



# Research overview



CityTree

# SUMMARY

## Key parameters:



General specs



Fine dust particle reduction performance



Black carbon



Virus particles



Germs



Cooling Performance

## ENVIRONMENTAL PERFORMANCE

Extensive measurements of the particle number concentration of fine and ultrafine particles as well as the humidification and cooling performance were performed. A filter effect of **53% at 1m distance** was observed. In addition, at a distance at 1m the CityTree was measured with a cooling effect of **4 °C**.



## ILK DRESDEN- INVESTIGATION OF A MOSS MODULE TO SEPARATE OR KILL VIRAL GERMS

In this project, an air filter solution based on vital moss mats, called the CityTree, should be investigated to what extent they are able to separate or inactivate coronaviruses. Consequently, the moss modules eliminates or inactivates the tested coronavirus in the air, by an **depletion by 20%**.



## RECURRENT MEASUREMENTS ILK DRESDEN

The filter effect on fine dust concentrations (PM1 to PM8, see on page 2) of about **82%** on average were proven by the renowned and independent Institute for Air Handling and Refrigeration (ILK) Dresden and confirmed in recurring measurement.



## TROPOS- MEASUREMENT CAMPAIGNS "H2020 PROGRAMME"

Three different measurement campaigns were conducted for several CityTree arrangements with the purpose to evaluate air quality improvements in the outflow field of one or several CityTree(s). As a result, a filter efficiency of ambient air and reduction of fine and ultrafine particles by up to **30% have been observed**.



# KEY FACTS

GENERAL SPECS		
Moss module (0,48 m <sup>2</sup> ) hourly volume (0,3 m/s fan speed):	<b>531,0</b>	m <sup>3</sup> /h
Cooling performance per Moss Module (0,3 m/s fan speed):	<b>816</b>	W (watts)
Moisturing performance per Moss Module (0,3 m/s fan speed):	<b>1,344</b>	kg/h

FINE DUST PARTICLE REDUCTION PERFORMANCE		
A solution of the problem of air pollution comes from nature. Special moss cultures have the ability to filter pollutants from the air. Fine dust particles are electrostatically attracted to this surface similar to a microfibre cloth.		
PM1	30	%
PM2	63	%
PM3	70	%
PM4	70	%
PM5	75	%
PM6 (average particle in diameter and weight)	82	%
PM7	90	%
PM8	96	%

BLACK CARBON		
black carbon diameters: between 0,01 and 0,3 micrometres (approx. 10% of the whole fine dust concentration)		40%

VIRUS PARTICLES		
virus reduction performance (University Leipzig) - feline Corona viruses comparable to SARS2-COVID-19 - virus diameters: between 0,12 and 0,16 micrometres		20%

GERMS		
bacteria reduction performance		2,08%
mould reduction performance		46,40%
TOTAL germs reduction		17,26%

COOLING PERFORMANCE		
1m		4°C
3m		1,5°C
5m		1°C

NOX		
different measurements between 0-8%. (improvements planned for Q3/2021)		3%

# ENVIRONMENTAL PERFORMANCE

## FILTER EFFECT

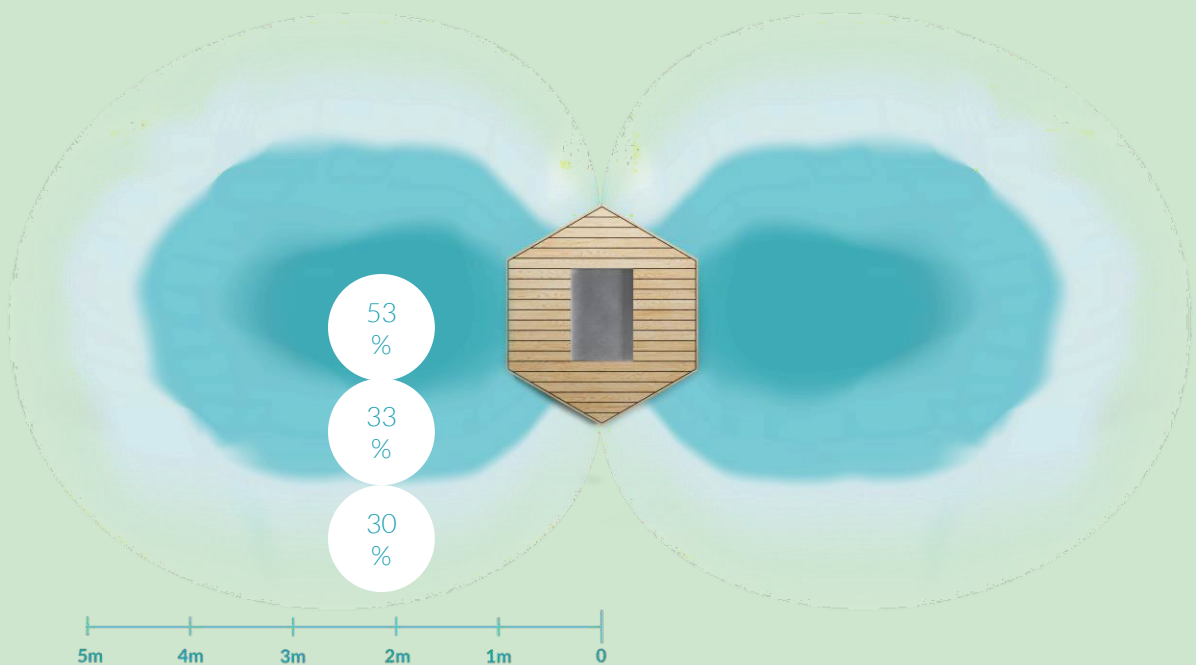
According to independent research from Jan 10-11, 2020 from scientific partner Leibniz Institute for Tropospheric Research TROPOS

Extensive measurements of the particle number concentration of fine and ultrafine particles were performed in January 2020 for the determination of the filter effect of the new City Tree model CT2020. Behind the CT three measurement platforms were assembled. The distances to the CT were 1 m, 3 m and 5 m.

## COOLING EFFECT

According to independent research from Oct 17th 2019 from scientific partner ILK Dresden.

Extensive measurements of the humidification and cooling performance were performed from October until December 2019. Therefore, the City Tree was installed inside a production hall within an arrangement of three City Trees. Also, behind the CT three measurement platforms were assembled. The distances to the CT were 1 m, 3 m and 5 m.



For ultrafine particles the impact of the CT can be described with the following efficiency factors:

**1m: 53% Filter Effect**  
**3m: 36% Filter Effect**  
**5m: 33% Filter Effect**

For humidification and cooling performance, the impact of the CT can be described with the following efficiency factors:

**1m: 4 °C Cooling Effect**  
**3m: 1,5 °C Cooling Effect**  
**5m: 1 °C Cooling Effect**

# ILK DRESDEN MEASUREMENT "H2020 PROGRAMME"

## DESCRIPTION:

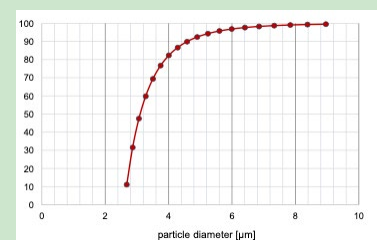
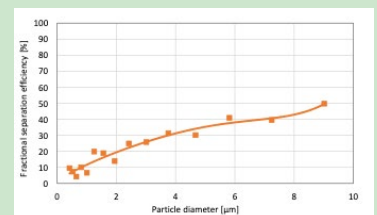
Within the H2020 programme an investigation of the range of influence and the efficiency of the City Tree was established. Four measurement campaigns were carried out at several City Tree arrangements with the purpose to evaluate air quality improvements in the outflow field of the City Tree(s). The impacts on temperature, humidity and fine dust concentration as well as microbiological contamination were subjects to the investigations summarized below.

Two out of four campaigns were arranged inside a production hall, focussing on the range of influence at several distances from the moss. Additionally, two campaigns were set outside. Hereby, the performance measurements targeted a reduced number of measurement points, especially upstream and downstream points of the moss and the centre of the "clean air zone".

Within the cooling effect temperature differences between the reference and the downstream position were determined.

The filter performance of particulate matter was evaluated through concise particulate matter measurements. In detail, different measurements techniques were used in order to obtain reasonable results for different particle size ranges, depending on the current setup and conditions.

Inside	Fine Dust	A separation efficiency was estimated up to 50%.
In October and December 2019, in Bestensee up to three City Trees were examined in its efficiency, especially in the "clean air zone".	Cooling	The cooling effect showed were more homogeneous, in detail from 5 to 3 K (0.3 m/s) and from 3.5 to 1.5 K (0.1 m/s)
Outside	Fine Dust	A good fine dust separation was measured at 5 $\mu\text{m}$ above 90%.
In July 2020, at the Walter-Benjamin-Platz in Berlin City and at the CGS area in Bestensee three City Trees were analysed in their "clean air zone". First comparing all at the same time, then concentrating on one City Tree.	Cooling	With a direct downstream position, up to 6K cooling effect was examined.



The resulting performance of the city tree contained a local air quality impact, evaluated downstream near the moss, showing a significant cooling effect up to 6 K, depending on the operation point and the surrounding air conditions. Furthermore, an ambient fine dust removal could be observed up to 20% in the nanometre size range.

# TROPOS- MEASUREMENT “H2020 PROGRAMME”

## DESCRIPTION:

Within the H2020 programm an investigation was made to evaluate the filter efficiency of the City Tree. Three different measurement campaigns were conducted for several CityTree arrangements with the purpose to evaluate air quality improvements in the outflow field of one or several CityTree(s). The impacts on coarse, fine and ultrafine particles and their number, mass and black carbon concentration were subjects to these investigations.

The first campaign was selected to show the filter efficiency of the City Tree inside a huge workshop hall in Bestensee. The performance measurement was done several meters away from the CityTree. Next, the second campaign arranged three CityTrees in the workshop, analyzing the particule size distribution, the number and mass concentration. The third campaign took place at the Walter-Benjamin-Platz in Berlin City, to evaluate the performance of the CityTrees in the outside world.

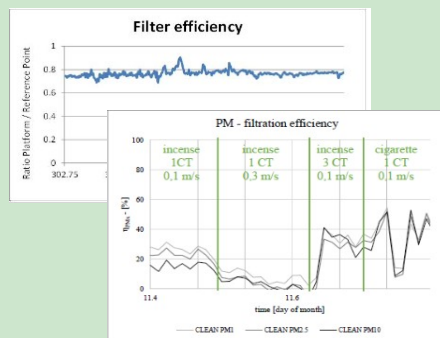
To determine the reduction of particle number concentration, particle mass concentration as well as black carbon concentration, different measurements were set up and compared to reference measurements outside the flow field.

### Inside

In October 2019 and January 2020, in Bestensee Berlin, two campaigns managed to analyze the CityTrees filter efficiency by focussing on one CityTree and on three CityTree within their “clean air zone”.

1 CityTree: The mean filter efficiency of the CT is 0.77.

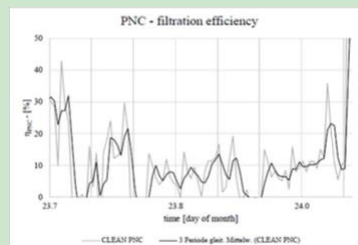
3 CityTrees: The efficiency is 45 percent in average for a distance of 1 m and at least 25 percent for 3 and 5 m platform measurements



### Outside

In July 2020 at the Walter-Benjamin-Platz in Berlin City, one campaign took place to analyze the filter efficiency of 6 CityTrees within 2 “clean air zones”.

Particle number concentration was reduced by up to 30 %



Consequently, **the outcome** showed a filter efficiency of ambient air and reduction of fine and ultrafine particles by up to 30% in close environments. For urban environments, mean reductions of 10 % for the particle number concentration and up to 40 % for black carbon were measured for individual time periods.

# ILK DRESDEN INVESTIGATION OF A MOSS MODULE TO SEPARATE OR KILL VIRAL GERMS

## DESCRIPTION:

In this project, an air filter solution based on vital moss mats, called the CityTree, should be investigated to what extent they are able to separate or inactivate coronaviruses. At the university of Leipzig moss modules from the City Tree were installed in a test stand in an S2 safe laboratory. The investigation period was on November 30, 2020.

The test setup consisted of the test bench in the safety laboratory, to which the moss module was connected directly via an adapter plate. The viruses used are the feline coronavirus, which is harmless to humans. After a subsequent biological analysis of the solution with regard to the virus concentration made it possible to obtain information on the extent to which the virus concentration was reduced by the built-in moss filter.



*Images of the testing environment at ILK Dresden*

**In summary**, we can say that the moss module eliminates or inactivates the tested pathogen feline coronavirus in the air. Under the test conditions there was an average depletion of **20%**.

# WE GROW FRESH AIR



**greencity  
solutions**

Green City Solutions GmbH | Fernstrasse 27 | 15741 Bestensee  
[info@mygcs.de](mailto:info@mygcs.de) | +49 (0) 33763 222 144