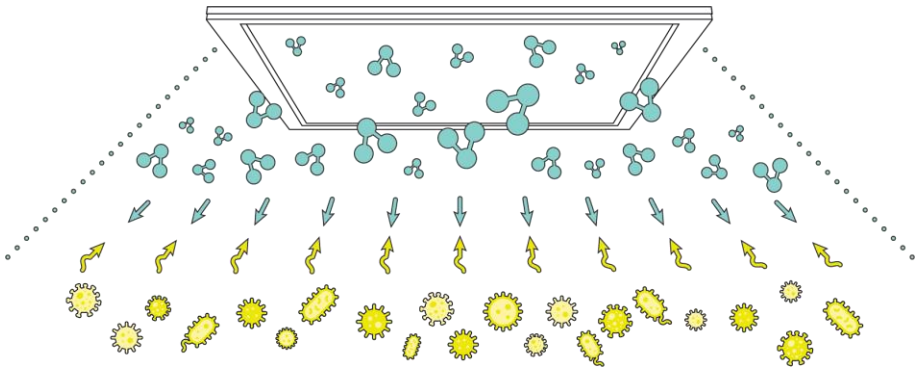
LIGHTICO

The science of infection control with TiO_2

CleanLight uses light emitting diodes and TiO_2 to clean the air. Coated with our patented nanomaterial, CleanLight deactivates airborne organic pathogens through photocatalytic oxidation. Generating hydroxyl free radicals, these highly reactive diatomic molecules oxidise microorganisms and gases when brought into contact with the panel through naturally occurring convection air currents

CleanLight



CleanLight

CleanLight uses Titanium dioxide (TiO_2) as a photocatalyst to generate an area of Photocatalytic Oxidation that is able to inactivate pathogens (like bacteria and viruses).

Titanium dioxide (TiO_2) has been widely used as a photocatalyst in many environmental and energy applications due to its efficient photoactivity, high stability, low cost, and safety to the environment and humans.

Photocatalysis is the activity occurring **when a light source interacts with the surface of semiconductor materials**, the so called photocatalysts. CleanLight uses TiO_2 as a photocatalyst.

This technology was first identified by AKIRA FUJISHIMA & KENICHI HONDA in 1972 and was quickly utilised in the reduction of cyanide in water.

UV radiation of 320-380 nm has been previously used to excite the photocatalyst (TiO_2). However long term exposure of the skin to this level of radiation can be harmful to human skin.

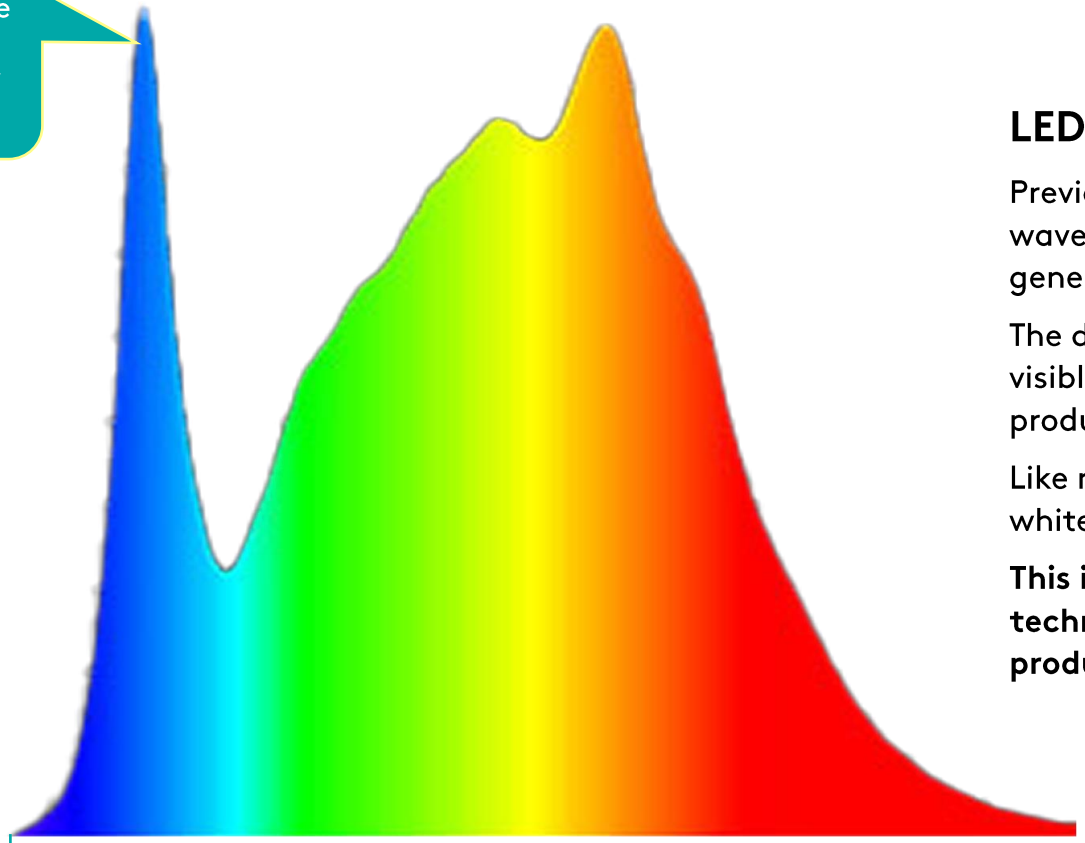
CleanLight does not use UV light

CleanLight uses light on the visible spectrum to excite the photocatalyst (TiO_2) and generate Photocatalytic Oxidation (PCO), oxidising pathogens that come into range. By using light on the visible spectrum this process is created safely by replacing existing LED lights already in use in most environments.

PCO is proven to safely kill viruses & bacteria

Peak “blue light” in the visible light spectrum generates the activity in the TiO_2.

4000K Panel



10 nm – 400nm

Ultraviolet

400nm – 780nm

Visible Light

780nm – 1mm

Infrared

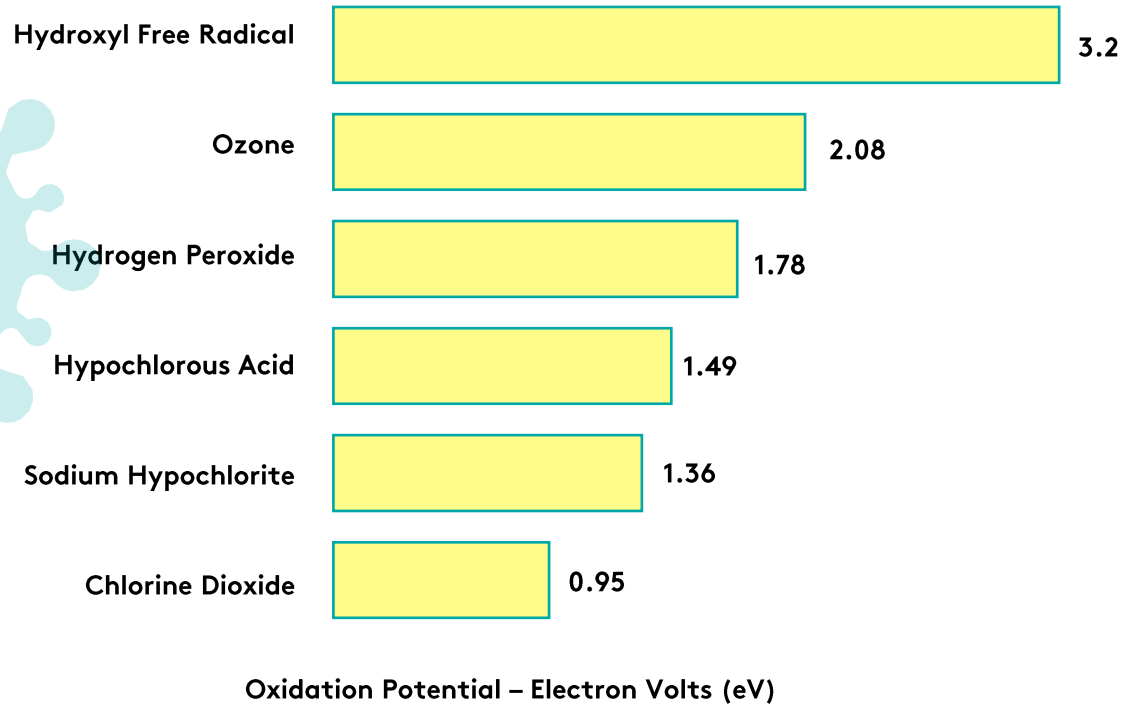
LED makes the difference

Previous applications of TiO_2 relied upon ultraviolet light with a maximum wavelength of 400 nm to activate the Photocatalytic Oxidation and generate the hydroxyl free radicals.

The development of LED lighting which is able to provide the full range of visible light wavelengths down to 380 nm means that the same activity produced from UV is possible without the associated risks.

Like most LEDs CleanLight panels use phosphor to convert blue light to white light, further restricting the emitting of and UV light.

This innovation massively expands the potential applications for this technology. Both the formula of the TiO_2 nanomaterial and the production of the panel are protected by international patents.



Oxidation Potential

The differing oxidation potential, or disinfection ability of similar types of disinfection is measured in Electron Volts and provide an Oxidation Potential.

By exciting the TiO_2 CleanLight photocatalytic oxidation is generated which releases Hydroxyl Free Radicals. It is there free radicals that attached micro organisms, changing their structure and destroying the bonds that link the carbon and oxygen atoms.

Other methods and substances that use a similar process are things like Ozone and Hydrogen Peroxide. However there are risks to humans and animals while these materials are being used meaning that spaces need to be sealed during their application.

With an oxidation potential of 3.2 eV, Hydroxyl Free Radicals generated by TiO_2 PCO are significantly more efficient at deactivating pathogens that bleach (Hydrogen Peroxide)

The excited photocatalyst (TiO_2) on the surface of CleanLight generates Photocatalytic Oxidation (PCO) with more efficiency and with no risk to humans and animals compared to similar methods currently being used to deep clean environments.

CleanLight is the safest and most efficient cleaning solution

Oxidation

At its most basic level, **oxidation** is the loss of electrons. It happens when an atom or compound loses one or more electrons.

Hydroxyl free radicals naturally form in the atmosphere through the reaction of sunlight with ozone. **CleanLight generates the same activity bringing fresh air inside.**

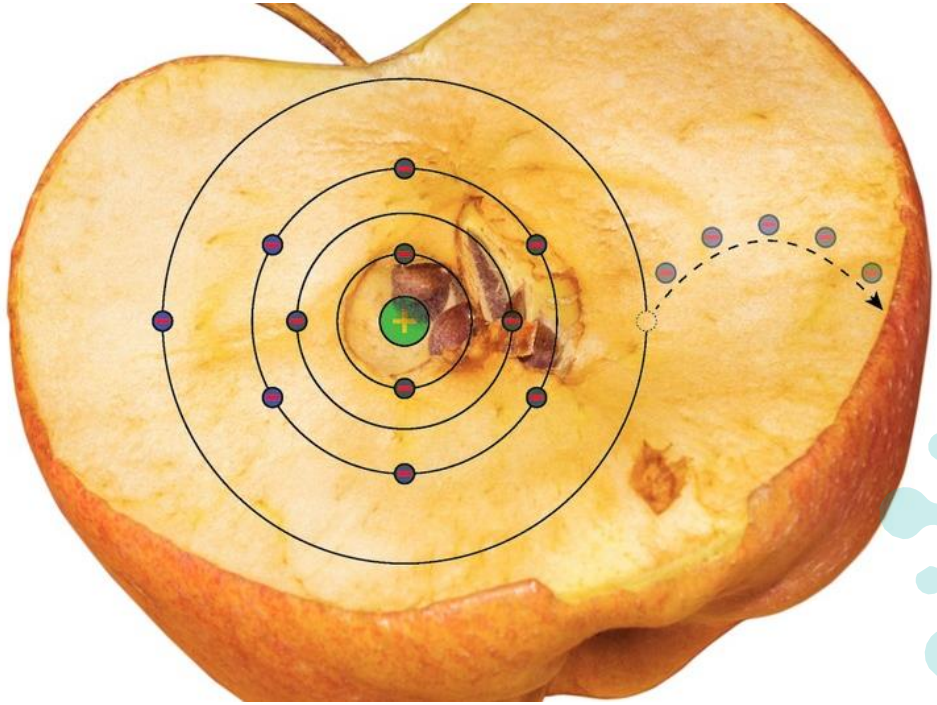
The production of hydroxyl free radicals through the photocatalytic reaction of the titanium dioxide (TiO_2) means that this loss of electrons is massively increased when particles come into the effect area of the CleanLight panel.

For simple particles and gases (like CO_2) this can result in molecular structure breaking down instantly as soon as it comes into range of the panel.

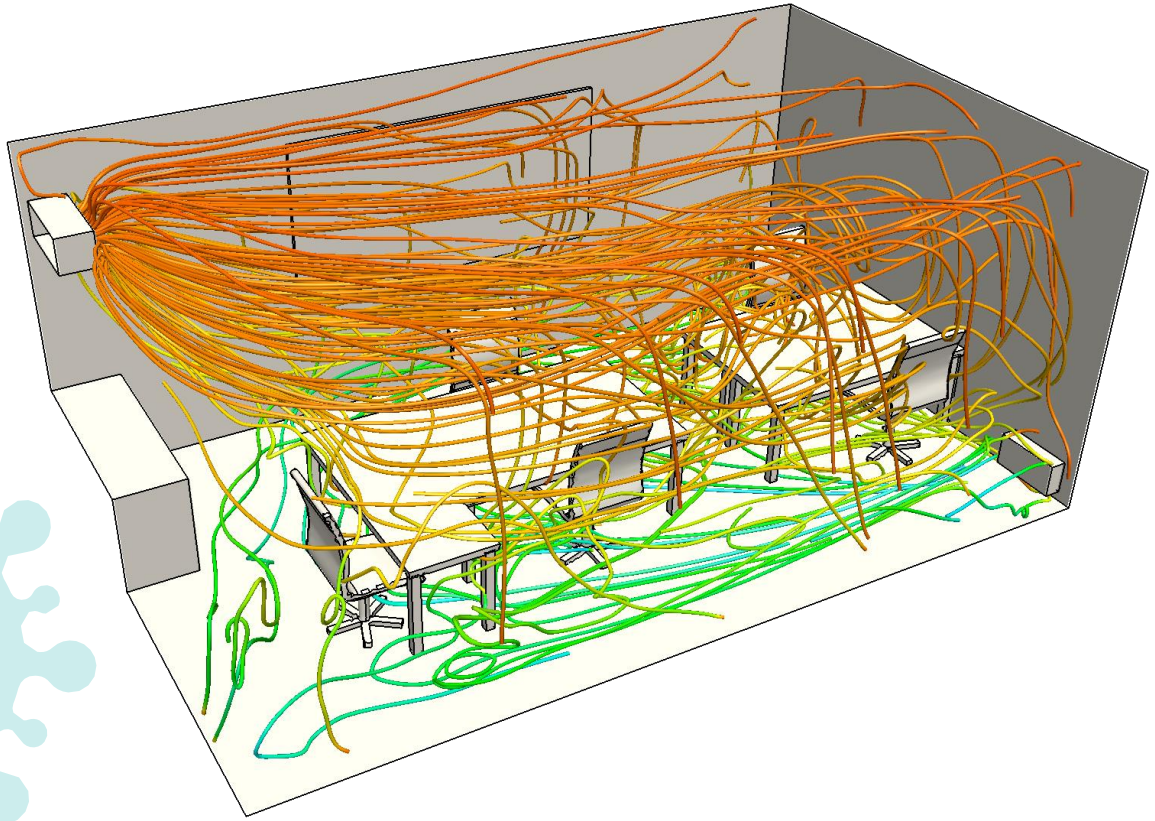
For more complex organisms (like SARS-CoV-2) studies have shown that as partially oxidized organisms move away from the effective area and come into contact with other similar organisms a chain reaction is triggered. The oxidation spreads from one organism to the other meaning that even those that haven't come into direct contact with the effective area start to become deactivated. **This process increases the effectiveness of CleanLight by a factor of 10X.**

For highly complex organisms (like humans) there is no impact from oxidation as the hydroxyl free radicals are absorbed by sweat and oil before they reach the skin.

*Gas-phase photolytic production of hydroxyl radicals in an ultraviolet purifier for air and surfaces - Link



CleanLight accelerates naturally occurring oxidation and causes a chain reaction that increases its effectives by a factor of 10X.



The importance of convection currents in a passive system

CleanLight is a passive air cleaning system, in that as air passes across the surface of the panels the hydroxyl free radicals that are released deactivate pathogens.

The benefits of a passive system is that it is easy to install, doesn't increase power consumption and with no moving parts there is a little of no maintenance required over the full lifespan of the product.

The process of natural convection, where warm air rises and cooler air sinks provides a circular patten of air flows that benefit the passive nature of a CleanLight installation.

In office environments where the air emitted by staff is close to body temperature (40°C) this rises against the ambient air (around 20°C) until it reaches the ceiling which then travels across the surface of the panels.

This circular air flow created by high occupancy enables CleanLight to operate more effectively but also increases the risk of onward airborne transmission of viruses. By installing CleanLight this risk is mitigated and the convection currents in an office no-longer pose a risk to staff and visitors.

CleanLight requires not additional power or maintenance

Independent Validation by Dr Carl Edwards

All the data presented in the pack has been independently inspected and validated my Dr Carl Edwards of the University of Leicester.

Dr Edwards, a commercial manager at Leicester University with over 35 years commercial and academic experience in clinical science and microbiology reviewed the data as part of his work with the Leicester Life Sciences Accelerator.

He provided written confirmation to Lightico as to the interpretation of the data confirming its validity and he also provided his own summary as to the efficacy of the product.

An extract of the letter he provided is supplied here...

The full letter can be downloaded here.

I would like to comment that the data provided confirms a good performance as an anti-bacterial and anti-fungal product against an internationally recognised range of organisms used for assessing disinfectant properties.

The CleanLight product produced significant reductions in E. coli, S. aureus, K. pneumoniae and C. albicans; that would be appropriate with it being regarded as a disinfectant product.

The additional research also shows CleanLight has a significant activity against SARS-CoV-2. This would be expected given the results against bacteria and fungi, but the explicit evidence provides additional support for the CleanLight being a generally applicable disinfectant product.

The intended use of CleanLight as part of a whole room hygiene solution is well supported by the data that has been generated. The exposure times of approximately an hour, generating 80-99% decrease in viable organisms, would translate well into reducing the microbial burden of a space illuminated constantly throughout a working day.

CleanLight has been tested to ISO standards and independently validated

Testing for SARS-CoV-2

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the technical name of the virus that causes the coronavirus disease, COVID-19. As of June 2021 over 3.81m people worldwide have died from COVID-19.

Tests were conducted to quantify the effectiveness of CleanLight against airborne SARS-CoV-2.

Active SARS-CoV-2 was placed on a lab plaque, 15 cm below the light panel surface. The light and test sample were placed in a $6m^3$ sterilised chamber. No air movement was applied to the chamber.

The light was switched on and samples taken at specific 15 minute intervals over a 60 minute period.

Over the course of 60minute exposure to CleanLight the following levels of viral load were recorded:

Time sample taken	Viral Load Reduced
15 mins	0%
30 mins	28%
45 mins	43%
60 mins	72%

In laboratory conditions CleanLight is PROVEN to kill SARS-CoV-2.

Current research identifies the half-life of SARS-CoV-2 when airborne at 3 hours* increasing the risk of transmission and surface contamination significantly.

van Doremalen N, Bushmaker T, Morris DH, et al. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *The New England Journal of Medicine*. 2020 Apr;382(16):1564-1567. DOI: 10.1056/NEJMc2004973

Testing for H1N1

Influenza A virus (H1N1) commonly known as "the flu" is an infectious disease which is a typical year can be contracted by between 5 and 15% of the population. This accounts for between 3 and 5 million cases worldwide. A respiratory illness transmission of influenza can be via contact or airborne means.

Prepared cells were exposed to a diluted strain of H1N1 for 1 hour with half the sample being used as a control and the second half used for testing.

The Reed-Muench method was used to calculate the $TCID_{50}$. From this the formula used for calculating viral inhibitory efficacy was:

Formula for calculating viral inhibitory efficacy: *percentage of inhibition = [1 - 10^ (-(viral load of the control group (Log10TCID50) - viral load of the experimental group (Log10TCID50)] x 100*

	Viral load ($Log_{10}TCID_{50}$)		
	1st	2nd	3rd
Virus Strains	4.0	5.7	5.7
Virus strains + JM	2.5	3.2	4.0
Cell strains	None	None	None
Cell strains + JM	None	None	None

In laboratory conditions CleanLight is PROVEN to kill 98.74% of H1N1 Influenza A virus.

With at least 5% of the population contracting The Flu each year and each case accounting for a minimum of 1.5 lost work days; the flu accounts for over 4 million lost working days every year

*Key Facts About Influenza (Flu) – CDC - https://www.cdc.gov/flu/about/keyfacts.htm

**Modelling the cost of influenza: the impact of missing costs of unreported complications and sick leave - https://pubmed.ncbi.nlm.nih.gov/21106057/

Testing for MRSA

Staphylococcus aureus (MRSA) is a type of bacteria that is resistant to several widely used antibiotics. This means infections with MRSA can be harder to treat than other bacterial infections.

The full name of MRSA is methicillin-resistant *Staphylococcus aureus*. Often called a "superbug".

Tests were conducted by the Guang Zhou Institute of Microbiology to quantify the effectiveness of CleanLight against MRSA.

MRSA was released into a $3m^3$ sealed test chamber and samples were taken after 60min exposure to CleanLight. These results were compared to the level of bacteria in the chamber after 60mins without the light turned on.

After 3 x 60mins exposure to CleanLight the following bacteria levels were recorded:

	Original Bacteria Count	Bacteria Count after Treatment	Reduction
Test 1	1.17×10^5	1.12×10^4	90.4%
Test 2	1.10×10^5	1.13×10^4	89.7%
Test 3	1.14×10^5	1.16×10^4	89.8%

In laboratory conditions CleanLight is PROVEN to kill 90% of airborne MRSA bacteria.

From over 80,000 cases of bacterial infections in the UK (including MRSA) over 12,000 people die*. MRSA accounts for an extra 1 million extra hospital days at the cost of £380m**

*Thirty-day all-cause mortality following MRSA, MSSA and Gram-negative bacteraemia and C. difficile infections – PHE – 2018/19
**Costs of healthcare-associated methicillin-resistant Staphylococcus aureus and its control - I. M. Gould , J. Reilly , D. Bunyan and A. Walker - 2010

Testing for E. Coli

Escherichia coli (E. coli) are bacteria found in the environment, foods, and intestines of people and animals. The bacterium is found in faeces and can survive several hours in the environment. E. Coli bacteria can cause a range of infections including urinary tract infection, cystitis (infection of the bladder), and intestinal infection. E. Coli bacteraemia (blood stream infection) may be caused by primary infections spreading to the blood.

In the past 12 months there have been 43,990 hospital admissions from E. Coli infection in the UK NHS.

Tests were conducted by the Guangdong Detection Center of Microbiology to quantify the effectiveness of CleanLight against E Coli.

The same method was used to that in the MRSA trials.

After 3 x 60mins exposure to CleanLight the following percentages of bacteria were eliminated:

Test 1 = 82.31%

Test 2 = 80.77%

Test 3 = 81.67%

Average Kill Rate = 81.58%

In laboratory conditions CleanLight is PROVEN to kill E. Coli to an 81% effectiveness.

The annual cost of E. coli bacteraemia was estimated to be £14,346,400, with third-generation cephalosporin resistance associated with excess costs per infection of £420*

*The health and cost burden of antibiotic resistant and susceptible Escherichia coli bacteraemia in the English hospital setting: A national retrospective cohort study - 2019 National Institute of Health Research

Surface Anti-Bacterial Testing

As well as acting as a photocatalyst TiO_2 has antimicrobial properties that deactivate virus and bacteria when coming into surface contact.

These properties were investigated by the Guang Zhou Institute of Microbiology by applying certain bacteria to the surface of the CleanLight Panel and a control panel without the TiO_2 treatment.

Samples were taken 24 hours after applying the bacteria and compared to the control.

After 24 hours the following kill rates were calculated:

Escherichia coli (E coli) = 99.9%

Staphylococcus aureus (MRSA) = 99.9%

Klebsiella pneumoniae = 99.8%

Candida albicans = 88.2%

In laboratory conditions the CleanLight surface is PROVEN to kill E. Coli to a 99.9% effectiveness.

E. coli bacteraemia places a substantial cost burden on NHS hospitals, being associated with an excess length of stay of almost four days per infection and an annual cost of over £14 million*

*The health and cost burden of antibiotic resistant and susceptible Escherichia co/ibacteraemia in the English hospital setting: A national retrospective cohort study - 2019

Room tests for NO_2 and CO

A recent test conducted at Lightico's own testing facility was designed to quantify the effectiveness of CleanLight in dealing with potential toxins in the air.

The toxins identified were Nitrogen dioxide (NO_2) and Carbon Monoxide (CO). Both toxins, generated by vehicle engines, are significant contributors to urban pollution.

Testing apparatus were established in an enclosed room, approximately $3m^2$ with a suspended ceiling 2.5m high. 2 CleanLight LED panels were installed in the ceiling and wired into the existing lighting circuit.

Damp wood was safely burnt inside the room, allowing smoke to fill the room increasing the CO and NO_2 levels, well beyond background norms.

The lights were switch on and a timer started to measure the reduction of the respective levels of CO and NO_2 over time.

The results are detailed here.

NO2 – 100% of the NO_2 detected in the room was removed within 1min 26 seconds.

CO – 67.39% of CO was removed from the room in 6mins. A 25% reduction was achieved within 3 minutes making the room safe to occupy.

In an enclosed room all NO_2 was removed in less than 1.5 minutes and safe levels of CO archived in 3 mins.

Two million Londoners – including more than 400,000 children – are living in areas which exceed legal limits for air pollution*

*Updates to the London Atmospheric Emission Inventory (LAEI) – April 2019

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