The project has received funding from the LIFE Programme of the European Union under GA number LIFE19 ENV/GR/000100

Process Equipment Design Laboratory AUTh

Energy efficiency of Demo Houses and Naval Academy: Simulation Results

Prof. Agis Papadopoulos

Dr. Effrosyni Giama

On behalf of PEDL RESEARCH TEAM

fgiama@auth.gr

The project has received funding from the LIFE Programme of the European Union under GA number LIFE19 ENV/GR/000100

LIFEVISIONS
InnoVative photocatalytic paintS for healthy envirOnment and eNergy Saving

The European Green Deal

- Strong linkage between energy and environmental policies
- The EU should be climate neutral by 2050
- Reaching this target will require action by all sectors of our economy, including
  - investing in environmentally-friendly technologies
  - supporting industry to innovate
  - rolling out cleaner, cheaper and healthier forms of private and public transport
  - decarbonising the energy sector
  - ensuring buildings are more energy efficient
  - working with international partners to improve global environmental standards

The project has received funding from the LIFE Programme of the European Union under GA number LIFE19 ENV/GR/000100

LIFEVISIONS
InnoVative photocatalytic paintS for healthy envirOnment and eNergy Saving

Key pillars in EU Energy Policy for Buildings

- Energy Efficiency
- Renewable Energy
- Energy Performance
- Decarbonisation

Clean energy for all Europeans package - legislative process

	European Commission Proposal	EU Inter-institutional Negotiations	European Parliament Adoption	Council Adoption	Official Journal Publication
Energy Performance in Buildings	30/11/2016	Political Agreement	17/04/2018	14/05/2018	19/06/2018 - Directive (EU) 2018/844
Renewable Energy	30/11/2016	Political Agreement	13/11/2018	04/12/2008	21/12/2018 - Directive (EU) 2018/2001
Energy Efficiency	30/11/2016	Political Agreement	13/11/2018	04/12/2018	21/12/2018 - Directive (EU) 2018/2002
Governance of the Energy Union	30/11/2016	Political Agreement	13/11/2018	04/12/2018	21/12/2018 - Regulation (EU) 2018/1999
Electricity Regulation	30/11/2016	Political Agreement	26/03/2019	22/05/2019	14/06/2019 - Regulation (EU) 2019/943
Electricity Directive	30/11/2016	Political Agreement	26/03/2019	22/05/2019	14/06/2019 - Directive (EU) 2019/944
Risk Preparedness	30/11/2016	Political Agreement	26/03/2019	22/05/2019	14/06/2019 - Regulation (EU) 2019/941
ACER	30/11/2016	Political Agreement	26/03/2019	22/05/2019	14/06/2019 - Regulation (EU) 2019/942

The project has received funding from the LIFE Programme of the European Union under GA number LIFE19 ENV/GR/000100

Methodology in brief

Measurements – Simulations in Demo Houses and in real scale application in Naval Academy

Simulations with DesignBuilder and Contam

- Energy consumption
- CO_2 emissions
- Thermal comfort

The target was to identify the correlation of ventilation rates and photocatalysis (ventilation is related to energy consumption).

Indirect reduction of energy consumption because of the ventilation rate reduction.

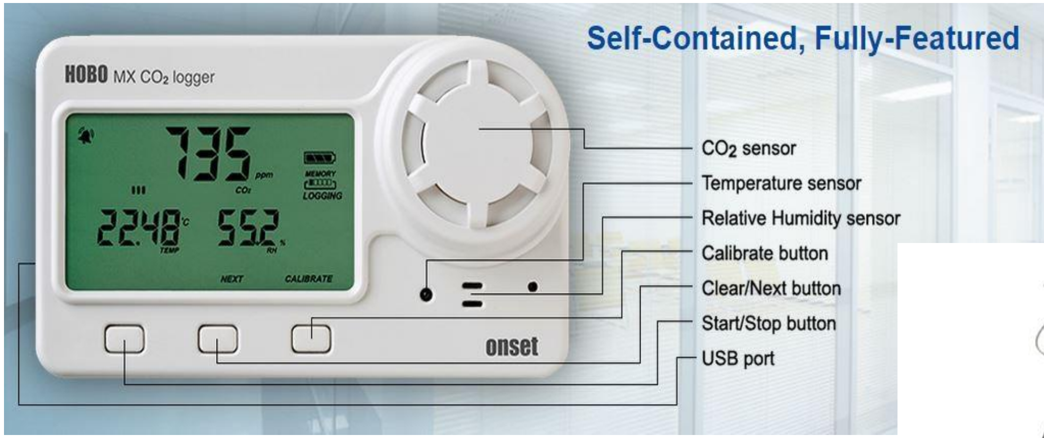
The project has received funding from the LIFE Programme of the European Union under GA number LIFE19 ENV/GR/000100

Indoor conditions measurement equipment

System	Measurements	Measurement equipment
DEMO HOUSES	Air temperature Relative Humidity Air velocity Radiant temperature PMV/PPD CO_2	• Comfort and air quality conditions using testo 480 and the necessary sensor probes (temperature, radiant temperature, relative humidity, CO2, air velocity, pmv/ppd) • HOBO MX1102 (temperature, relative humidity, CO2). The installation and methodology is based on the international standards ISO 7726:1998 and ASHRAE 55

The project has received funding from the LIFE Programme of the European Union under GA number LIFE19 ENV/GR/000100

Indoor conditions data loggers



The project has received funding from the LIFE Programme of the European Union under GA number LIFE19 ENV/GR/000100

A. Simulation - Demo Houses

Parameters:

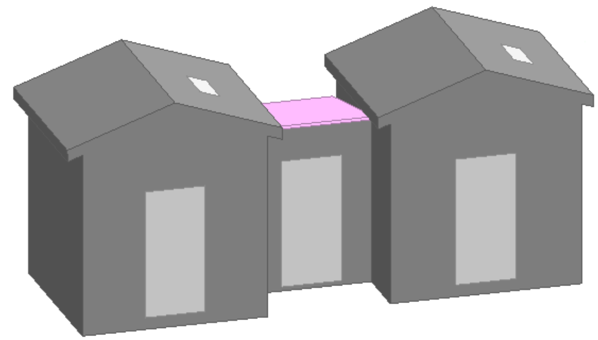
- Mechanical ventilation (ASHRAE 62.1)
- Natural ventilation
- Photocatalysis

Output data:

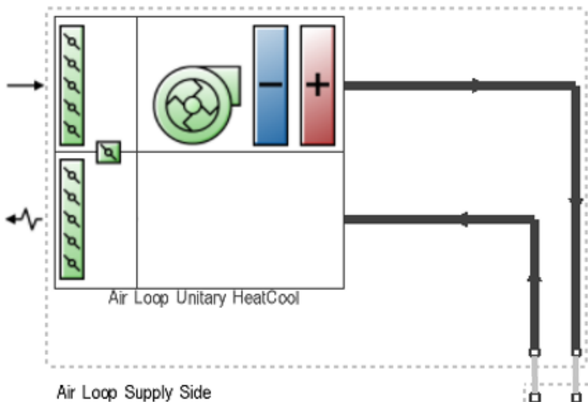
- Energy consumption
- CO_2 emissions
- NOx emissions

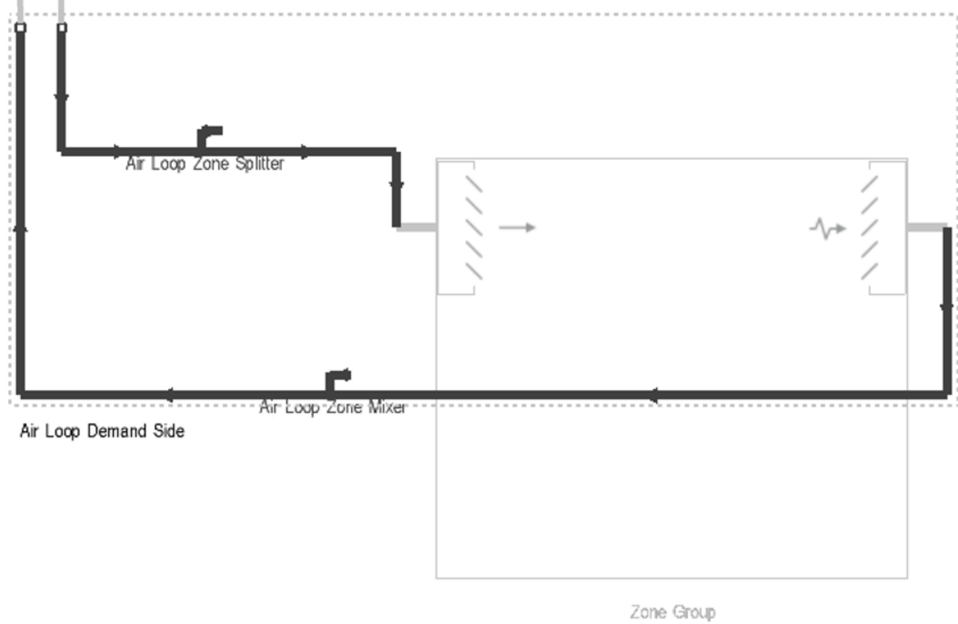
The project has received funding from the LIFE Programme of the European Union under GA number LIFE19 ENV/GR/000100

A. Simulation - Demo Houses



Envelope design





HVAC systems

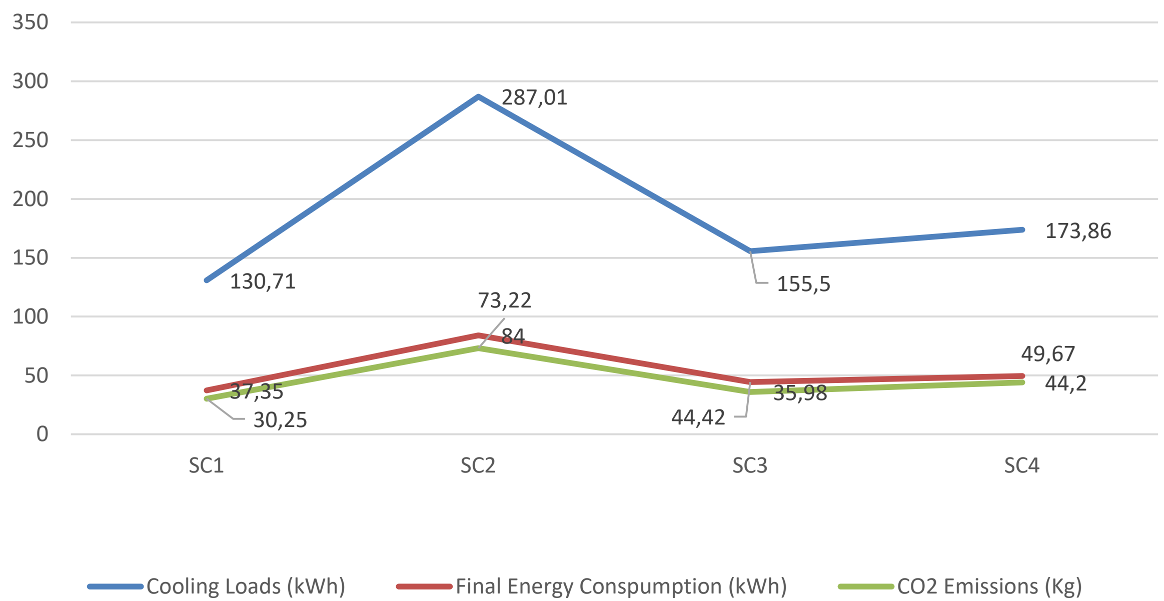
The project has received funding from the LIFE Programme of the European Union under GA number LIFE19 ENV/GR/000100

A. Simulation scenarios - Demo Houses

Scenario	Scenario description	Ventilation m3/h, Air changes per hour	Concentration NO,NO2,CO2	Pollutants reduction efficiency
Baseline	Conventional without photocatalysis and not adequate mechanical ventilation	17.57 m3/h, 0.74 ACH	NO:27μg/m3 NO2:32μg/m3 CO2:455 ppm	
1	Photocatalysis and mechanical ventilation	17.57 m3/h, 0.74 ACH	NO:10μg/m3 NO2:12.6μg/m3 CO2:455 ppm	NO:63% NO2:60.6%
2	Increased mechanical ventilation in order to accomplish the same emission reduction as with photocatalysis	151.2m3/h, 6.36 ACH	NO:10.7μg/m3 NO2:12.9μg/m3 CO2:400 ppm	NO:60.3% NO2:59.6%
3	Maximum of natural ventilation	72.68m3/h, 3 ACH	NO:14μg/m3 NO2:17μg/m3 CO2:447 ppm	NO:48% NO2:46.8%
4	Night ventilation	35.2m3/h, 1.5 ACH 7:00 p.m-17:00a.m. 151.2m3/h, 6.36 ACH	NO:15.1μg/m3 NO2:18.1μg/m3 CO2:419.4 ppm	NO:44.1% NO2:43.4%

The project has received funding from the LIFE Programme of the European Union under GA number LIFE19 ENV/GR/000100

A. Simulation results - Demo Houses

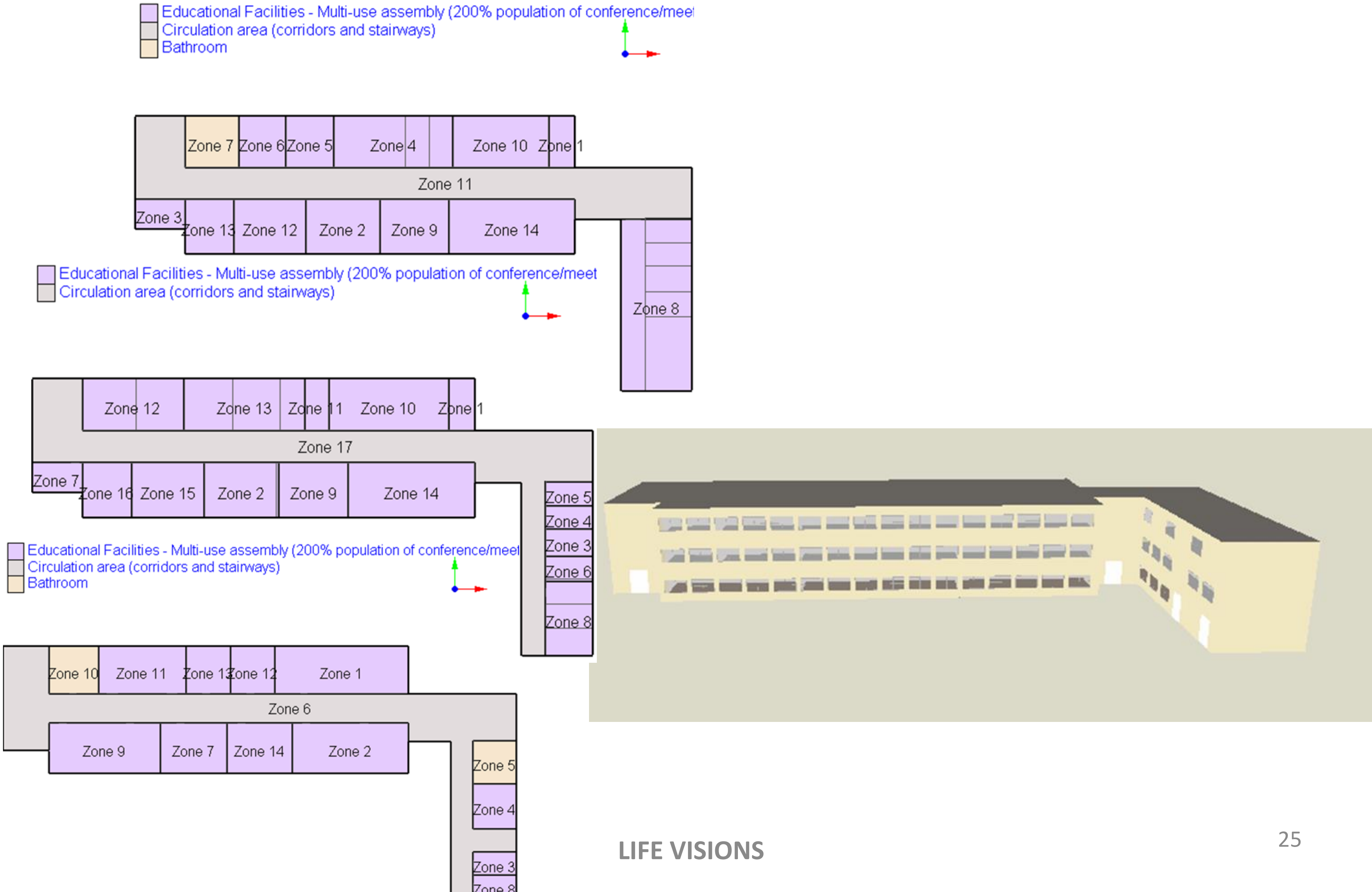


The issue is to find the scenario that can achieve the same emissions reduction as with photocatalysis with the least energy consumption in regards to ventilation.

	Cooling Loads (kWh)	Final Energy Conspumption (kWh)	CO2 Emissions (Kg)
SC1	130,71	37,35	30,25
SC2	287,01	84	73,22
SC3	155,5	44,42	35,98
SC4	173,86	49,67	44,2

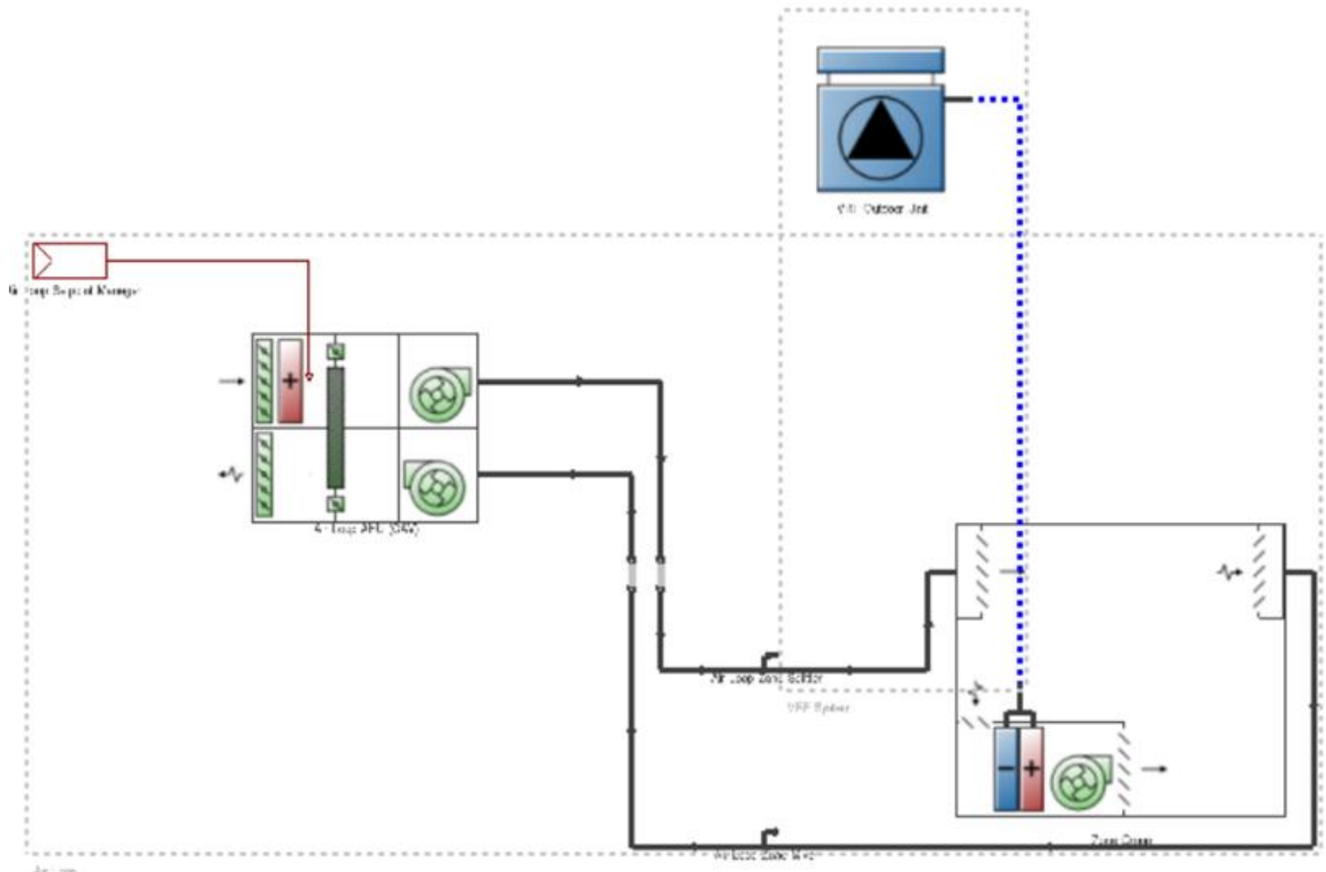
The project has received funding from the LIFE Programme of the
European Union under GA number LIFE19 ENV/GR/000100

B. Simulation – Naval Academy



The project has received funding from the LIFE Programme of the European Union under GA number LIFE19 ENV/GR/000100

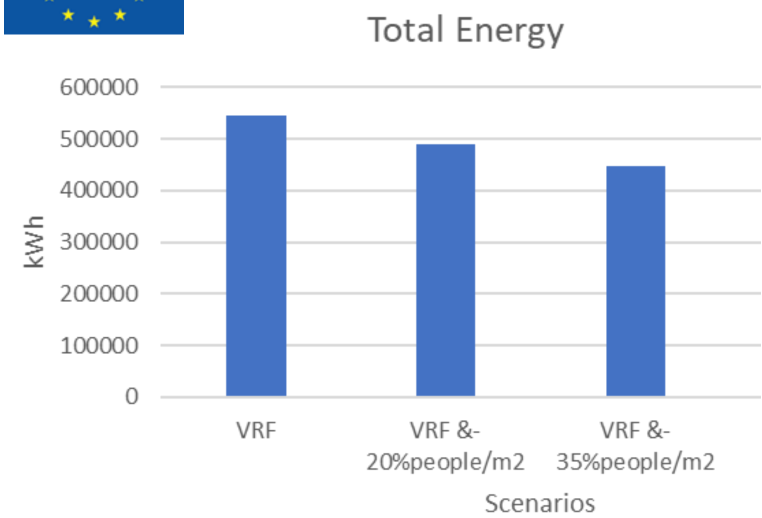
B. Simulation – Naval Academy

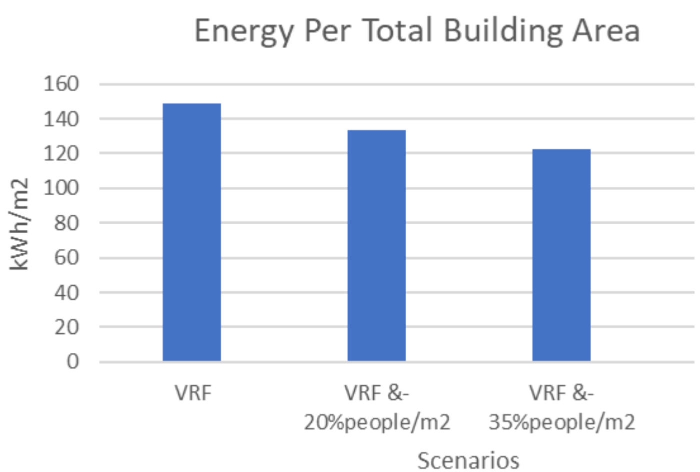


Naval academy-VRF (Variable Refrigerant Flow) system simulation

The project has received funding from the LIFE Programme of the European Union under GA number LIFE19 ENV/GR/000100

B. Simulation Results – Naval Academy





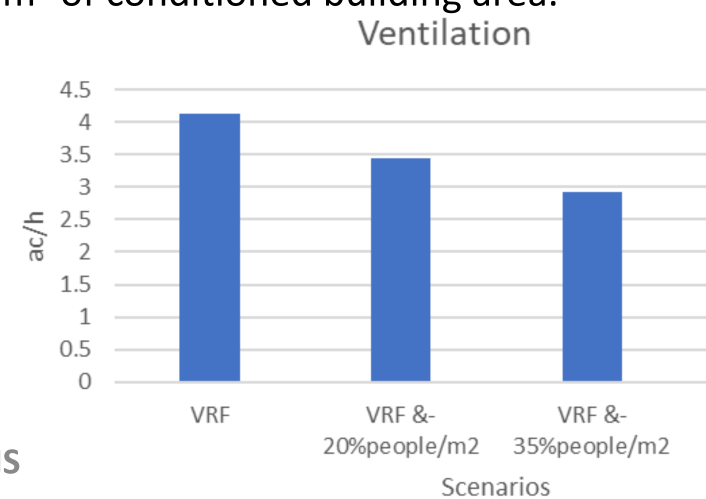
SC1 (without photocatalysis) the energy consumption reaches 544103.64 kWh and 236.76 kWh/m^2 of conditioned building area. Increased ventilation rate.

SC2 (with photocatalysis) and people density reduced by 20%.

Reduced people density – reduction to ventilation rate. Energy consumption reaches 488796.48 kWh and 212.69 kWh/m^2 of conditioned building area.

SC3 (with photocatalysis reduce more the people density).

Energy consumption reaches 447965.8 kWh and 194.93 kWh/m^2 of conditioned building area.



The project has received funding from the LIFE Programme of the European Union under GA number LIFE19 ENV/GR/000100

Key Results & Discussion

- There is a correlation of ventilation rates and photocatalysis (ventilation is related to energy consumption).

- The simulations determined significant energy consumption reduction compared to the conventional scenario (without photocatalysis) because of the ventilation rate reduction (given as a fact that we want specific ventilation rate to reduce pollutants concentration).

- The results in real scale application showed a correlation of ventilation rates and photocatalysis (ventilation is related to energy consumption). **The simulations determined about 11 – 22% energy reduction compared to the conventional scenario (without photocatalysis) because of the ventilation rate reduction.** The ventilation rate was determined by the occupancy in the photocatalytic scenarios.

The project has received funding from the LIFE Programme of the European Union under GA number LIFE19 ENV/GR/000100

LIFEVISIONS

THANK YOU!

https://lifevisions.gr/

PEDL
Process Equipment Design Laboratory