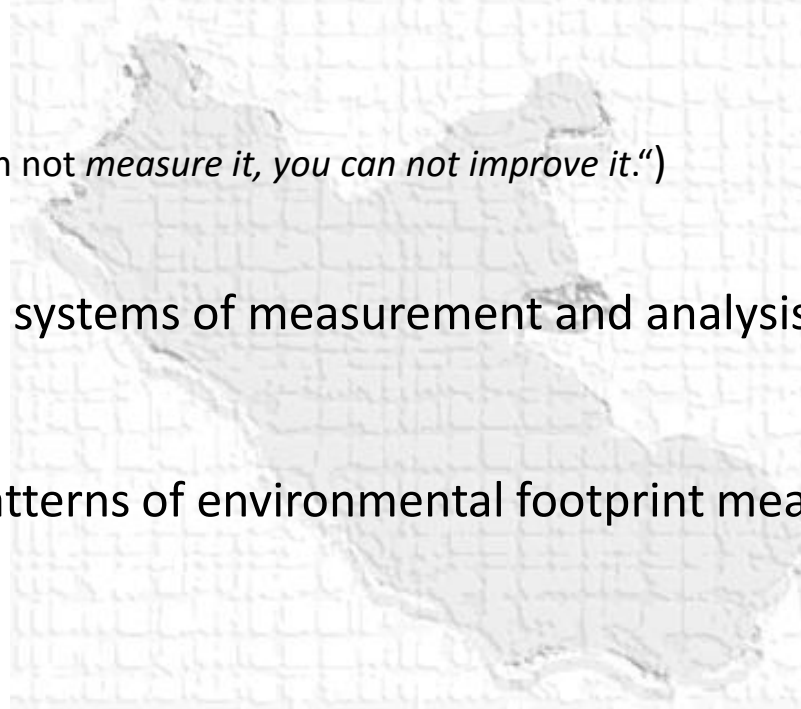


A Systemic Response

The importance of knowledge and the relevance of energy behavior analysis

(Lord Kelvin: *"If you can not measure it, you can not improve it."*)

- Advanced systems of measurement and analysis
- Shared patterns of environmental footprint measuring activities



BIG DATA ANALYSIS

Raising Awareness

❑ The student competitions

**Rhome for DenCity:
Winner of 2014 Solar Decathlon**



A Contribution for the Territory

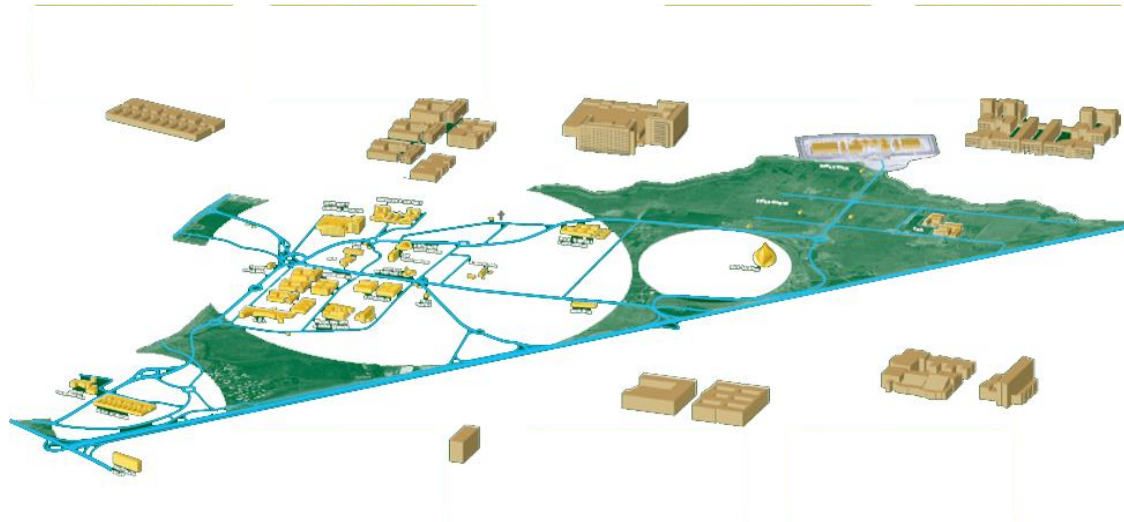
- ❑ A set of best practices and management methods
- ❑ The possibility to realize real-scale applications
- ❑ A qualified interlocutor for energy planning



The ecological footprint of Tor Vergata University Campus

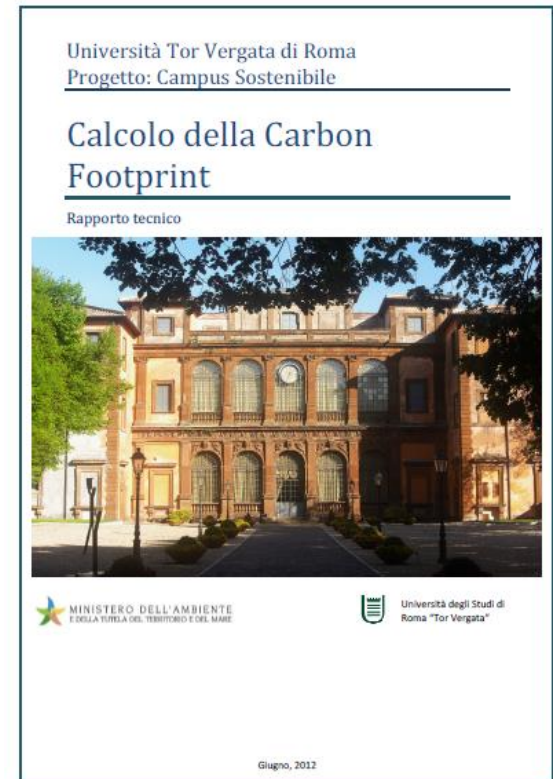


Tor Vergata University Campus

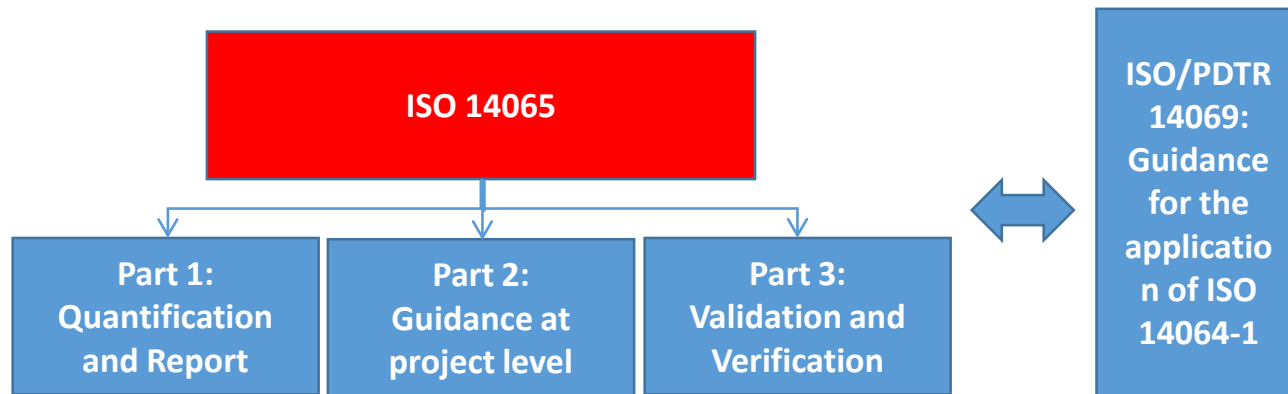


- Six schools (Law, Business and Enterprise, Engineering, Humanities, Science, Medicine)
 - **40.000** **Students**
 - 1.570 Professors and Researchers (staff)
 - 1.000 Technician and administration (staff)

- The Carbon Footprint report



❑ International Standard and Guidance



- The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (1st ed. and revised ed.)
- ISO 14064 part 1 Specific with Guidance at the Organization Level for Quantification and Reporting the Greenhouse Gas Emissions and Removals
- Draft ISO/TR 14069 Carbon Footprint for Organizations

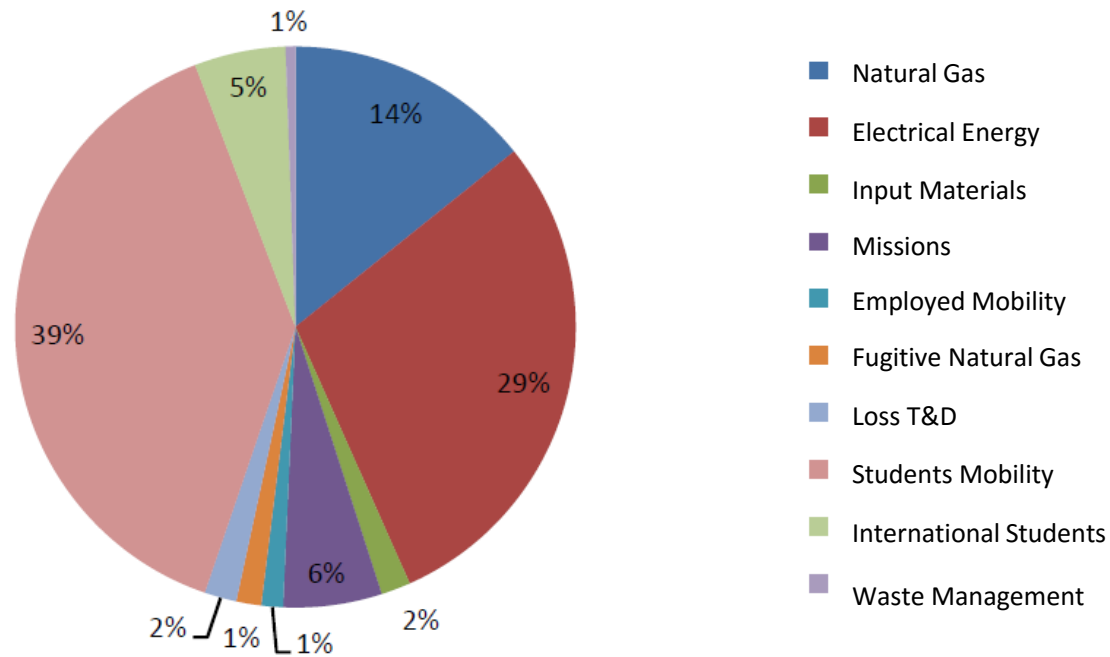
□ Certification



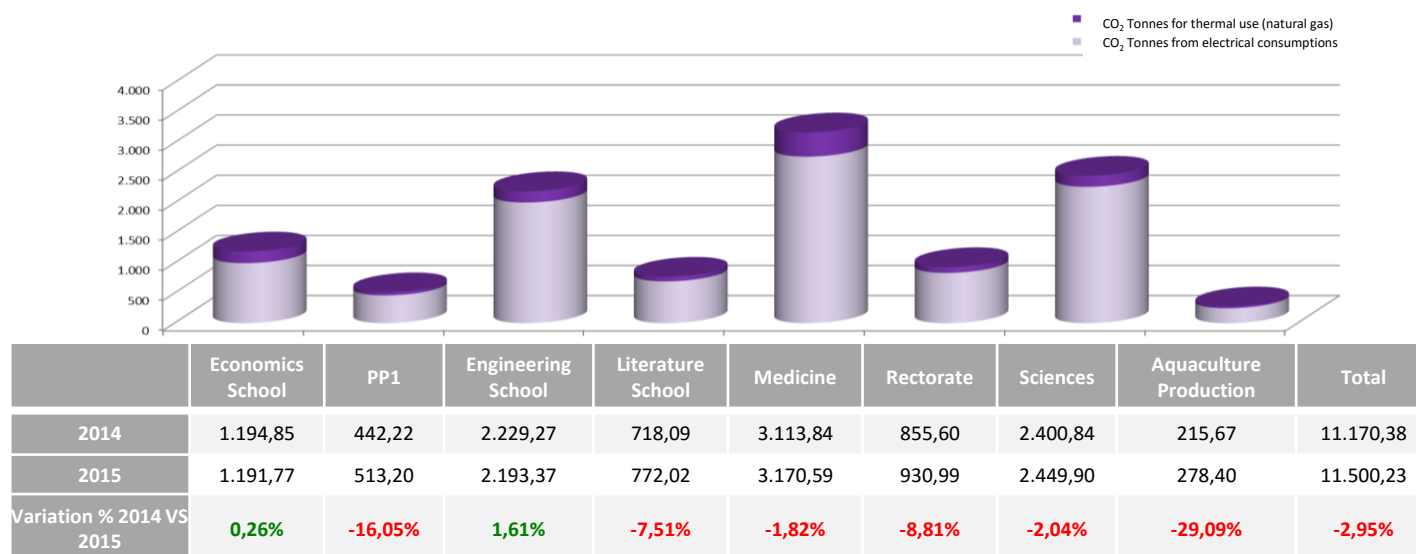
- The CF calculation have been certified by Bureau Veritas Italia S.p.A.
- Bureau Veritas Italia S.p.A. has verified :
 - the completeness, the accuracy and the coherence of the GHG emissions inventory within the defined boundaries
 - the correctness of the methodology applied to the evaluation of GHG emissions.

Tor Vergata University Campus

□ Total Emissions



CO₂ emissions from large university utilities - YEAR 2015 -

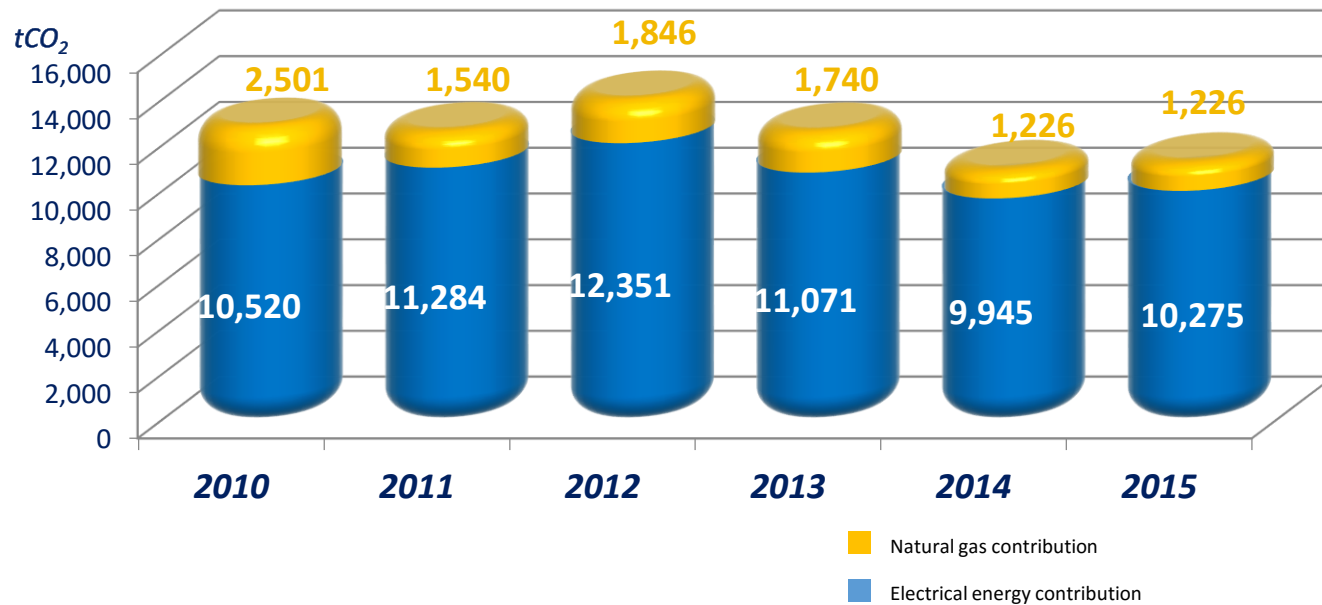


N.B. Emissions associated with the use of electricity during December 2015 were assumed coincident with those of the same month last year (assuming the same emission factor [gCO₂ / kWh] for 2014 and 2015).

Regarding the emissions from consumption of natural gas, since the total volumes of gas for the year 2015 will only be available early next year, we have assumed the emission of CO₂ equivalent to that of 2014.

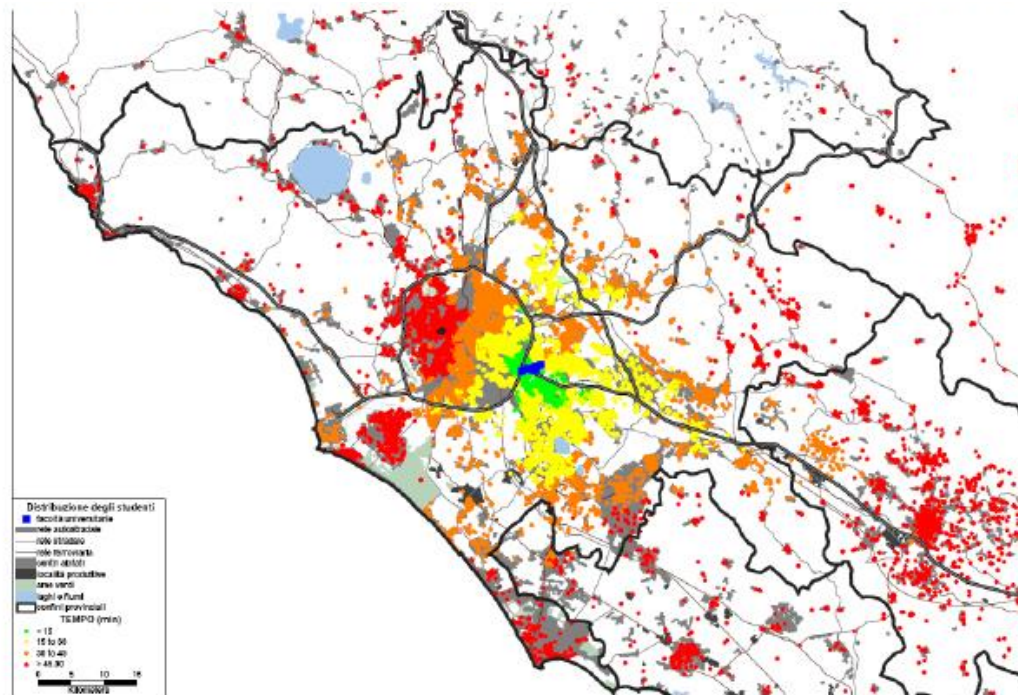
Tor Vergata University Campus

□ Historical trend of CO2 emissions from large university utilities

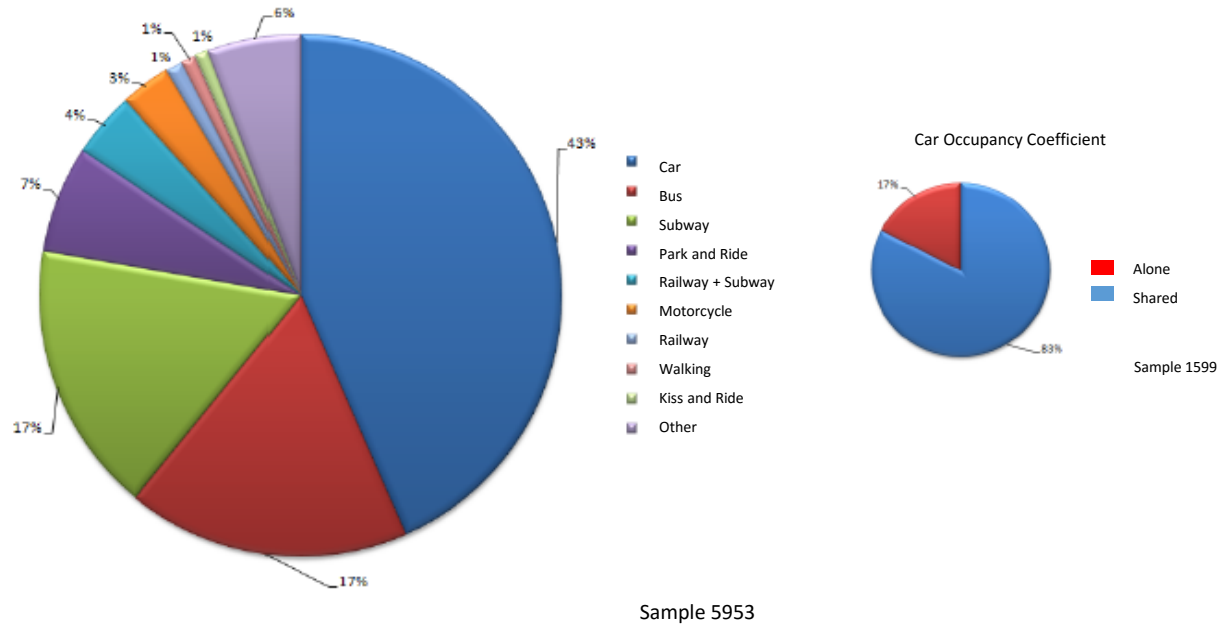


Tor Vergata University Campus

- ❑ Transportation current scenario, distribution of houses and times of access by car



❑ Transportation current scenario and distribution by transport mode



Factors that have led to CO₂ emissions reduction:

- Energy efficiency measures;
- Monitoring;
- Effective and efficient management;
- Awareness of sustainable development.

The Solar Cooling Application

“PTV” University Polyclinic



Tor Vergata University Campus

- n. 205 vacuum operated solar panels with nominal surface of $4,5 \text{ m}^2$, for a total of $922,5 \text{ m}^2$;
- n. 1 high efficiency single stage absorption cooler with a nominal cooling power of 340 kW, producing chilled water at $7\text{-}12^\circ\text{C}$;
- n. 2 evaporative cooling towers;
- n. 2 heat storage tanks for a total of 6.000 l;
- n. 1 boiler for hot water production.



☐ CO₂ avoided

- Avoided CO₂ emissions (203 gCO₂/kWh) 25,5 ton (4 months).
- Energy saved (11.628 kWh/TEP) 10,8 TEP.

The ecological footprint of Roma TRE University Campus



Roma TRE University Campus

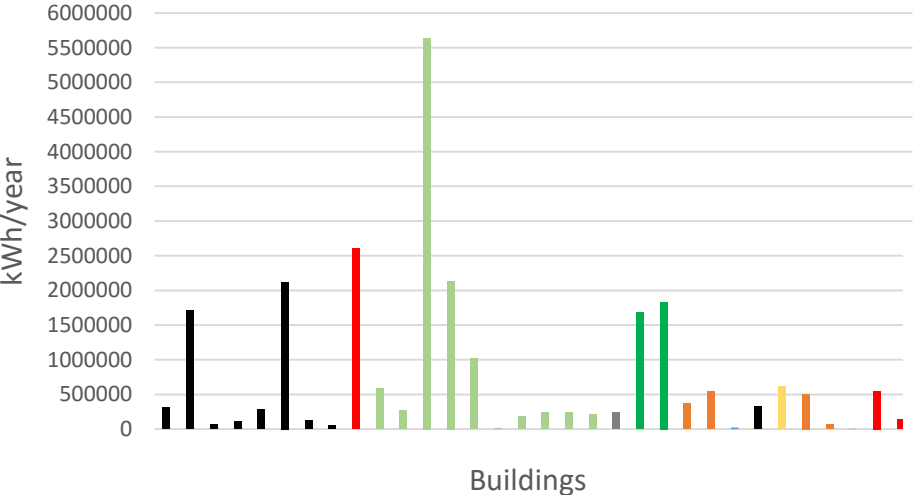
- 40.000 Students
- 830 Faculties (staff)
- 650 Technician and administration (staff)



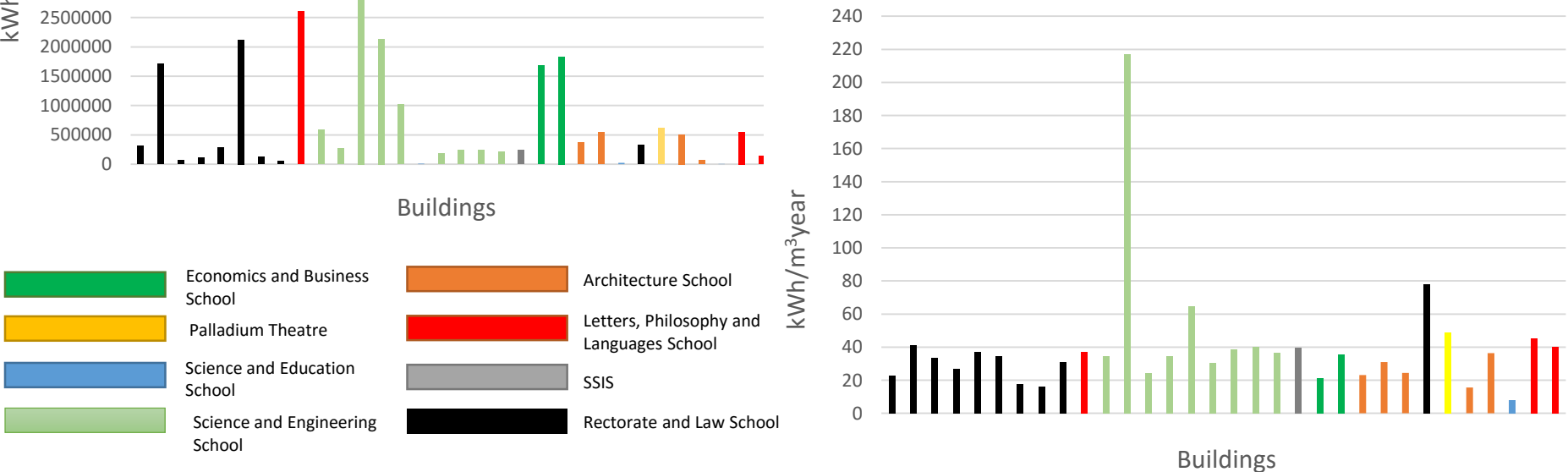
Roma TRE University Campus

Buildings Energy Needs

Yearly energy needs per building

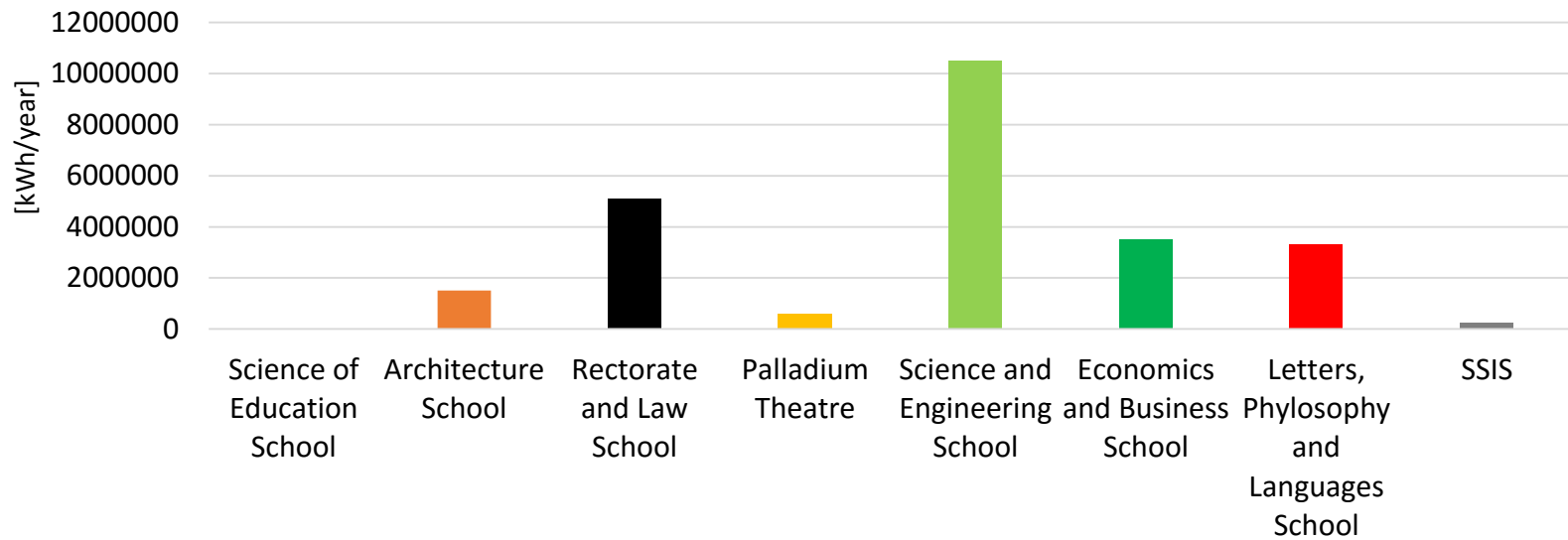


Buildings yearly energy needs per cubic meter



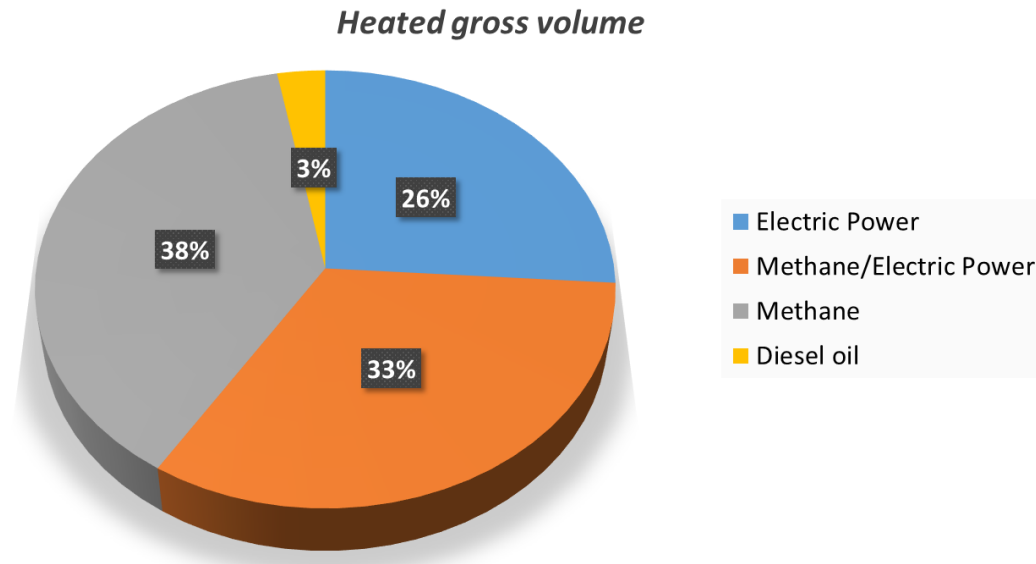
Roma TRE University Campus

Energy Needs per Year



Roma TRE University Campus

☐ Fuel supply distribution for heating and cooling calcuted over the total heated gross volume

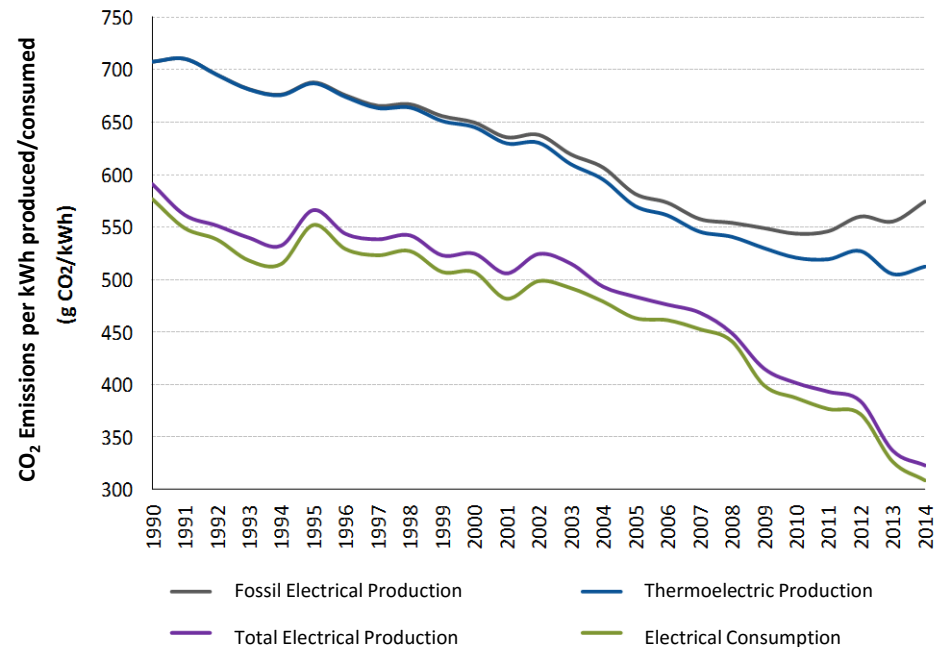


Emission Factor Trend

☐ CO₂ emission factor trend (g) for gross electrical energy production and consumed [kWh].

☐ Thermal generation also includes generation from biomass, bioliquids, and biogas. Total electricity generation including electricity generated from renewable sources.

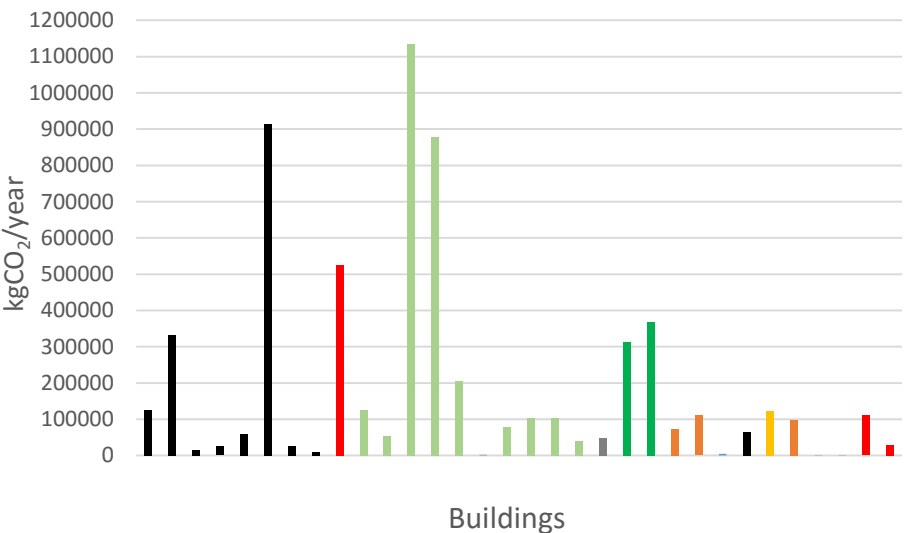
☐ Electrical consumption includes network losses, energy required by auxiliary services and the imported electricity share.



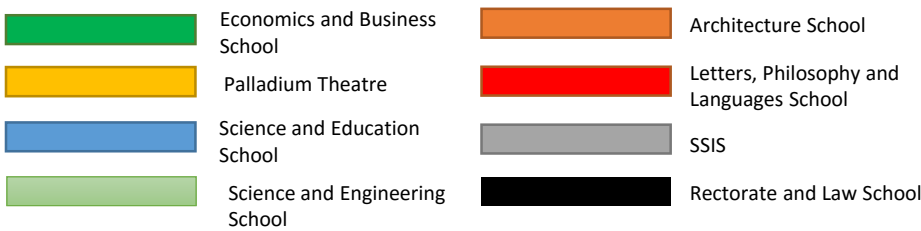
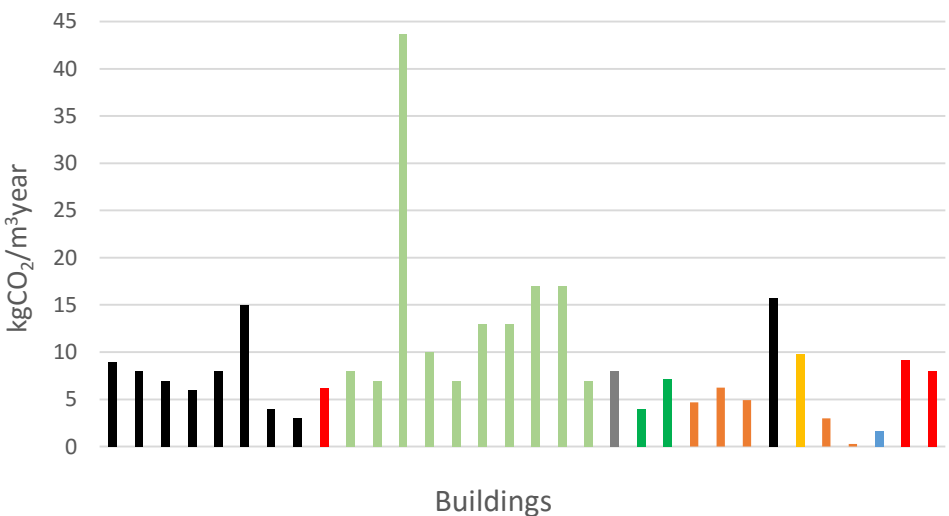
Roma TRE University Campus

Buildings Carbon Footprint

Yearly carbon footprint per building

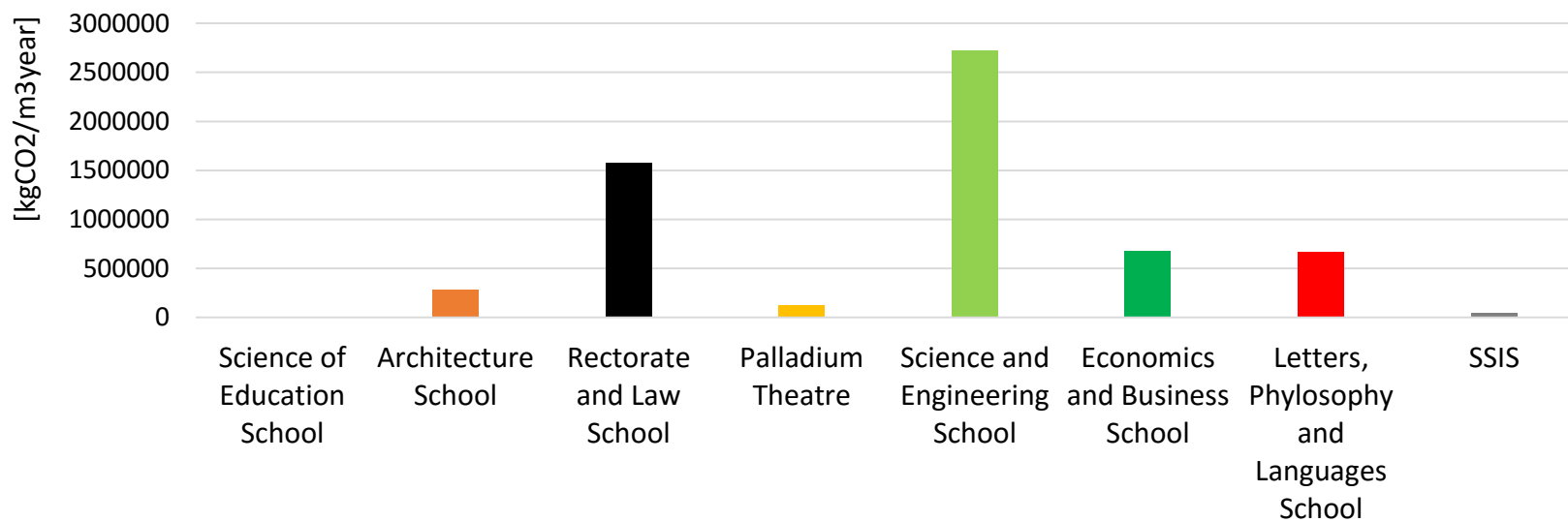


Buildings Yearly carbon footprint per cubic meter



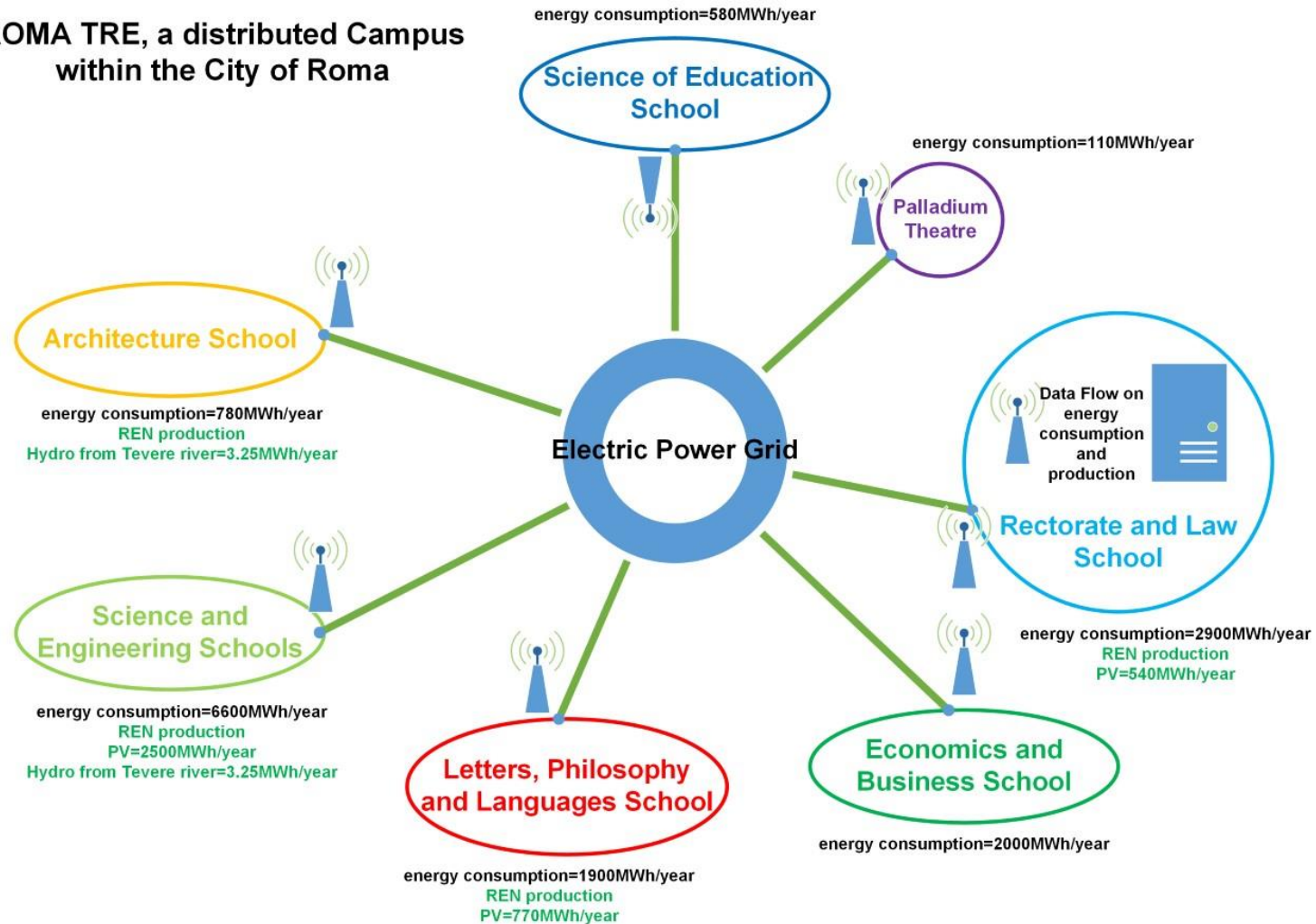
Roma TRE University Campus

Carbon Footprint per Year



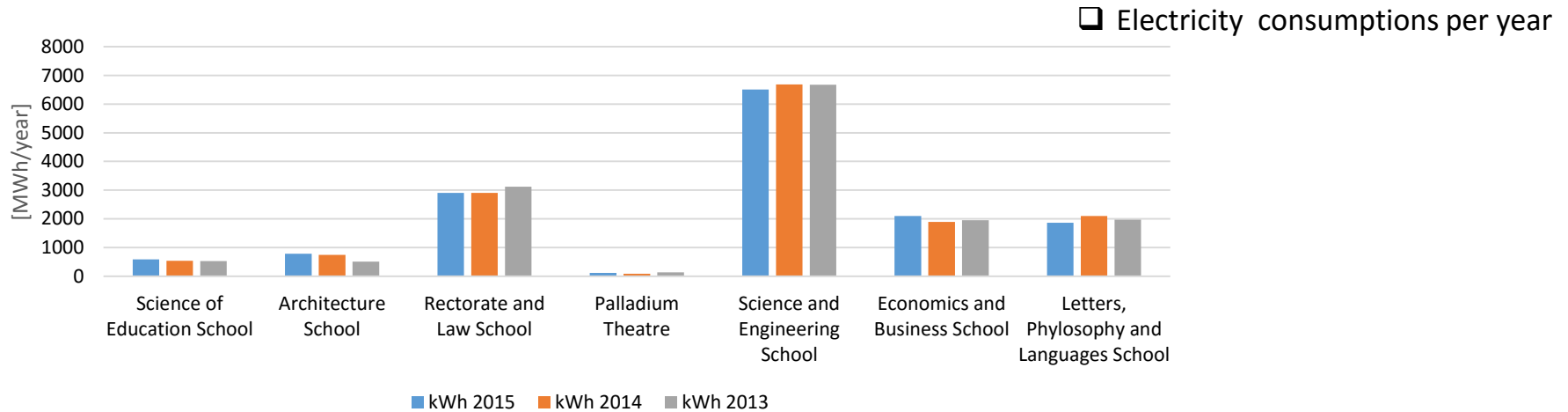
Roma TRE University Campus

ROMA TRE, a distributed Campus
within the City of Roma

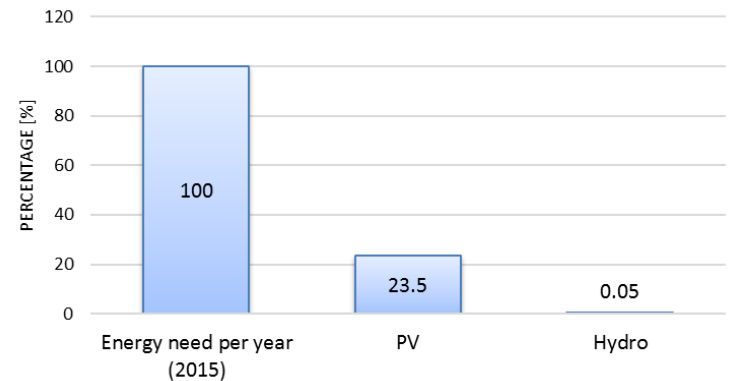


Roma TRE University Campus

Electricity Consumption and Renewable Energy Production



Renewable energy production per year compared to the total energy need over the Roma TRE Campus



Micro-Hydro propeller turbine

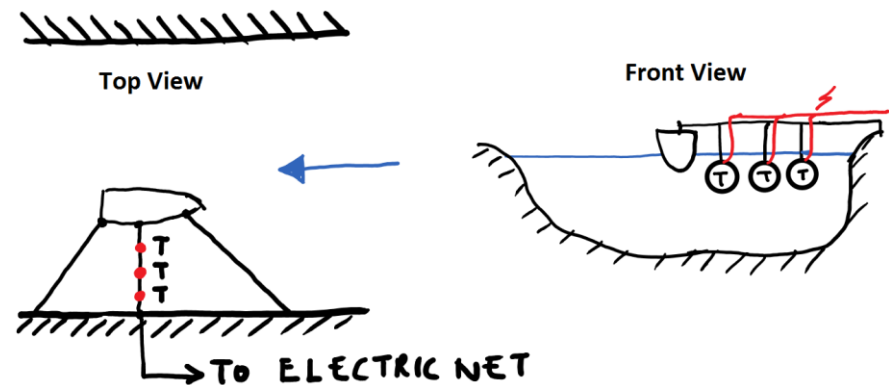


The proximity of the main buildings of Roma Tre to the river Tevere suggests the installation of micro-hydro propeller turbines.

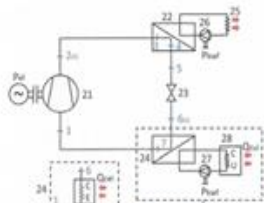
These are very simple and small machines, whose installation is totally environmental friendly, from all points of view. The installation can be removed quickly, if necessary.

This machine can be completely immersed in flowing water, no infrastructures are required for its installation. Up to 140W can be produced by the single propeller. The electric production occurs if the flow velocity is greater than 1m/s and increases with the velocity.

A possible configuration foresees a moored boat and a beam, whose extremities lay on the boat and the bank. A row of N turbines is supported by the beam. The obtainable electric power is up to $N \times 140W$.



ROMA TRE HEAT PUMP PLANT ENERGY CONSUMPTION IMPROVEMENT

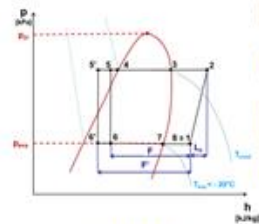


$$CP \approx 14W = 10MW$$

$$CP = \dot{m}_c \cdot F$$

$$P_c = \dot{m}_c \cdot L_c = CP \cdot L_c / F = CP / COP$$

$$COP = F / L_c$$

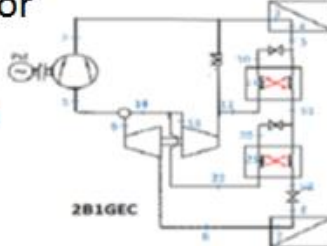


$$CP = \text{Const}$$

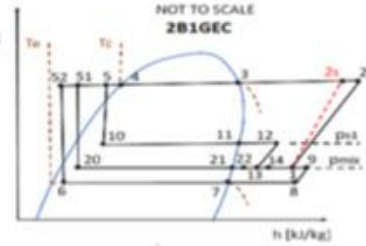
$$F' > F \quad P_c' < P_c$$

$$\dot{m}_c' < \dot{m}_c \quad COP' > COP$$

cycle
modification for
performance
improvement



2a



2b



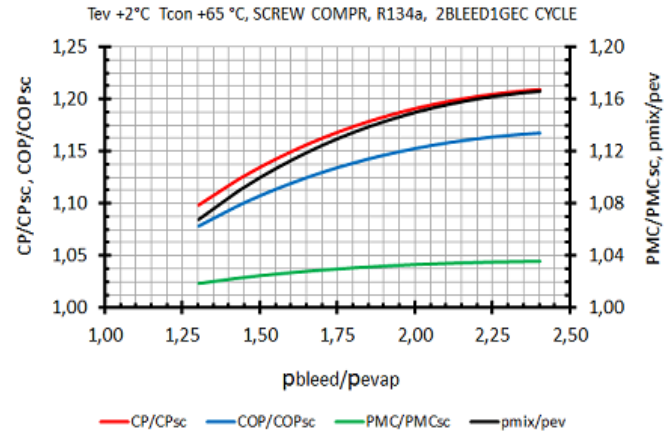
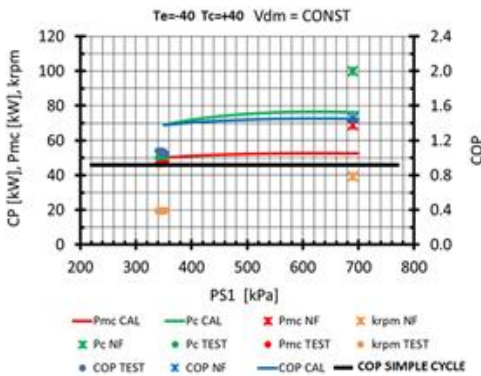
Compressor wheel, front and rear disks



machinery

experiments

AIR CONDITIONING PLANT ENERGY
SAVING FORECAST 17%



The ecological footprint of Roma Sapienza University Campus



Roma Sapienza University Campus



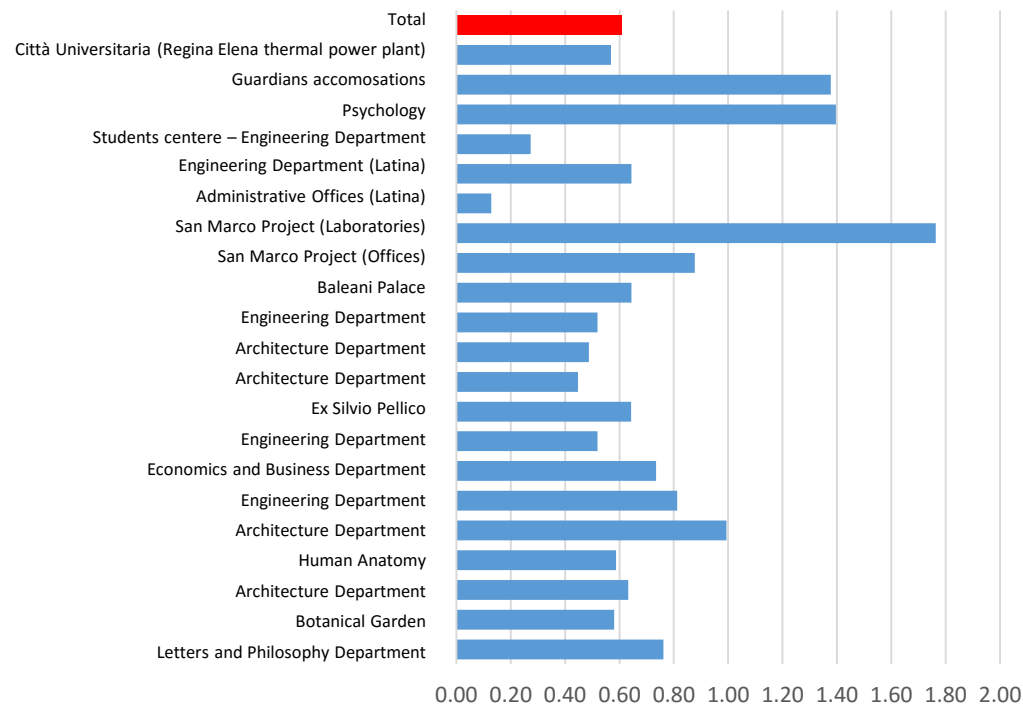
- 91.000 Students
- 3579 Faculties (staff)
- 1900 Technician and administration (staff)

❑ Total and specific natural gas consumptions

BUILDING	CONSUMPTION 2014_2015	VOLUME	SPECIFIC CONSUMPTION
	Nm3	m3	Nm3/m3
Letters and Philosophy Department	30.007	39.400	0,76
Botanical Garden	6.212	10.700	0,58
Architecture Department	33.817	53.500	0,63
Human Anatomy	27.221	46.300	0,59
Architecture Department	14.322	14.406	0,99
Engineering Department	5.431	6.684	0,81
Economics and Business Department	109.843	149.600	0,73
Engineering Department	17.905	34.500	0,52
Ex Silvio Pellico	19.934	30.984	0,64
Architecture Department	12.075	27.000	0,45
Architecture Department	11.450	23.500	0,49
Engineering Department	87.853	169.200	0,52
Baleani Palace	17.335	26.900	0,64
S. Marco Project (Offices)	10.621	12.100	0,88
S. Marco Project (Laboratories)	1.764	1.000	1,76
Administrative Offices Latina	2.804	21.800	0,13
Engineering Department Latina	7.892	12.250	0,64
Students center – Engineering Department	1.066	3.900	0,27
Psychology Department	69.242	49.600	1,40
Guardians accomosations	10.308	7.482	1,38
Città Universitaria (Regina Elena thermal power plant)	624.067	1.096.726	0,57
Total	1.121.168	1.837.532	0,61
Total (TEP)	919		

Roma Sapienza University Campus

□ Gas consumptions per cubic meter [Nm^3/m^3]



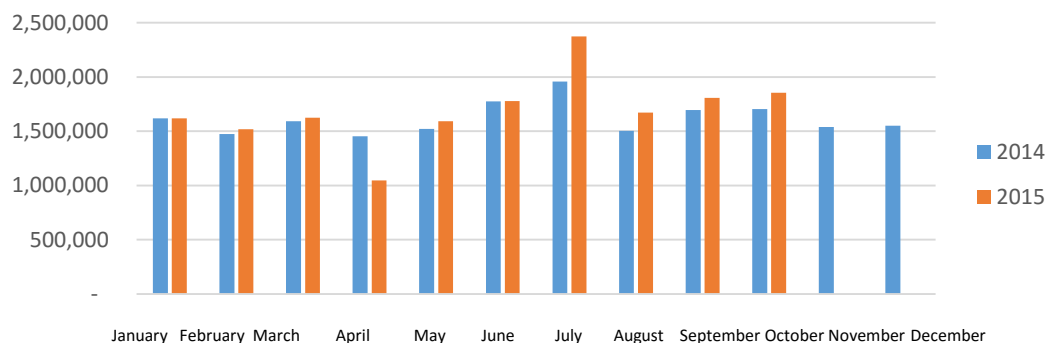
❑ Total and specific electrical consumptions

CITTA' UNIVERSITARIA					OTHER BUILDINGS		
	2014	2015				2014	2015
January	1.619.615	1.618.773			January	1.264.121	1.300.098
February	1.474.807	1.517.113			February	1.107.056	1.231.574
March	1.591.081	1.623.494			March	1.177.955	1.278.351
April	1.453.170	1.045.787			April	984.852	1.457.392
May	1.520.133	1.591.678			May	1.001.176	1.113.873
June	1.774.244	1.778.017			June	1.257.398	1.261.427
July	1.958.525	2.373.854			July	1.383.709	1.610.665
August	1.502.792	1.671.399			August	998.946	1.023.676
September	1.693.811	1.807.752			September	1.229.324	1.316.659
October	1.704.501	1.853.742			October	1.163.416	1.280.302
November	1.539.706				November	1.093.061	
December	1.550.137				December	1.174.205	
TOT	19.384.536	kWh			TOT	13.837.233	kWh
Volume	1.104.568	m3			Volume	899.861	m3
Specific consumption	17,5	kWh/m3			Specific consumption	15,4	kWh/m3
TEP	4.458				TEP	3.183	

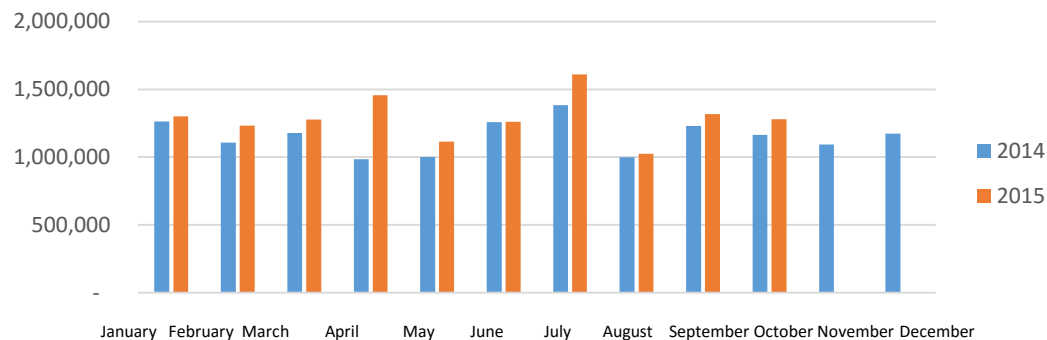
Roma Sapienza University Campus

☐ Total electrical consumptions [kWh]

University Campus «Città Universitaria»



Other Buildings



Conclusions

- Energy efficiency is paramount
- Electric heating and cooling leads to a reduction of the carbon footprint, due to the increasing amount of green electricity in the grid
- Transportation is a very significant contribution
- Prioritization is fundamental
- The three public Universities in Rome have started a collaboration in order to share methodologies, results and best practices in order to reduce their carbon footprint