



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



# Inno**V**ative photocatalyt**I**c paint**S** for health**y** enviro**N**ment and e**N**ergy **S**aving «**VISIONS**»

**PROJECT LOCATION: Greece**

## **BUDGET INFO**

**Total amount: 1,403,752**

**% EC Co-funding: 757,763**

**DURATION: Start: 07/09/20 - End: 06/09/23**



***Project Coordinator:***

**Dr. Thomas Maggos, Research Director**  
**Head of Atmospheric Chemistry & Innovative Technologies Lab/NCSR "Demokritos"**



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## PROJECT'S IMPLEMENTORS:

### Coordinating Beneficiary:

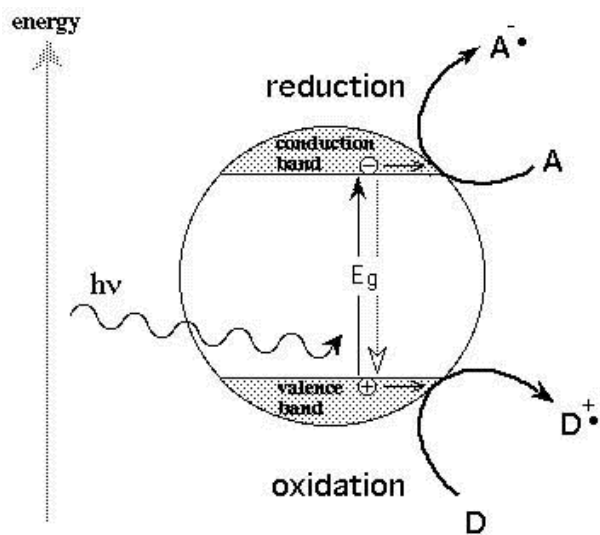
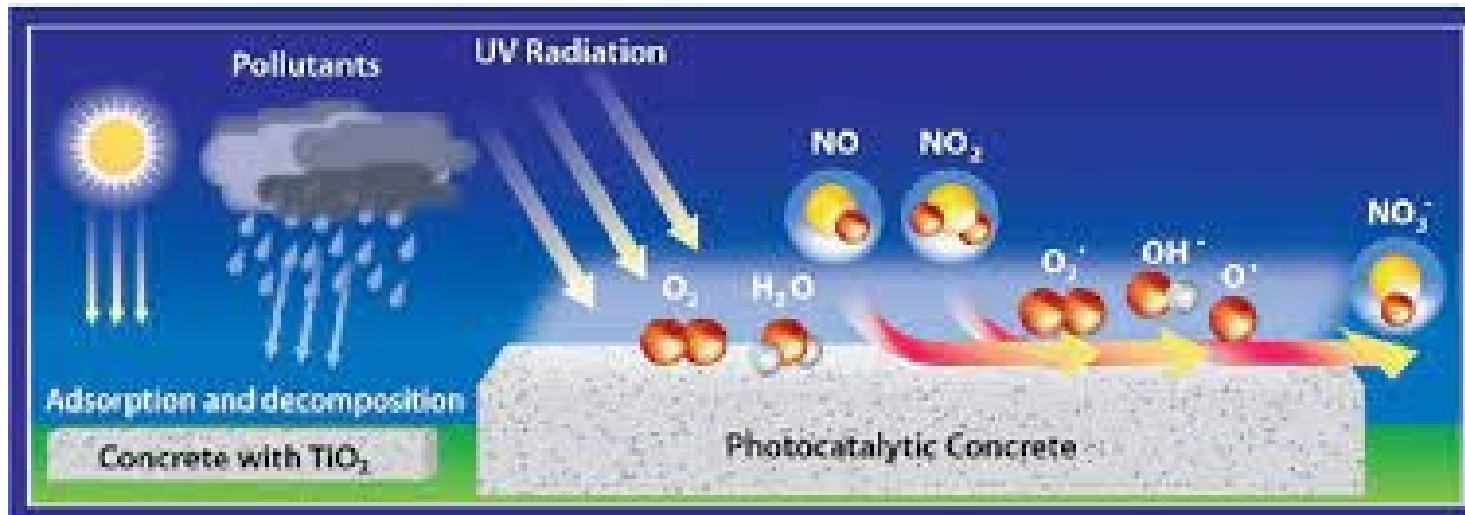


### National Center for Scientific Research "Demokritos"

### Associated Beneficiaries:

- *Aristotelio Panepistimio Thessalonikis*
- *Foundation for Research and Technology - Hellas*
- *MICHOPOULOS I. & CH. G.P.*
- *VITEX*





- Με την επίδραση ακτινοβολίας σχηματισμός στην επιφάνεια του καταλύτη ζευγούς θετικών οπών και ελεύθερων  $e^-$
- Συμμετοχή αυτών σε αντιδράσεις με μόρια δότες και δέκτες  $e^-$  αντίστοιχα
- Σχηματισμός ισχυρών οξειδωτικών όπως ανιονικών ριζών οξυγόνου ( $\cdot O_2^-$ ) και ριζών υδροξυλίων ( $OH\cdot$ ) τα οποία έχουν την δυνατότητα οξείδωσης οργανικών και ανόργανων ενώσεων.

## ΠΕΔΙΑ ΕΦΑΡΜΟΓΗΣ ΦΩΤΟΚΑΤΑΛΥΤΙΚΗΣ ΔΡΑΣΗΣ $\text{TiO}_2$

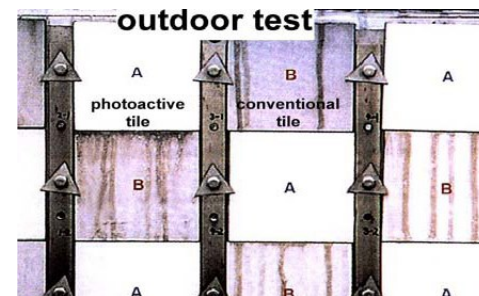
### Αντιθαμβοτική Δράση



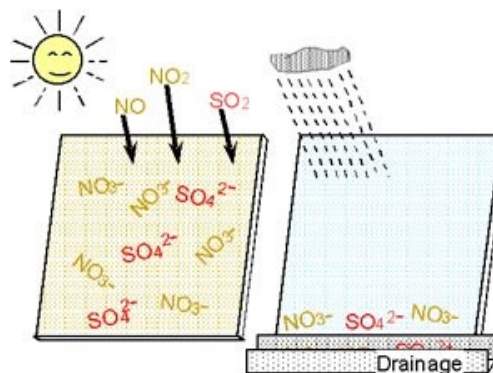
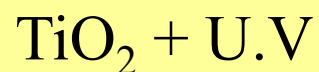
### Αντιβακτηριδιακή Δράση



### Αυτοκαθαρισμός Υλικού



### Επεξεργασία Υδάτων



### Αντιμετώπιση Αέριας Ρύπανσης





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## SCOPE

**The main scope of the project is the production of an innovative photocatalytic paint, which aims at improving the quality of the indoor environment while it will enable significant energy savings in buildings**





## OBJECTIVES & SCOPE

**The main scope of the project is the production of an innovative photocatalytic paint, which aims at improving the quality of the indoor environment while it will enable significant energy savings in buildings**

**The project main objectives are:**

- **Optimization and Upscaling of a novel photocatalytic powder**
- **Semi-industrial production of innovative photocatalytic paints** (VISIONS Photo-Paints)
- **Real scale application** of the VISIONS Photo-Paints in a set of existing **Demo-Houses** and in **public building (HNA)**.
- Establishment of a **commercial company** which aims to deliver the project outcomes into the market

Key "After Life" action





# Optimization and Upscaling of synthesis route of the novel photocatalytic powder (FORTH)

The optimization process concerned 3 main parameters:

## Optimization of Synthetic Pathways

In order to find the best synthetic procedure which will be easy, cost effective and lead to photoactive titanium dioxide,  $\text{TiO}_2$  powders with different synthetic procedures were synthesized.

## Optimization of Concentration of Dopants

Metal doped  $\text{TiO}_2$  powders with 0.04 dopant concentration

## Optimization and control of the particle size

Optimization and control of the particle size with ball milling system.

FORTH prepared 30 optimized powders. Among them the 4 most promising powders in terms of air pollutants degradation were further evaluated for their physicochemical properties and photocatalytic efficiency and 1 (V3) was selected for the VISIONS photopaint production

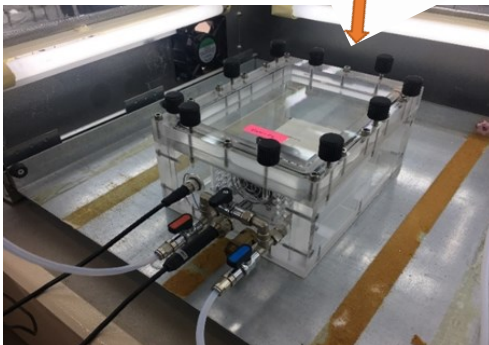
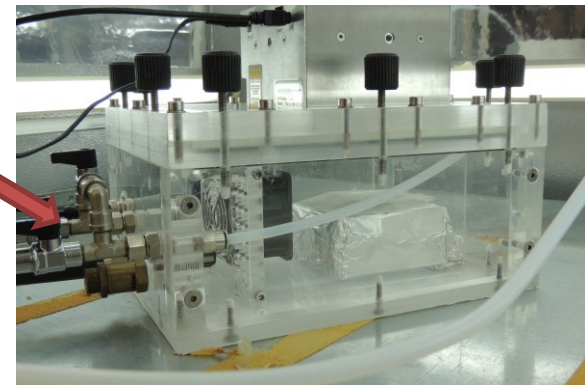
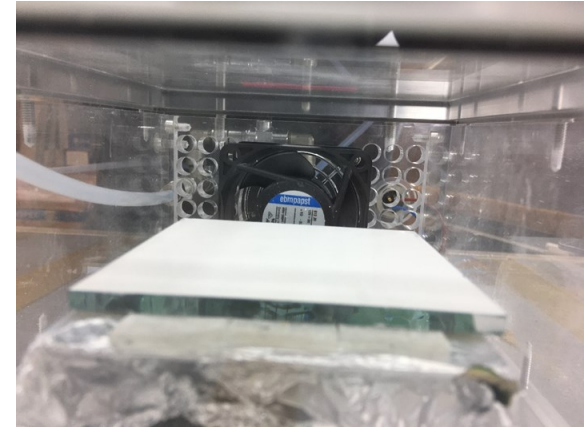
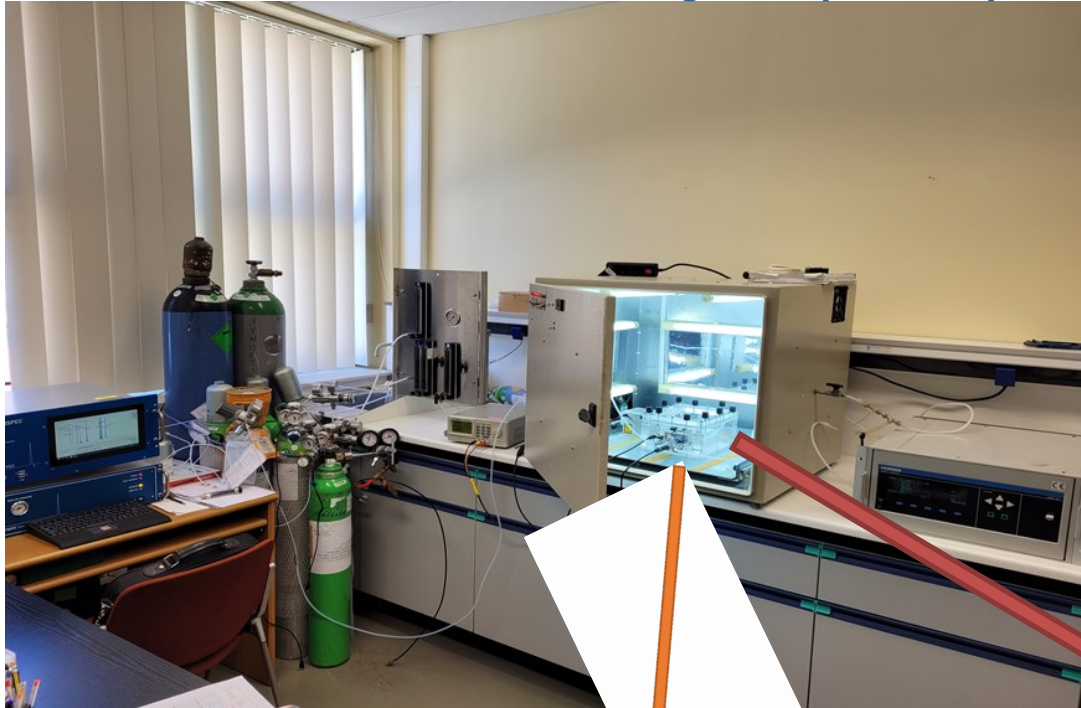




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## Lab - scale tests

**Detailed information on the efficiency of the optimized powders and paints to photocatalytically degrade air pollutants such as Nitrogen Oxide (NO) & Volatile Organic Compounds e.g toluene (VOCs) in the gaseous phase are provided**





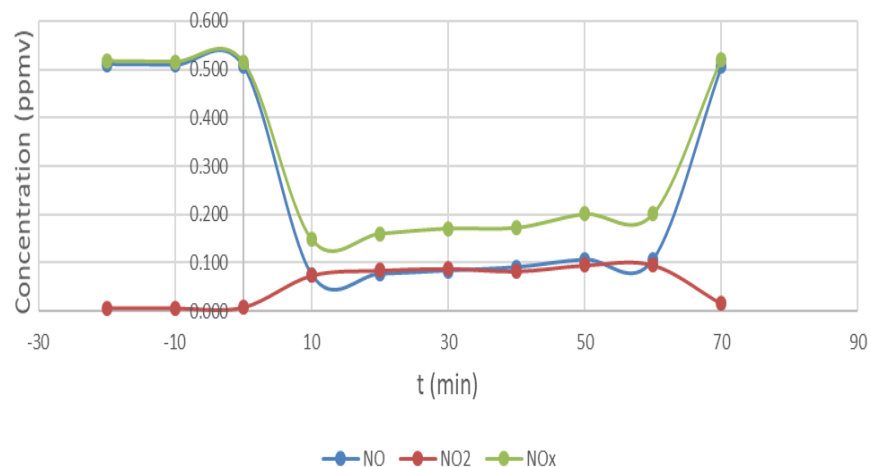


## Results

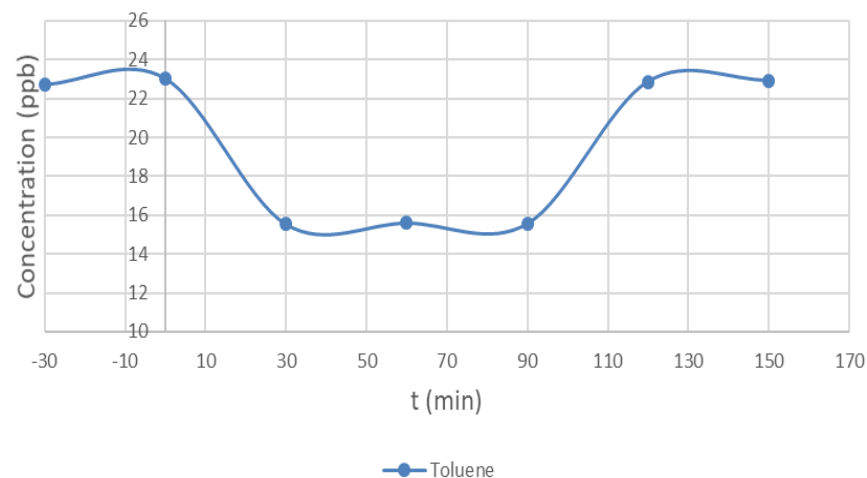
### Sample V -3-

$\eta_{\text{NO}_i}^{\text{total}}$	85.4%
$\eta_{\text{Toluene}}^{\text{total}}$	31.9%

Typical trend of NO, NO<sub>2</sub> and NO<sub>x</sub> concentrations during a photocatalytic test



Typical trend of Toluene concentrations during a photocatalytic test

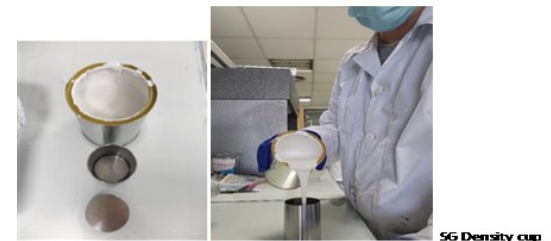
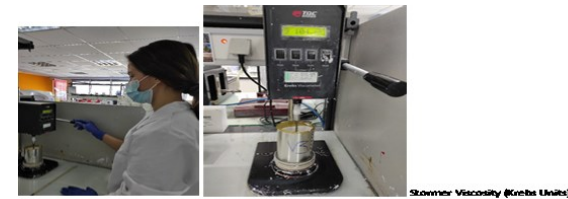




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# Semi-Industrial production of Photo-Paints (VITEX)

1. Organic (with organic binder)
  2. Inorganic silicate paint (with potassium silicate binder)
- high surface porosity to increase photo-paints action and the appropriate all-around performance (appearance, gloss, easy of application, water scrub resistance etc)
  - formulations are above the CPVC (Critical Pigment volume Concentration).
  - The stability of the formulated paints in storage overtime was checked in the lab using also accelerated methods (oven ~50o C, centrifuge, etc).
  - The concentration of the VISIONS powder in these matrices ranged between 5% to 20%.
  - increase the porosity of the film (reducing resins while increasing fillers - elevate P.V.C.) and the quantity of powder up to 20% (> will be economically unviable)

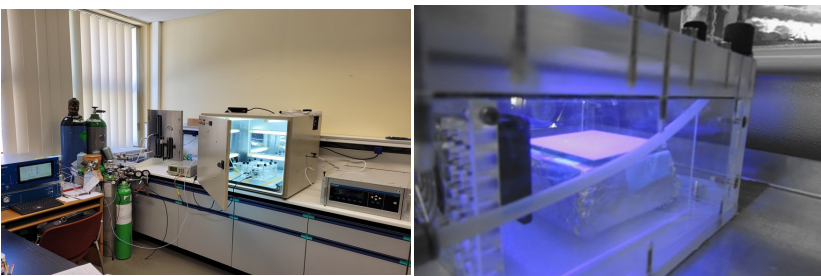




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## Semi-Industrial production of Photo-Paints (VITEX) (Lab tests)

*More than 20 paint formulation were tested in NCSRDL labs*



*and finally VITEX produced:*

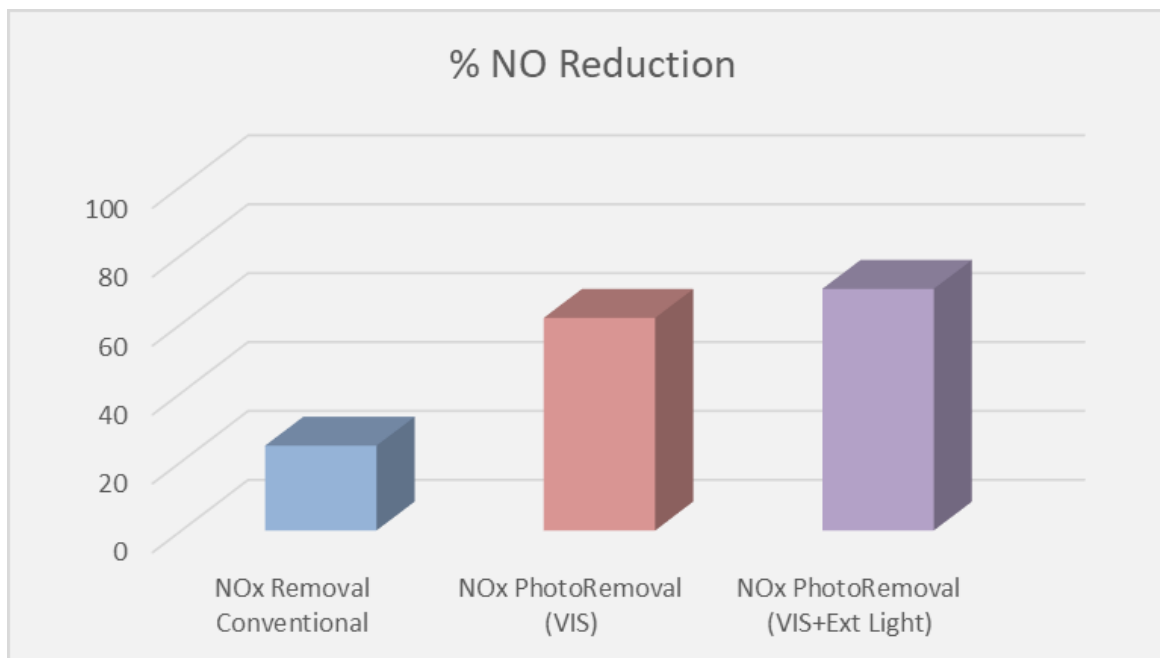


- **Organic Paint (tested in DEMO houses)**
- **Inorganic Paint (tested in DEMO houses)**
- **Hybrid Paint – Production failed due to stability issues**

## Action B.3 Real Scale Applications (NCSRD)

### ***Subaction B3.1 Application of Photo-Paints in Demo-Houses prototype demonstrator (FORTH)***





	% NO Removal	Fd (µg/m²s)	Vd (cm/s)
NOx Removal Conventional	24.6	0.046	0.006
NOx PhotoRemoval (VIS)	61.7	0.096	0.028
NOx PhotoRemoval (VIS+Ext Light)	70.1	0.125	0.034
Toluene PhotoRemoval (VIS)	5.79	0.011	0.001

$$\text{PPD (\%)} = (\text{C}_{in} - \text{C}_{fin} / \text{C}_{in}) \times 100$$

$$r_{NO} (\mu\text{g}/\text{m}^2\text{s}) = (\text{C}_{in} - \text{C}_{fin}) \times V / A \times t$$

$$Vd = r_{NO} / C_{in} NO$$

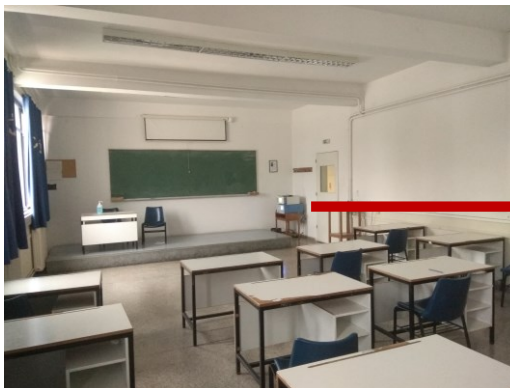
$$V=30 \text{ m}^3, A=40 \text{ m}^2$$





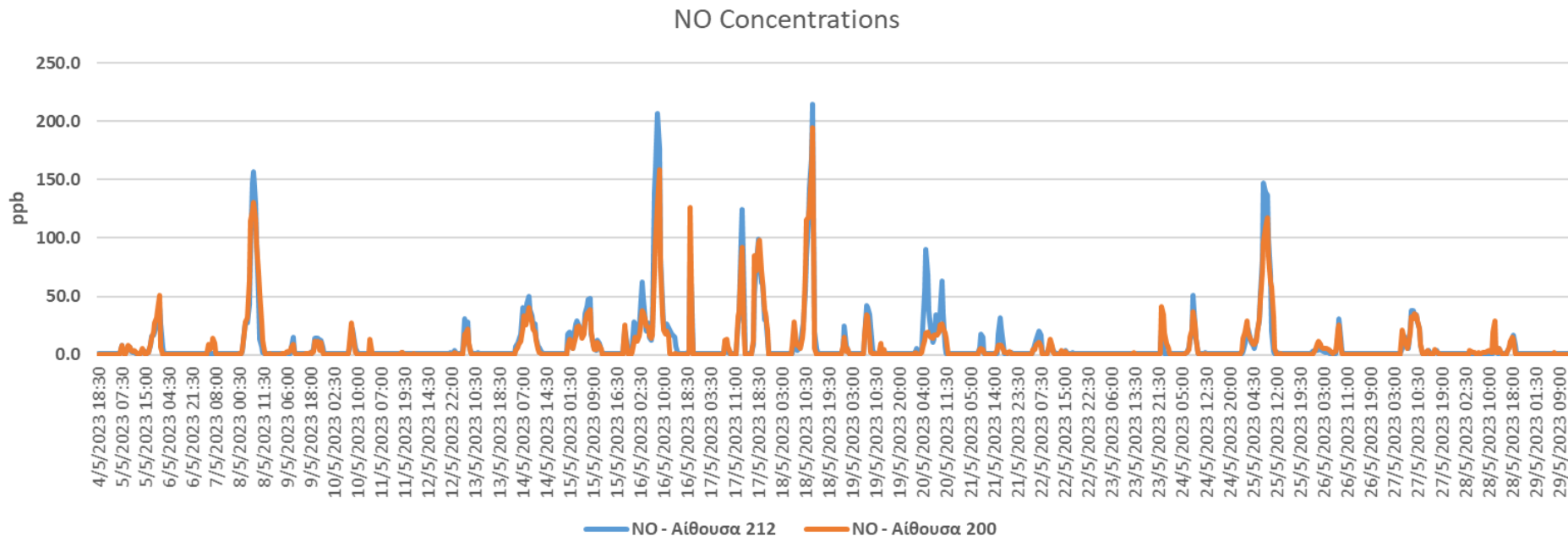
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## ***Subaction B3.2 Application of the most promising Photo-Paint in real life conditions. The case of Hellenic Naval Academy (HNA) Buildings***





## Indicative Preliminary Results



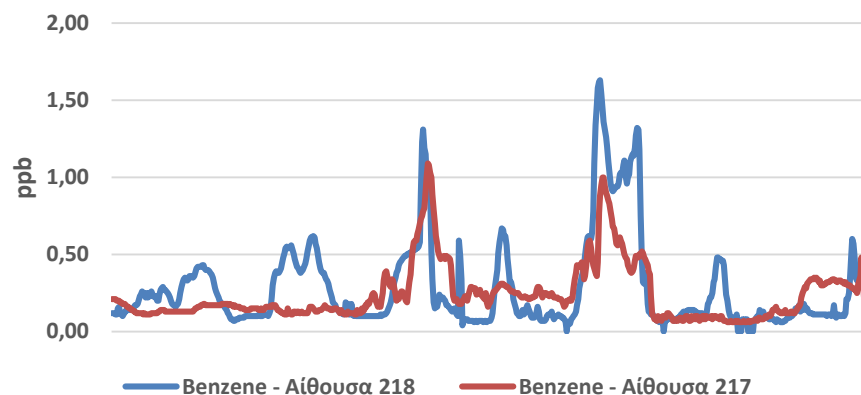
Date: 4-24/5/2023	Average	SDTV	Max
NO - Room 212	9.60	23.5	215
NO - Room 200	7.51	20.2	190

**21.8% reduction of NO**

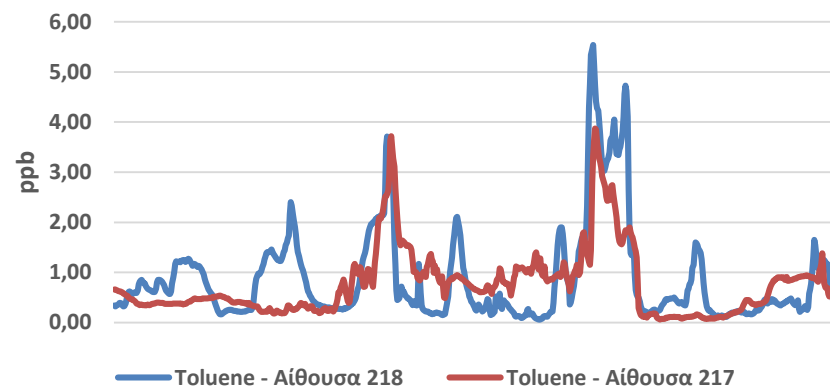


## Indicative Preliminary Results

BENZENE Concentrations



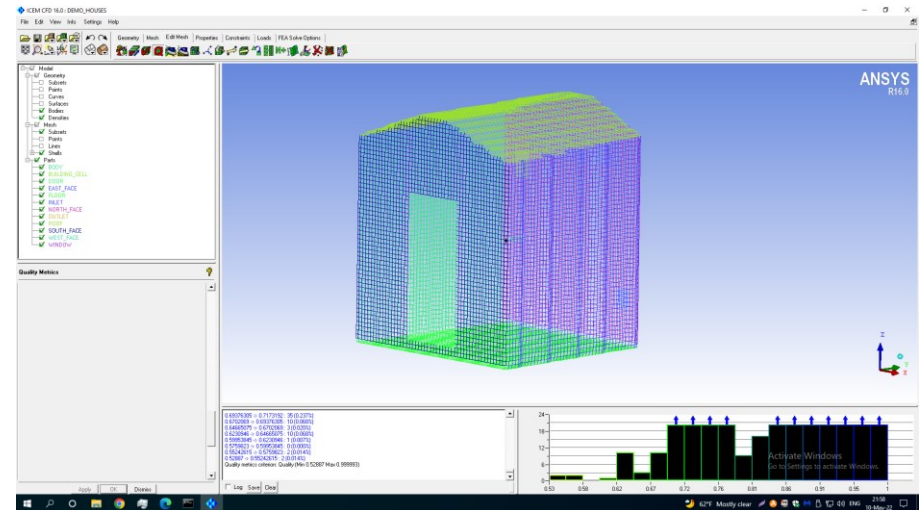
TOLUENE Concentrations



	% Benzene reduction	% Toluene reduction
NO - Room 218	8.87	12.5
NO - Room 217		

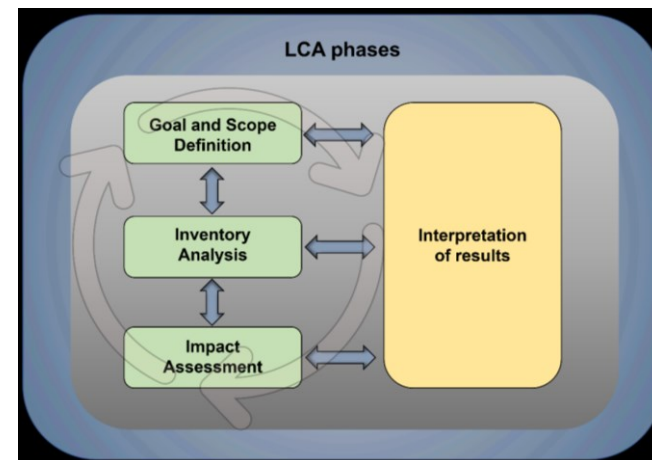
## Depollution modelling (CFD)

In the frame of the Life Visions project the methodology for CFD modelling in indoor environments will be followed in order to estimate through simulations the effectiveness of paints to improve IAQ.



## LCA, CBA, CEA Methodology

- Environmental impacts comparison:
  - Conventional paint vs Innovative photocatalytic paint
- Cradle-to-Gate & Cradle-to-Grave approach

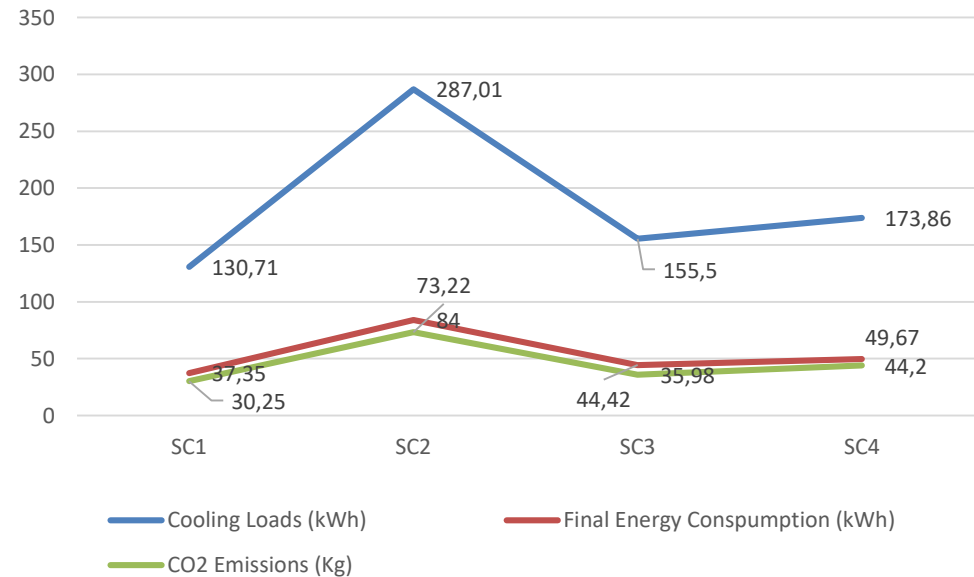
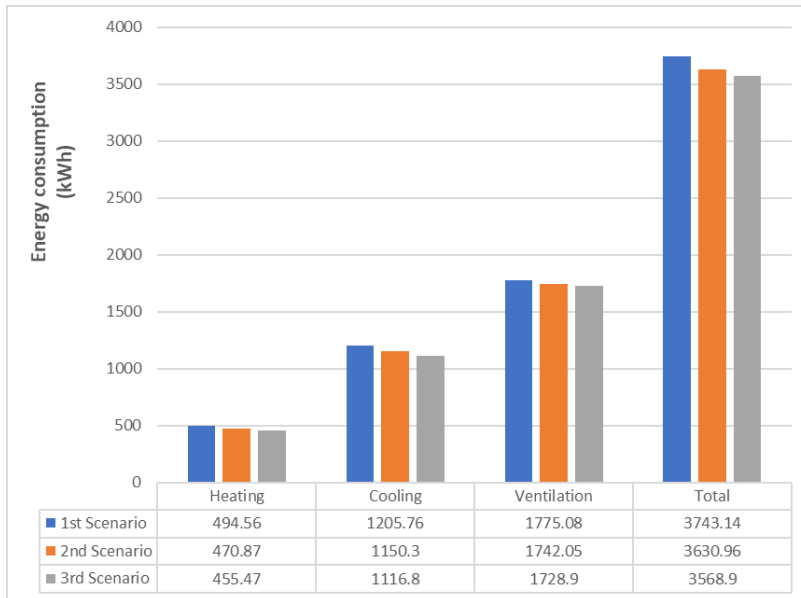
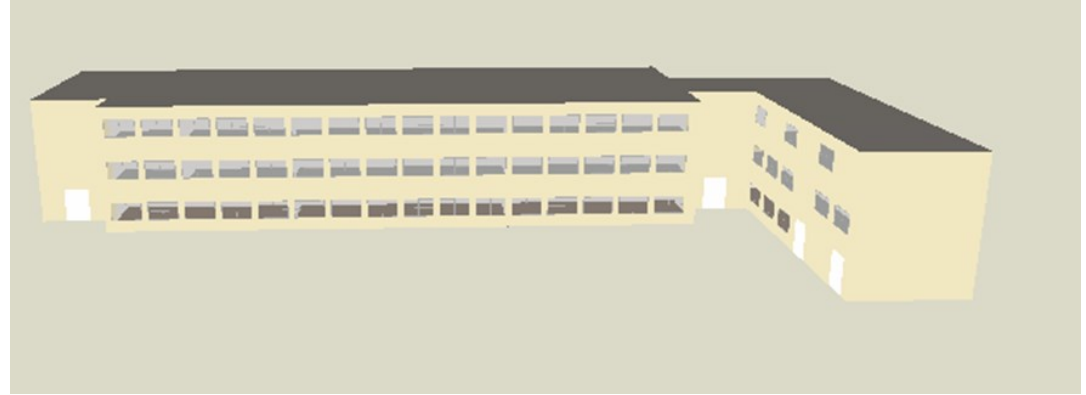
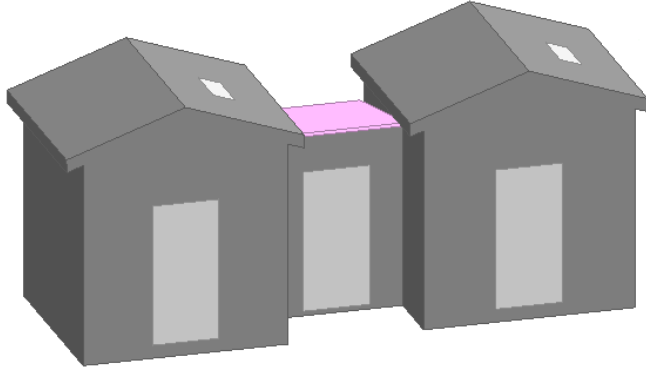




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# Energy efficiency of Demo Houses and Naval Academy



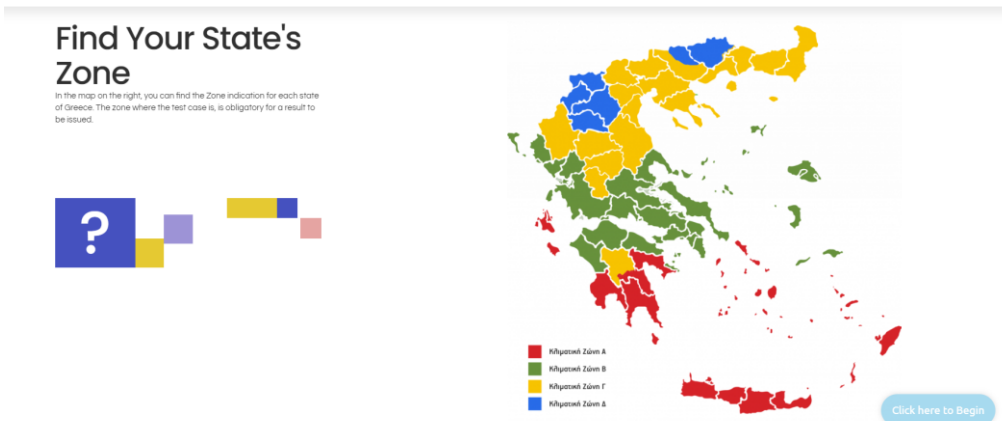
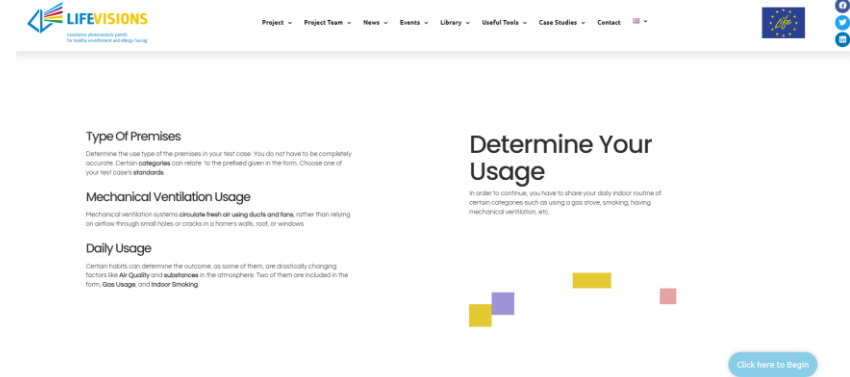
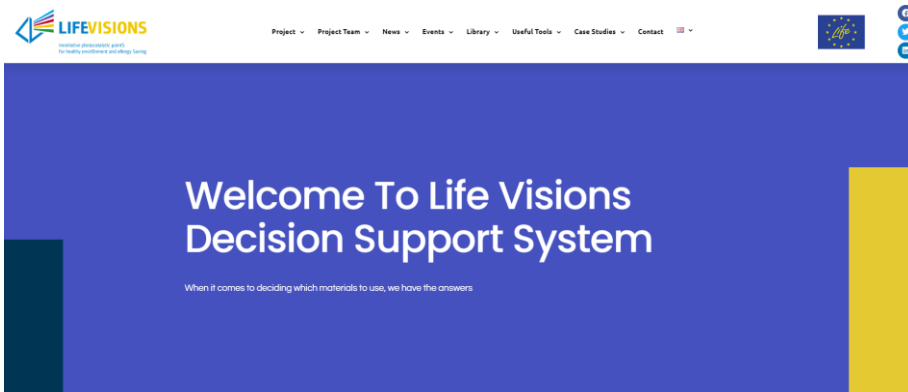




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# Instruction and Password Page



This content is password protected. To view it please enter your password below:

Password:

ENTER



## Form Page and Results

# Complete The Form

<b>Mechanical Ventilation usage:</b>	<b>State's Zone:</b>
<input type="text" value="Yes"/>	<input type="text" value="A"/>
<b>Type of Premises:</b>	<b>Smoking indoors:</b>
<input type="text" value="Offices"/>	<input type="text" value="Yes"/>
<b>Gas Usage:</b>	<b>City's Zone:</b>
<input type="text" value="No"/>	<input type="text" value="Suburban"/>
<b>Construction Year:</b>	<b>Square Meters:</b>
<input type="text" value="2005"/>	<input type="text" value="350"/>
<input type="button" value="SUBMIT"/>	



***Establishment of LIFEVISIONS company:***

***ProVisionAir+***

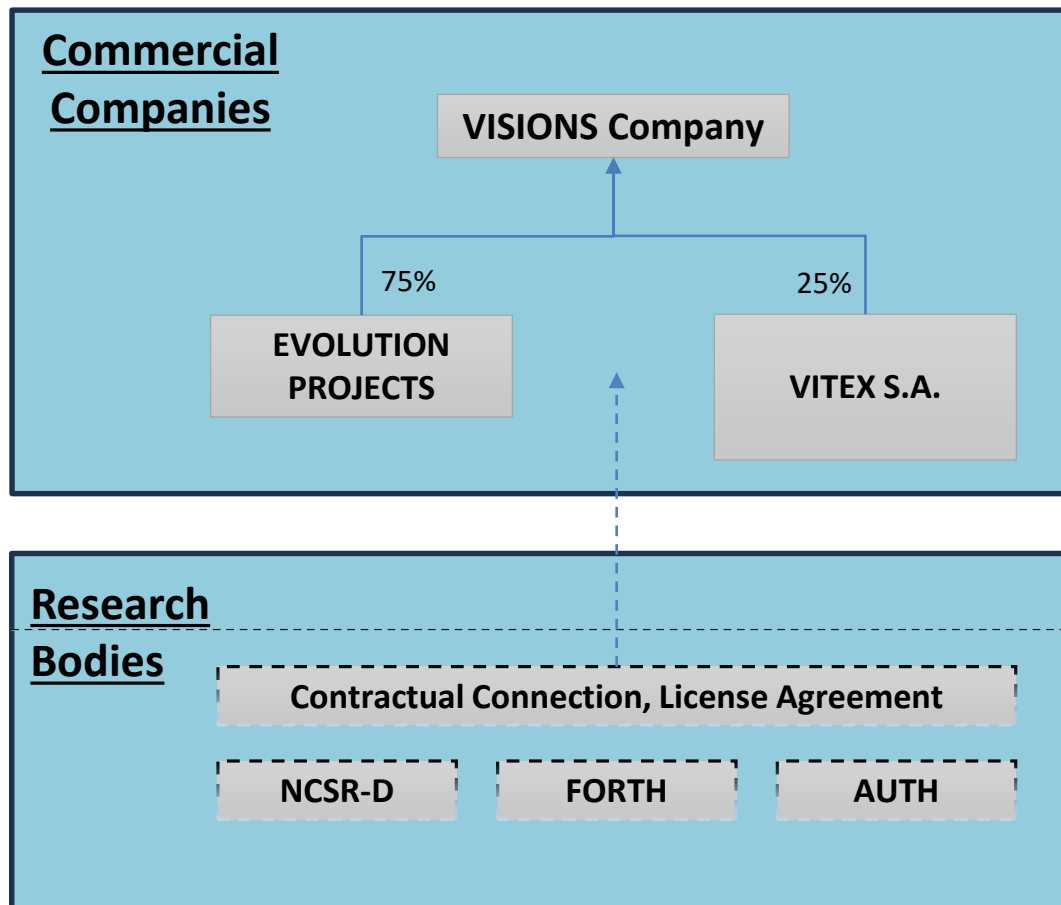
Promote the photocatalytic technology in terms of both photocatalytic building materials as well as the IT tools that accompanies them

All partners will be involved

*Key "After Life" action*



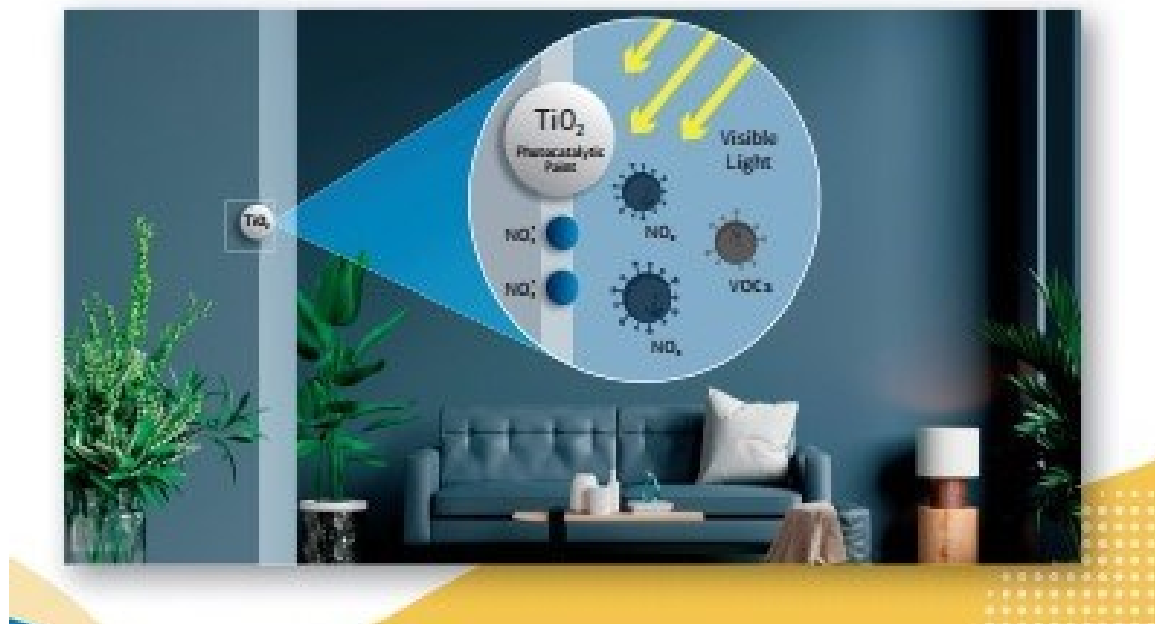
## ***ProVisions+***



ΕΜΠΟΡΙΚΗ ΕΤΑΙΡΕΙΑ – ΕΤΑΙΡΟΙ ΕΡΓΟΥ: Η αξιοποίηση των αποτελεσμάτων του έργου θα γίνει από μία **νέα Εμπορική Εταιρεία**, ιδρυόμενη από τους εταίρους που έχουν σήμερα εμπορική νομική φύση δηλ. τις εμπορικές εταιρείες.

Η νέα Εταιρεία θα συμπράξει με τους άλλους εταίρους (ερευνητικοί φορείς) με σχετικές Συμβάσεις βάσει των οποίων οι ερευνητικοί φορείς θα παραχωρούν δικαίωμα χρήσης της τεχνογνωσίας τους και θα υποστηρίζουν την δραστηριότητα της εταιρείας.

**The comparative advantage of VISIONS** outcome is not only the innovative product (VISIONS photo-paint) but also the full set of IT tools that accompanies it.



**To that end** the proposed actions give a clear and **integrated answer** to the **real needs of the market** in terms of:

- **the innovative photo-paint**
- **recommendations** (how to use these materials and techniques),
- **design tools**
- **simulations** of possible **air pollution and energy consumption** abatement under real conditions.





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# <http://lifevisions.gr/>

## LIFE VISIONS Facebook page

The project Facebook page is available as [LifeVisions](#). (@LifeVisionsGR)

## LIFE VISIONS Twitter account

The project Twitter account is available as [LifeVisionsGR](#), (@gr\_visions)

**VISIONS - LIFE19 ENV/GR/000100**

Καινοτόμα Φωτοκαταλυτικά Χρώματα για Υγιές Περιβάλλον και Εξοικονόμηση Ενέργειας / Innovative photocatalytic paints for healthy environment and energy saving

Βελτιώνουμε  
περιβαλλοντικές  
και οικονομικές  
εξοικονομούμε ενέργεια

Κύριο αντικείμενο του έργου είναι η παραγωγή μιας καινοτόμου φωτοκαταλυτικής βαφής, η οποία στοχεύει στη βελτίωση της ποιότητας του εσωτερικού περιβάλλοντος, ενώ θα επιτρέψει σημαντική εξοικονόμηση ενέργειας στα κτίρια.

Προϋπολογισμός: 1.403.752€ (Ποσοστό συγχρηματοδότησης 54%)

Διάρκεια υλοποίησης: 07/09/2020 - 06/09/2023

Εταίροι του έργου:

Συντονιστής: Εθνικό Κέντρο Τρεφών Φυσικών Επιστημών «ΔΗΜΟΚΡΙΤΟΣ»  
Ίδρυμα Τεχνολογίας και Έρευνας (ITE)  
Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης  
VITEX A.E.  
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