ASHRAE Hellenic Chapter

ΤΕΕ

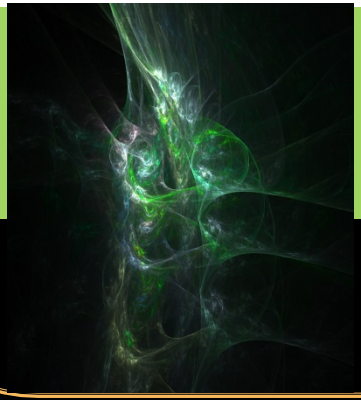
Energy Consumption and Energy Saving Practices for Laboratory Design

Konstantina Glampedaki, Speaker

kon@glampedakis.gr

Giorgos Kouzilos,

Antonios Glampedakis



What is a LABORATORY?

LABORATORY is a space in which specialised procedures and experiments are performed.

Laboratory and Energy Consumption

Why LABORATORY SPACES consume a great amount of energy in order to operate?

Laboratory and Energy Consumption

In order to be

- ✓*SAFE,*
- ✓*FUNCTIONAL,*
- ✓*EFFICIENT and*
- ✓*USER-FRIENDLY*

they have to operate under controlled environment. This means:

Laboratory and Energy Consumption

Substantial amount of energy is spent 24/7 for:

- Heating
- Ventilation
- Air Conditioning
- Special Equipment operation
- Other Supplies

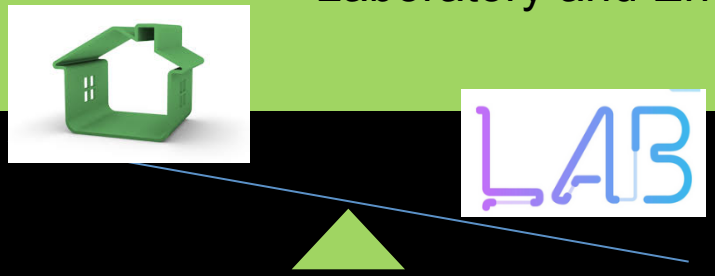
Whether the laboratory is fully occupied, partially occupied or vacant.

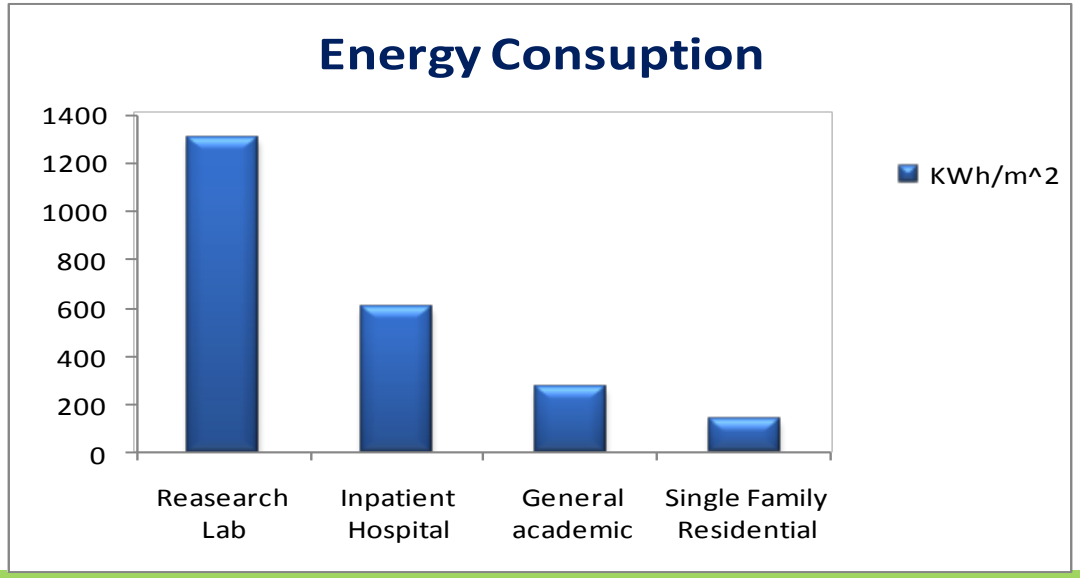
Laboratory and Energy Consumption

According to the:

- ASHRAE Handbook, an average laboratory uses ***TEN TIMES*** more energy than an office on a square meter basis.
- U.S Energy Information Administration, laboratories have the greatest Energy Use Index in relation to all other buildings.

Laboratory and Energy Consumption





Laboratory and Energy Consumption

The main reason for this excessive **Energy Consumption in Laboratories** is due to their constant need to ***MAINTAIN THE AIR QUALITY*** on a predefined standard, which is absolutely necessary for the safety of:

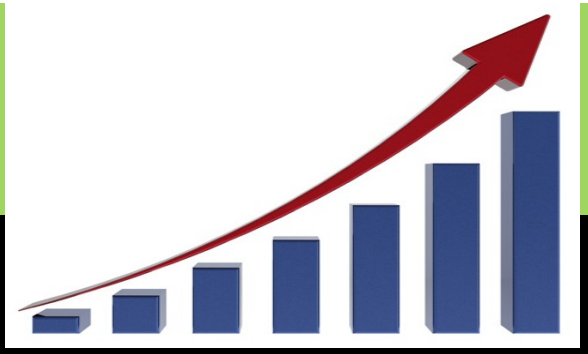
- ✓ the people working
- ✓ the experiment samples

Laboratory and Energy Consumption

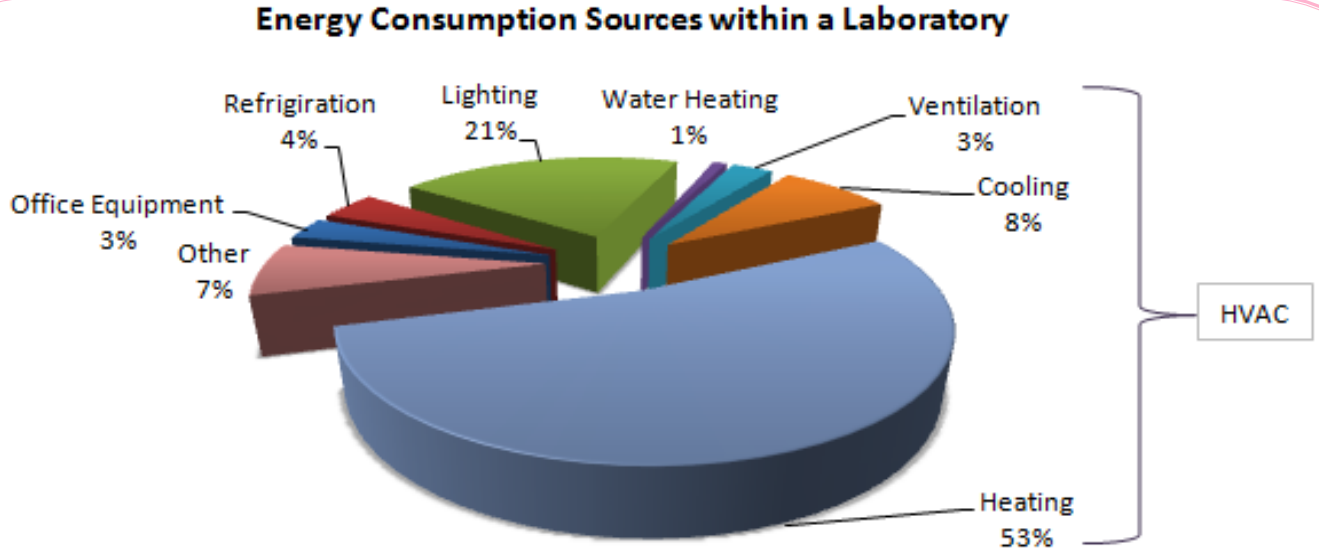
The maintenance of air quality directly affects the demands in:

- ❑ Ventilation
- ❑ Air condition

According to the U.S Energy Information Administration ***HVAC is responsible for 64%*** of the total energy consumption of a laboratory.

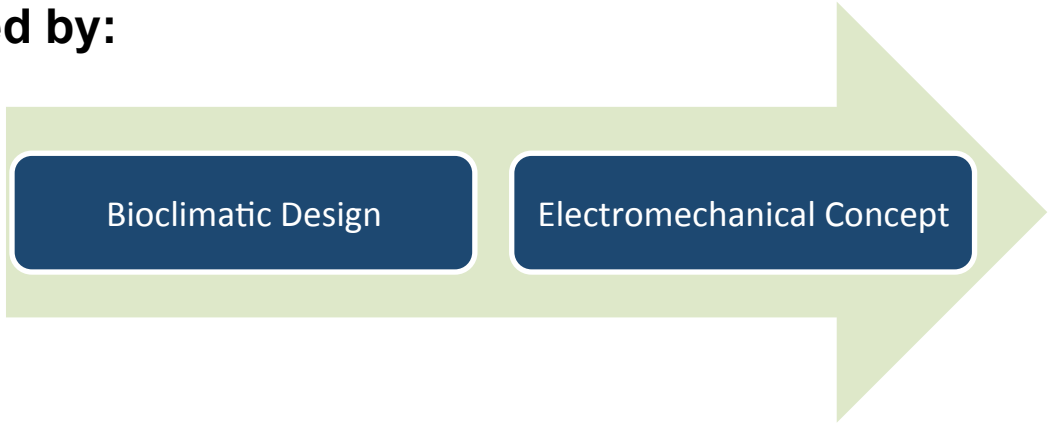


Laboratory and Energy Consumption



Laboratory and Energy Consumption

Planning and Designing a laboratory nowadays should include the aspect of **Energy Sustainability. This could be achieved by:**



Laboratory Energy Saving Technique

Bioclimatic Design of any building is attempting to create:

- Green,
- Sustainable,
- Eco Friendly buildings by:
  - ✓ Harmonizing the environment with the requirements of the building, and
  - ✓ Utilizing the power of the environmental sources (sun, air, wind, water, soil, etc) for HVCA.

Laboratory Energy Saving Technique
Bioclimatic Design

The core aspects of Bioclimatic Architecture are:


TOPOLOGY

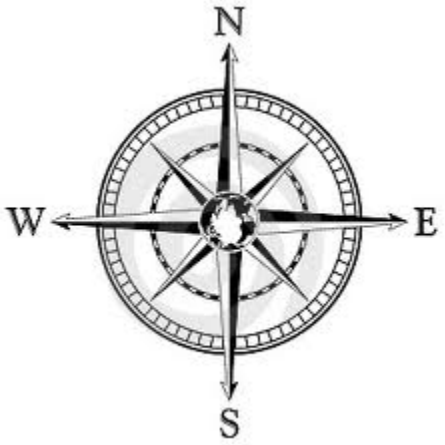

CONSTRUCTION


ARCHITECTURE
DESIGN

Laboratory Energy Saving Technique
Bioclimatic Design

TOPOLOGY-ORIENTATION

The orientation of the building basically depends on the weather conditions of the area.



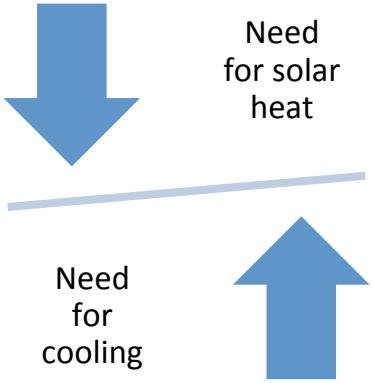
Laboratory Energy Saving Technique
Bioclimatic Design

Proper Orientation and allocation of the building would contribute in:

- Exploiting the solar energy and the natural light in winter time
- Protecting from the wind in winter time but also
- Take advantage of the wind in summer time

Laboratory Energy Saving Technique
Bioclimatic Design

Example:

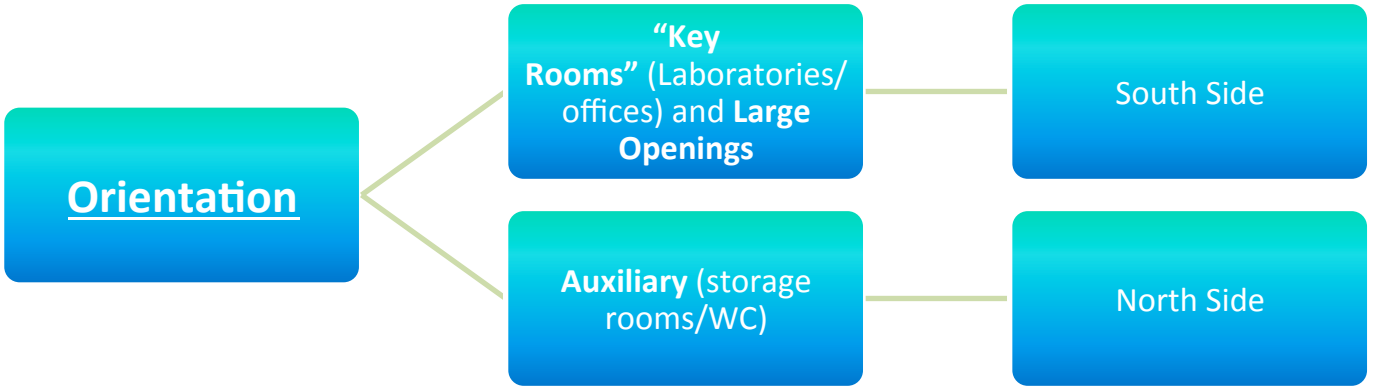


then

Building is placed at the North side of the plot in order to avoid shading from neighboring elements

Laboratory Energy Saving Technique
Bioclimatic Design

Furthermore,



Laboratory Energy Saving Technique
Bioclimatic Design

CONSTRUCTION

Considering the building envelope, two are the main goals to be achieved:

- ❑ **Thermal Resistance**
- ❑ **Low Heat Losses**

In order for the envelope to:

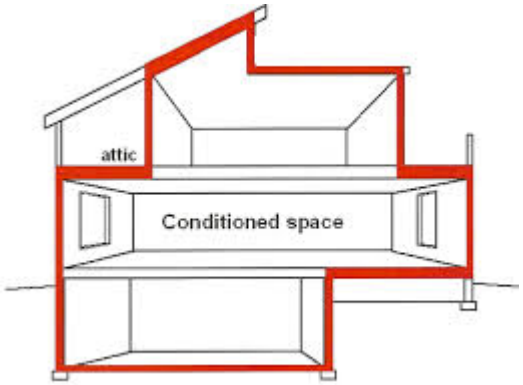
- **Storage** the heat in thermal mass and
- **Increase** the response time,

…. the construction must be **AIRTIGHT**.

Laboratory Energy Saving Technique
Bioclimatic Design

To protect the building from energy waste, the below factors must be ensured:

- ✓ Zero construction gaps
- ✓ Effective insulation
- ✓ Humidity control
- ✓ Proper casings



Laboratory Energy Saving Technique
Bioclimatic Design

ARCHITECTURE DESIGN

Architecture Design is crucial during the design Process,

- Skylights,
- Atria,
- Natural/artificial shading,
- Vegetation in the building's surrounding area

Always have to be considered in order to create the appropriae conditions inside.

Laboratory Energy Saving Techniques
Design

Furthermore, buildings should be designed by grouping spaces in **ZONES.**

Laboratory buildings consist of a variety of individual rooms, such as:

- Labs (high energy needs)
- Offices (common energy needs)
- Auxiliary spaces (low energy needs)

Spaces with similar requirements create a zone.

In order for every room or zone to operate under the proper conditions for its use, and not more or less, it is critical to have its **own HVAC Control System**.

A room/zone could be **adjusted separately** or even **shut down** when not operating.

Air Condition System is an aggregation of components with a fixed **structure** and **function** which must fulfill four objectives:

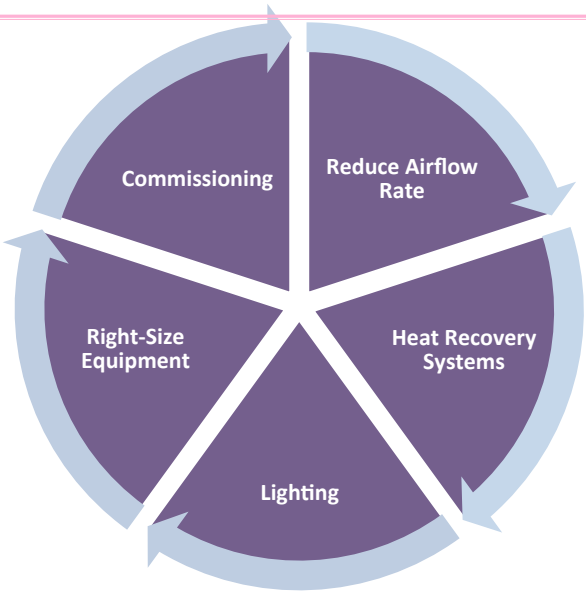
- Air Temperature
- Humidity Control
- Air Circulation Control
- Air quality Control

Laboratory Energy Saving Techniques
HVAC

Laboratories must be designed and constructed in such a way that they will **use the minimum energy without compromising the safety.**

To achieve this goal, five major factors must be examined.

Laboratory Energy Saving Techniques
HVAC



Laboratory Energy Saving Techniques

Reduce the Airflow Rate of special equipment

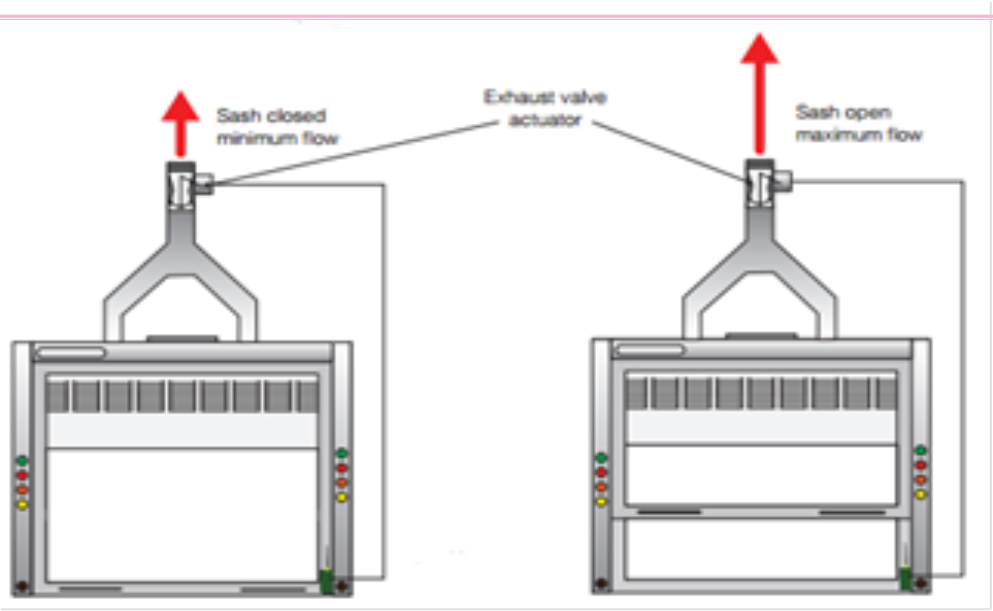
- Fume-hoods and related containment devices are critical to protecting the health and safety of lab workers handling chemicals and/or biological materials.
- Sash management techniques include installing fume-hood sash restrictors, and occupancy and proximity sensors.

Laboratory Energy Saving Techniques
HVAC-Reduce Airflow Rate

… Reduce the Airflow Rate

- VAV fume-hoods are capable of reducing energy usage and energy costs respectively as the minimum air is always supplied, conditioned and exhausted.
- Staff training can also be very important in better sash management practices.

Laboratory Energy Saving Techniques
HVAC-Reduce Airflow Rate



Laboratory Energy Saving Techniques
HVAC-Reduce Airflow Rate

Heat Recovery Systems

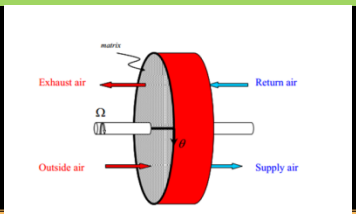
Heat recovery systems are used for reducing the energy required for heating and cooling.

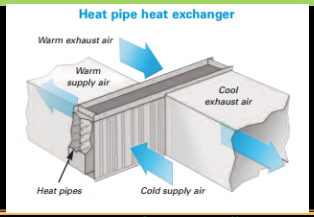
They recycle thermal energy from the exhausted air of the exhaust system of the lab and transfer it to back to the air intake system.

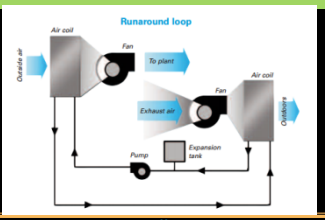
Popular Technologies of **HEAT RECOVERY SYSTEMS** are:

- Rotary enthalpy Wheel
- Heat Pipe
- Run-Around Loop

Laboratory Energy Saving Techniques
HVAC-Heat Recovery Systems







Lighting

Lab research is a visually intense activity and the ability to see clearly is crucial.

From chemical reactions …
to physical characteristics and biological processes

Lighting

Proper lighting is a combination of

- ✓colour temperature,
- ✓colour rendering,
- ✓directionality and diffusion
- ✓intensity

And impacts not only the consumption of energy,
but also the workers' comfort, health and performance

Lighting

Energy efficiency may be attained by…

- ✓turning off lights in unoccupied rooms or where there is sufficient natural light.
- ✓Adjusting artificial light output
- ✓replacing or designing the electric lighting installation with energy-efficient T8 lamps and electronic ballasts
- ✓Adding specular reflectors and new lenses

Lighting

Energy efficiency may be attained by…

- ✓Switching from traditional incandescent light bulbs to compact fluorescent light bulbs (CLFs)
- ✓Using timers and sensors to reduce light usage to the appropriate time and level of brightness.

Right-Size Equipment

Lab equipment consume about 1/7 of the lab energy waste, mostly because of the produced heat that must be removed by the HVAC systems.

It is essential for a lab space to have the proper devices and equipment in order to operate satisfactory at the present but also at the near future.

Commissioning is a process in which engineers check and tune up building systems to ensure their appropriate and efficient operation.

Commissioning in existing buildings is the most cost-effective way to **reduce energy use**, particularly in **high-tech facilities like Laboratories**.

Laboratory Energy Saving Techniques
Commissioning

In addition**, Commissioning,** is advantageous for laboratories, as:

- It increases systems performance
- It decreases annual maintenance needs
- It ensures occupant comfort and safety

Laboratory Energy Saving Techniques
Commissioning

ASHRAE Hellenic Chapter

ΤΕΕ

Thank you for your Attention

Konstantina Glampedaki

kon@glampedakis.gr

Any Questions?