



Design project III

# Outdoor Air Purifier

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Industrial Design  
IDC School of Design

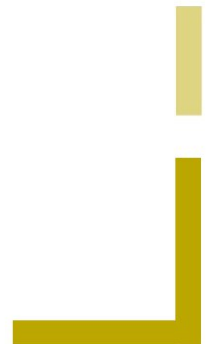
Guide- Avinash Shende

# ACKNOWLEDGEMENT



I would like to sincerely thank my guide Prof. Avinash Shende for his invaluable guidance at every stage of this project. I would also like to thank the faculty, staff and students of Industrial Design Centre for their kind help and useful suggestions.

My special thanks to Prof. Kums for giving me his valuable time and suggestions. At the end I would like to thank the workshop staff of IDC for their kind cooperation and help



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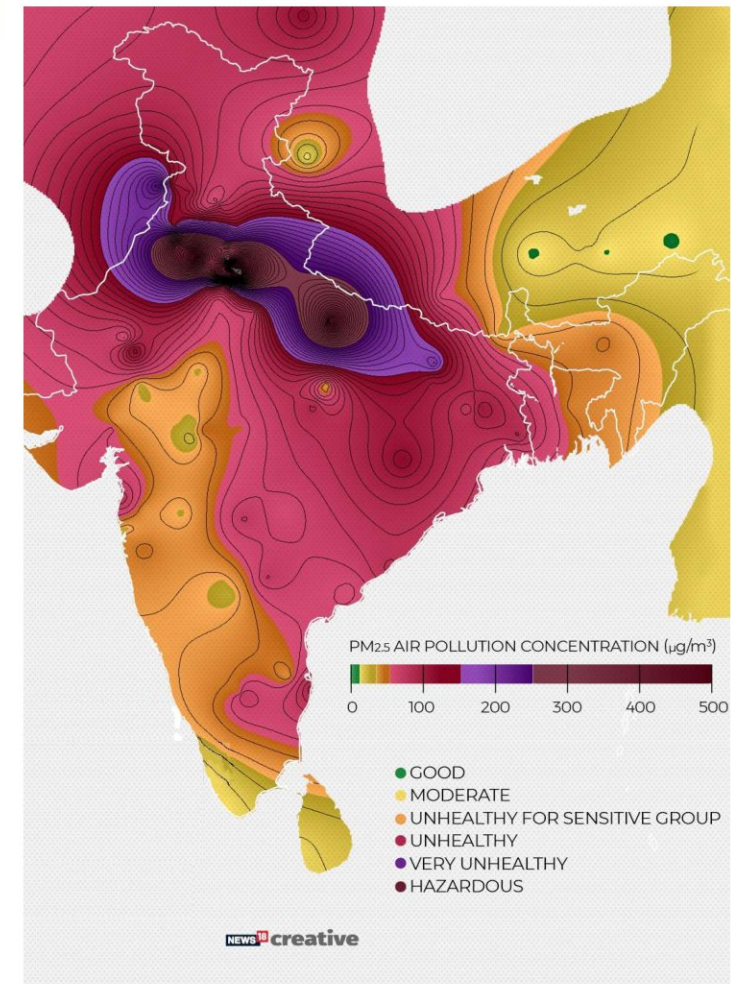
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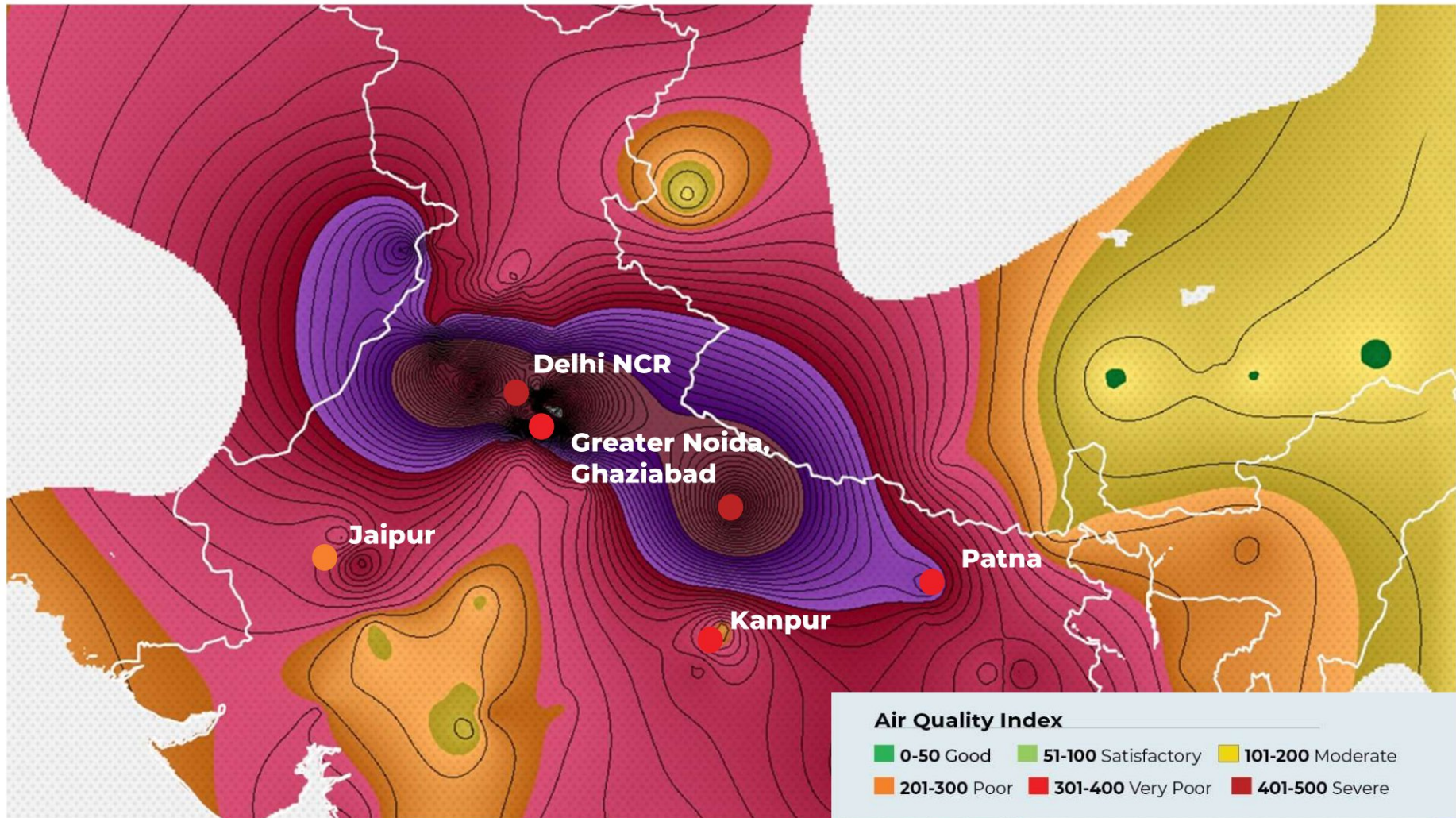
# 01 India's air pollution problem

I started this project with secondary research, trying to make sense of data that is already out there. Delhi pollution problem is very well documented. In this section I will articulate some of the findings.

- Indians lose more than 18 months of their lives to air pollution (Environment Science and Technology Letters)
- 22 out of 30 most polluted cities in the world, were in India in 2018 (Greenpeace)
- Total damage to India because of air pollution is USD 40 billion up to 2018 (World Bank)



*Air pollution distribution across India, with black parts are the worst effected place.*



*Delhi the nation capital is the host spot with neighbouring states having high levels of the pollution. The images names a few of the city effected by air pollution*

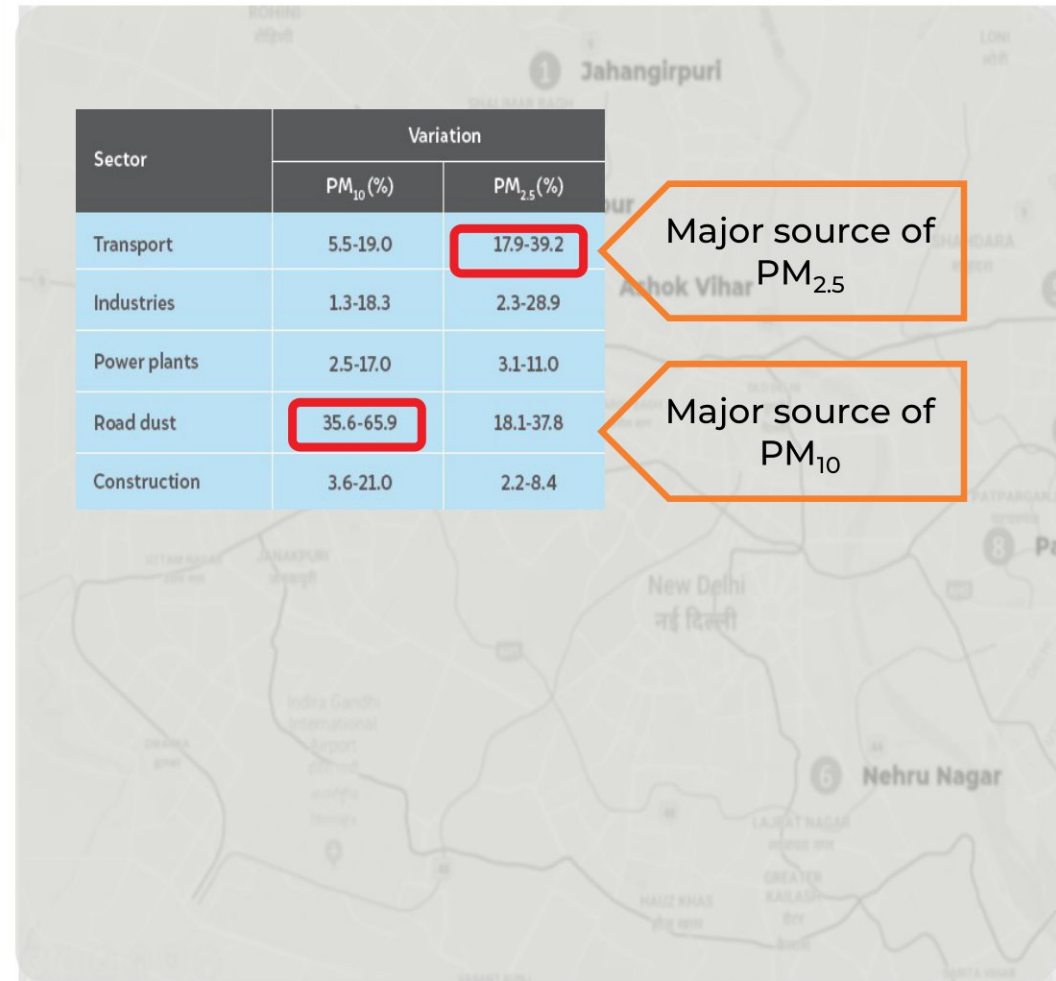


Doing a deeper dive into the data of Delhi we found top 10 areas having high concentration of air pollution.

# Pollution sources

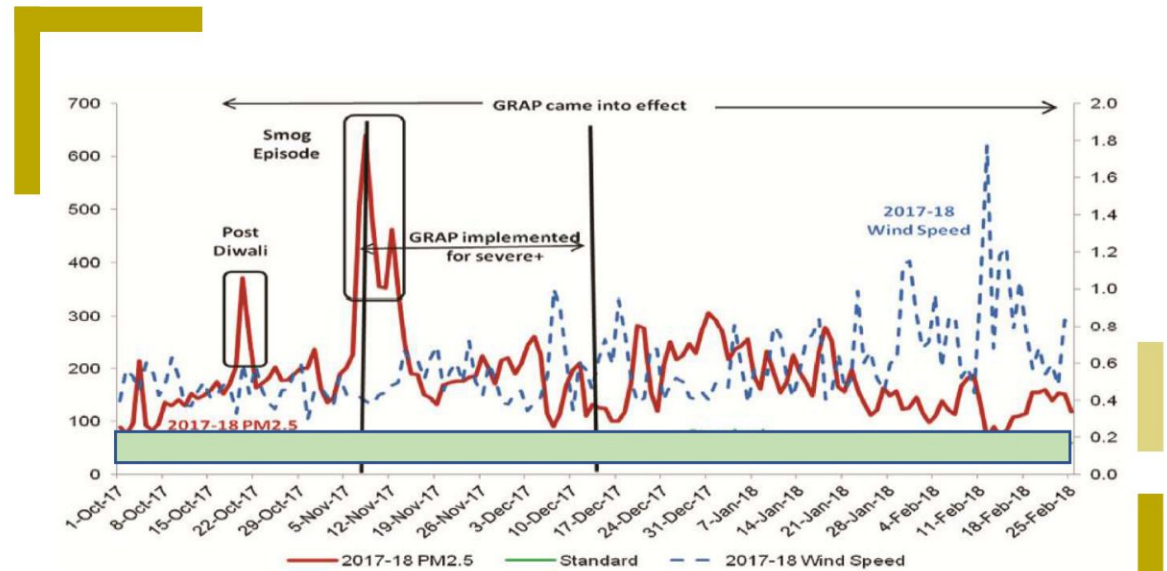
Council on Energy, Environment and Water (CEEW) did an elaborated report on the sources of air pollution. The report concluded that the vehicular pollution is the highest contributor of the PM<sub>2.5</sub> and road dust is the highest contributor for the PM<sub>10</sub>.

This shows that there is a higher concentration of PM in and around roads. This concludes an **air purifier in the vicinity of roads will be highly effective**. Subsequently consideration of this should be done while designing the outdoor air purifier.



*Vehicular pollution is the highest contributor for PM<sub>2.5</sub> while the road dust is the highest contributor for PM<sub>10</sub>*

# Seasonal Changes in AQI



Seasonal peaks happens during Diwali and stubble burning with a average AQI of 150

Due to the Diwali fire crackers and stubble burning in November the AQI becomes peak.

Even if we do some policy changes and reduce the air pollution of Diwali and stubble burning to zero still the average AQI for the whole year will be 150 which is very unhealthy.



# 02 Stakeholders

Any product that has mass populations exposure has many stakeholders. Here I tried to categorise them in five categories , to understand the requirements that each stakeholder has.



## Citizen

Family  
Children  
Working  
Professionals  
Daily wage  
workers



## Government Agencies

Municipal  
Corporation  
PWD



## Government

Policy Creation  
and Governance



## Technologist

RnD Thinktanks  
Technical  
Institutions  
NEERI



## Regulatory Agencies

Central Pollution  
Control Board

# Health issues due to air pollution

People had the constitutional right to live free of pollution.  
Long-term exposure to polluted air can have permanent health effects such as:

- Accelerated aging of the lungs
- Loss of lung capacity and decreased lung function
- Development of diseases such as asthma, bronchitis, emphysema, and possibly cancer
- Shortened life span



*Students have a very high exposure to the air pollution which can hinder the growth.*

# Health issues due to air pollution

Those most susceptible to severe health problems from air pollution are:

- Individuals with heart disease, coronary artery disease or congestive heart failure
- Individuals with lung diseases such as asthma, emphysema or chronic obstructive pulmonary disease (COPD)
- Pregnant women
- Outdoor workers
- Older adults and the elderly
- Children under age 14
- Athletes who exercise vigorously outdoors



*Daily wage workers are having high exposure to air pollution.*

# Contextual enquiry

Interviewed 14 citizen of Delhi.  
The focus was to understand what people feel about the air pollution and how they are dealing with it.  
Some question asked are as follows.

## Major findings of contextual enquiry

Immediate exposure resulted in Red eyes, sore throat and excessive breathing. Effected more to the people who has asthma and other cardiovascular diseases.

School going Children are effected, they are asked not to go out unless needed. They will usually stop playing during the month of November

People stopped morning walks for a time period, while some people accepted their faith and continued to workout

People are unaware about the inefficiency of the handkerchief and surgical mask

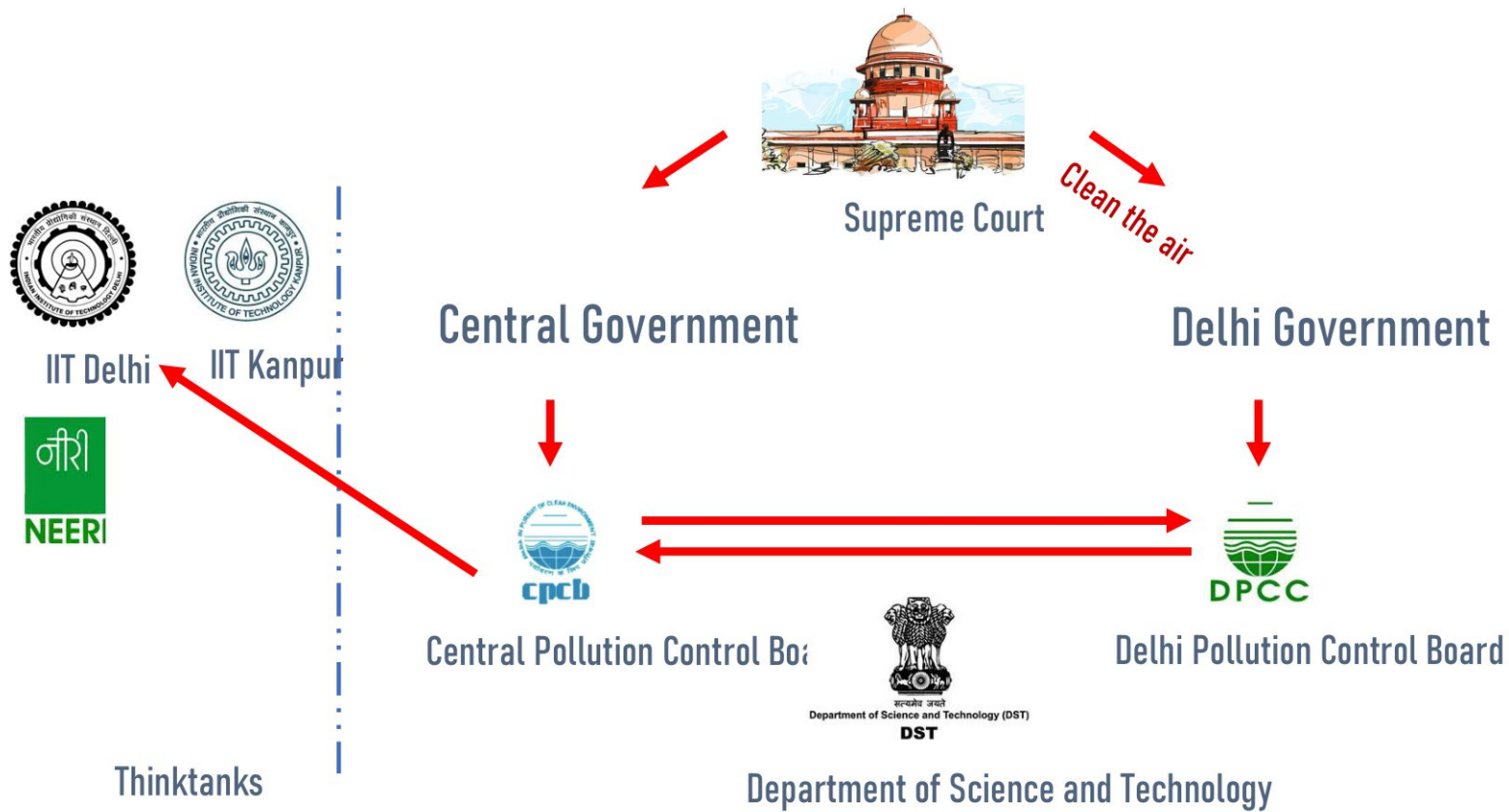
Daily wage workers are at higher risk because of the constant exposure to high Pm concentration



*Family taking morning walk during winters*

# Ecosystem

While listing down the stakeholders I realized that the ecosystem of such a problem is really complex and there is a huge role of policy making in this. Below is the ecosystem that helped me understand the ecosystem for policy making



## Thinktanks

*Air pollution distribution across India, with black parts are the worst effected place.*

# 03 History of air pollution in India

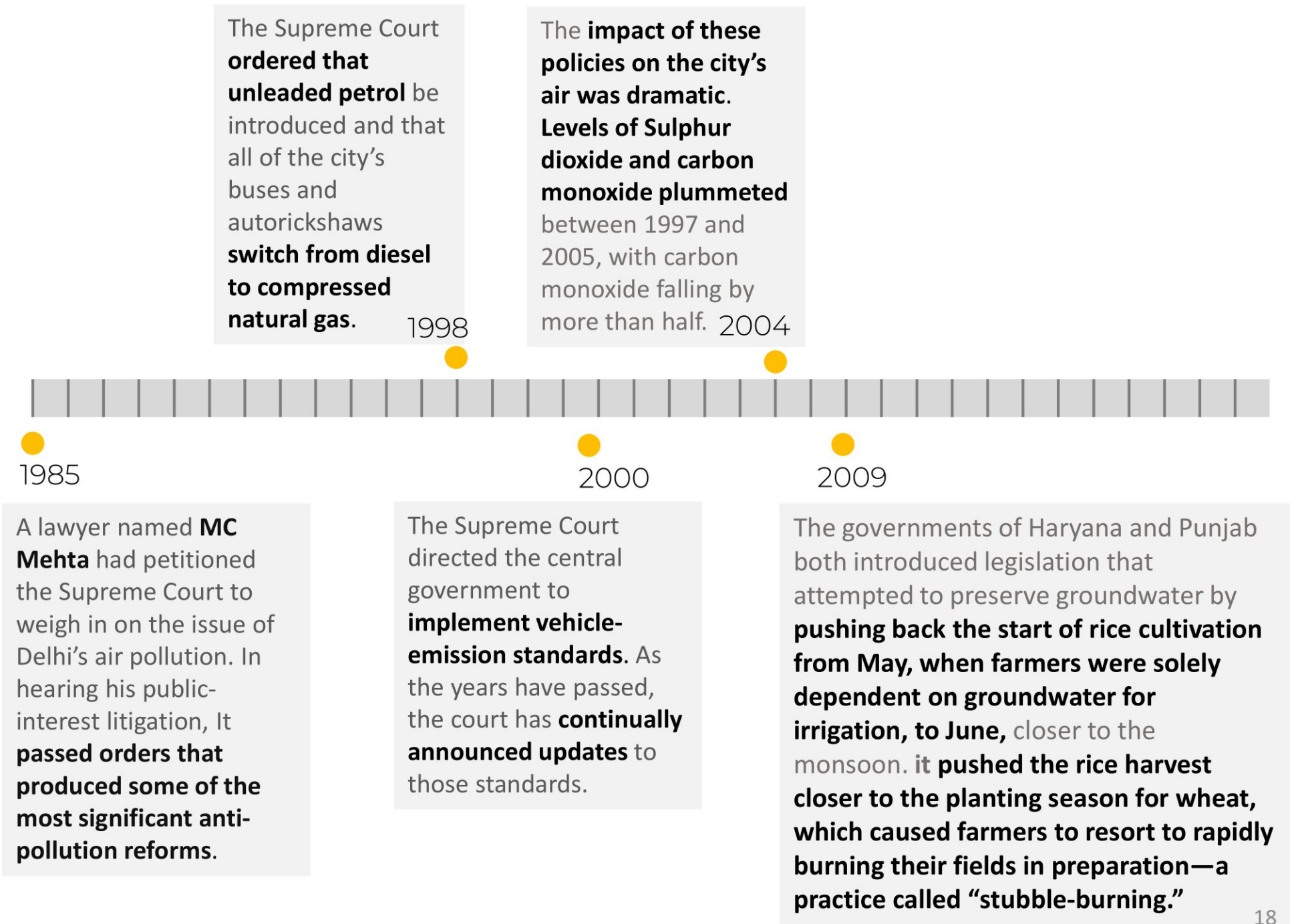
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While I was doing the secondary research, I found that there is a sequence of events that lead to the current air pollution problem. We just documented it and noted some of the stress point in this . This is a diachronic study of the events and policy making.

The study helped us understand the historical events and widen our understanding of the problem



*Stubble burning in a field of Punjab*



The **National Green Tribunal banned stubble-burning in Delhi, Rajasthan, Punjab, Uttar Pradesh and Haryana.** The burning continued, with **farmers continuing to argue that clearing their fields without burning was prohibitively expensive without government support.**

2015

Stubble-burning, the **CPCB said, was only contributing to seven percent of the total emissions.**

Major internal sources of pollution are road dust, vehicular emission, biomass burning and industrial emissions.

2018

2014

In **2014 WHO report found that Delhi's air was the worst in the world,** with an annual average PM2.5 concentration of 153 micrograms per cubic meter.

2016

Two professors of civil engineering at the Indian Institute of Technology Kanpur submitted a report to the Delhi government about the sources of the capital's air pollution. The report found that the **two most consistent contributors were vehicular emissions and "secondary particles,"** alternating days during periods of severe pollution, only cars with license plates ending in odd numbers or in even numbers would be allowed on the roads. An IIT Delhi study found that the first iteration of the **odd-even scheme reduced PM2.5 concentration by only two to three percent.**

2019

**Environment ministry launched the National Clean Air Program.** Rs 406 crore for the **NCAP** was spread across **102 cities.** The 28 most severely impacted cities received Rs 10 crore for two years.



On 13 January, the Supreme Court agreed with a **Delhi-government proposal to install a smog tower in Connaught Place within the next three months.** CPCB proposal to install one at Anand Vihar. The project is a collaboration between the **Indian Institute of Technology (IIT) Bombay, IIT-Delhi and the University of Minnesota.**



2020



Delhi finally has a smog tower which is **installed by Gautam Gambhir Trust.** The 20ft tall air purifying tower cleans air 500 to 750 meters around itself. The **device costs INR 7 Lakh and the operational and maintenance cost is 30K per month**



# Existing solution

## Anti smog gun

The device sprays atomized water (tiny droplets of water) up to a height of 50 meters, creating artificial mist, which is in turn expected to stick to air-borne pollutants and bring them down to the ground.

- Device cost around 20 lakh
- Has limited range and only effect the immediate surroundings.
- Has large consumption of water



*Antismog gun operations in Noida*

# Existing solution

## Smog Tower

This is a smog tower installed in Lajpat Nagar market by MLA Gautam Gambhir. It is a high performance filter based tower, capable of filtering 60,000 cubic meter of air and has an effective range of 500 to 700 meters

These are the high performance filters have an efficiency of 80 % at removing PM2.5. They are using HEPA technology, which is very effective in removing PM particles from the air.

The total cost of the project was 12 lacs and the maintenance of the smog tower will be done by a private body.



*Smog tower installed in Lajpat nagar.*

# Existing solution

## Smog Tower

We dissected the Lajpat nagar smog tower design to understand the working of it. Primarily it has three HEPA filter mounted on the duct. The design is a bit modular and you can increase the capacity by stacking more ducts.

### Pros

- 60,000 cubic meter of clean air
- A modular design
- Cost

### Cons

- Filters needs to be replaced frequently
- High maintenance cost

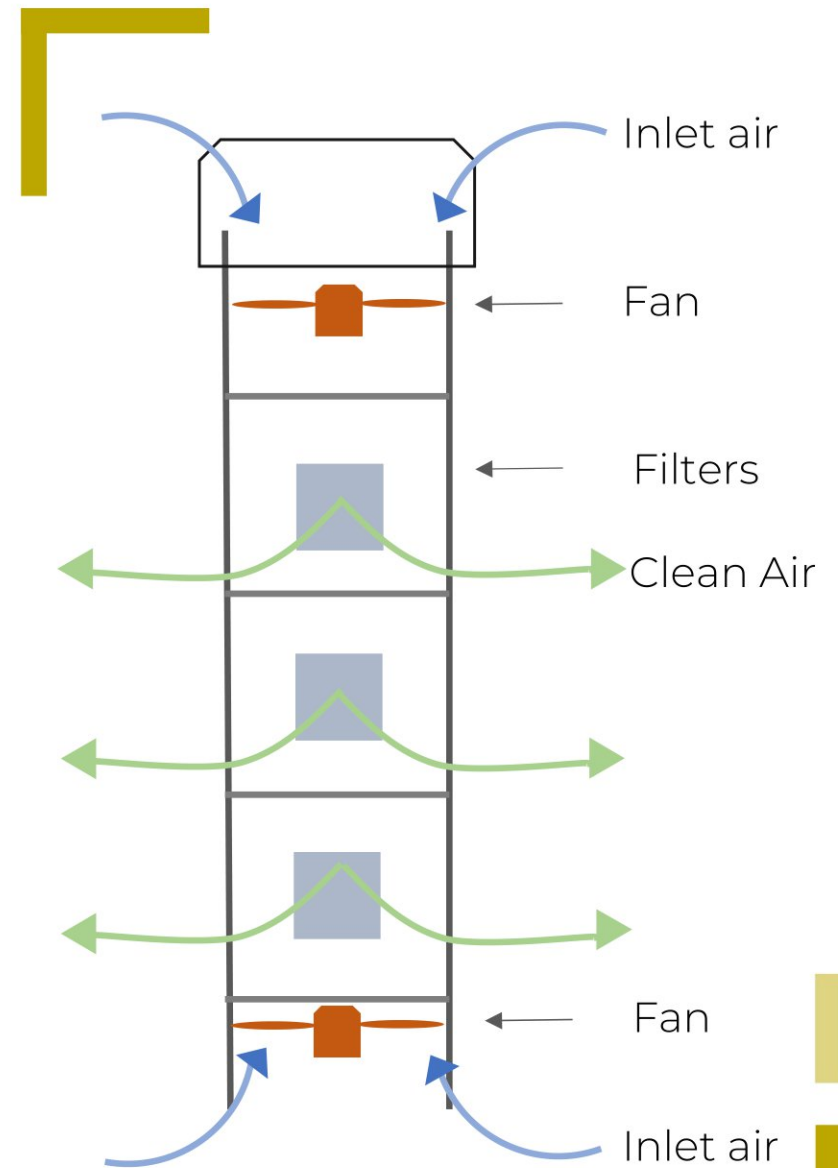


Illustration showing the working of a smog tower

# 04 Technology

The technology always acts as an enabler, without which a product will be incomplete. In this section we will discuss about the 10 ways of cleaning air out of which we will discuss four mostly used technology briefly. We will also discuss about a newer technology developed by a startup “Airth”. We will be looking into how the technology works and the advantages of it.



# 10 ways of cleaning air

Since there are multiple ways to clean air and many air purifier use a combination if technology to clean the air. I am discussing four main ways of cleaning air

- High-efficiency particulate air filter (HEPA)
- UV Light
- Titanium Dioxide
- Electrostatic
- Carbon Filters
- Pre filters
- Ozone
- Negative Ions
- Gas Chamber
- Water



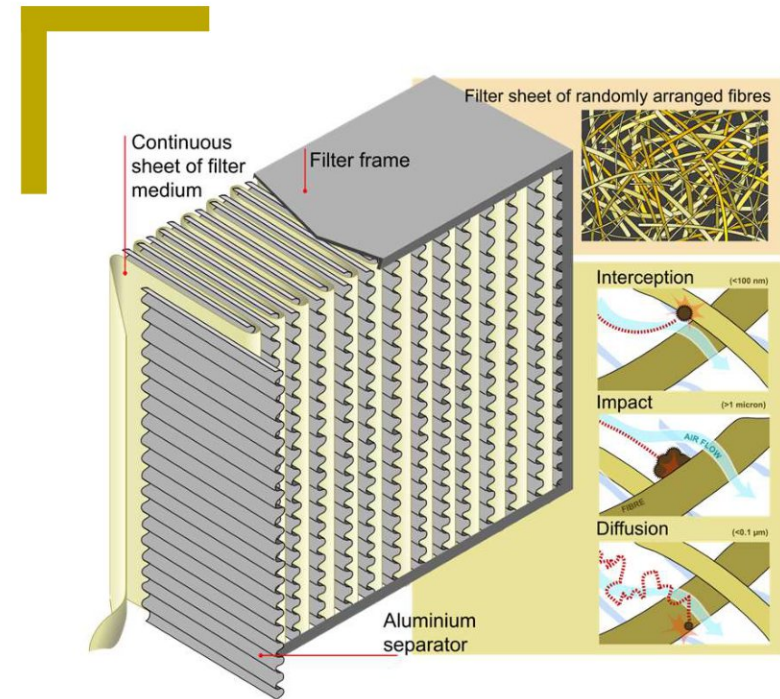
*HEPA based filter medium*

# 10 ways of cleaning air

## High-efficiency particulate air filter (HEPA)

HEPA air filter removes the particles from the air that passes through it with an efficiency of at least 99.95%. These are non woven polypropylene sheet, with very fine fibers.

The HEPA filters are commonly used in home air purifier. They are great in removing the PM particles but are not great at removing gases like NO<sub>2</sub>.



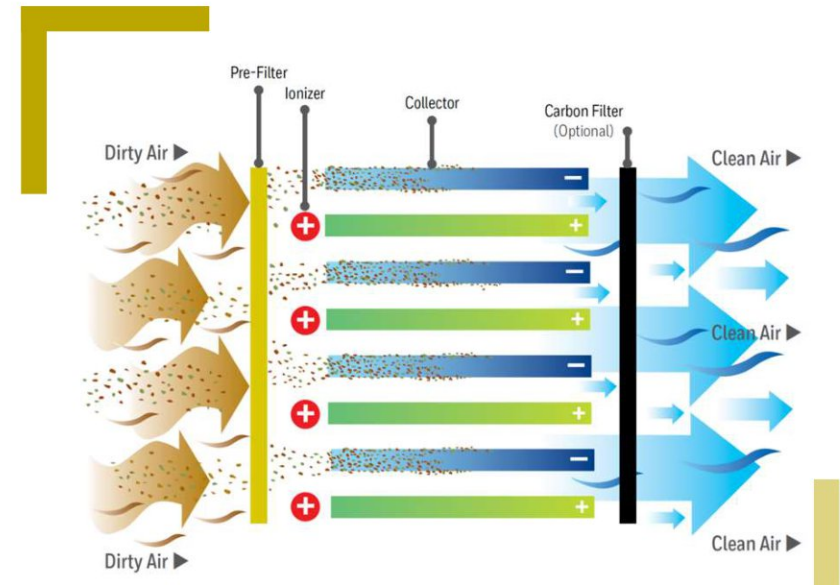
HEPA Filter working principle.

# 10 ways of cleaning air

## Electrostatic

An electrostatic filter has two main sections as shown in figure. The first section is the ionizing section; it consists of a series of fine wires charged to a voltage of up to 13 kV, placed alternately with earthed rods. This sets up a corona discharge, and as the airborne particles pass through the ionizing field, they receive a positive electrostatic charge. The second part is the collector section; this consists of a series of parallel, vertical metal plates with a potential difference of 6–7 kV between adjacent plates.

The ionized dust particles are attracted towards these plates to which they adhere. The plates are sometimes coated with oil to help dust retention. The filters are cleaned automatically by washing with high-pressure water.



*Working of electrostatic filter*



# 10 ways of cleaning air

## Carbon filters

Activated carbon filters are small pieces of carbon, typically in granular or powdered block form, that have been treated to be extremely porous. It is so cavernous, in fact, that just one gram of activated carbon can easily have a surface area of 500m<sup>2</sup> or higher. Vast surface area enables these carbon filters to adsorb exponentially more contaminants and allergens than traditional carbon.

Adsorption is a distinct process where organic compounds in the air or water react chemically with the activated carbon, which causes them to stick to the filter. The more porous the activated carbon is, the more contaminants it will capture. These filters are most notably used to remove hazardous compounds in home air purification systems.

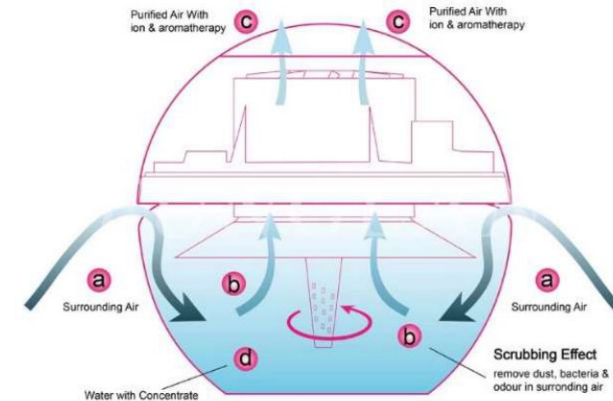


*Activated carbon filter with an pre-filter.*

# 10 ways of cleaning air

## Water

This filter works by passing air through the water. All the pollutants in the air get dissolved into the water. Over time the water becomes contaminated and needs to be changed. An added benefit to using a water-based air revitalizer is that they double as oil diffusers, and as humidifiers.



Product Detail

*Working of a water air purification*

# Airth's Technology

Ravi Kausik a student of Mtech Environmental science with the guidance of Prof. Kumaresan and resources of POC(ignition lab) developed a filter less air cleaning technology. Ravi Kaushik then further worked to create a start-up "Airth"

The technology is the greenest in terms of environment impact.

- The purifier is filter less
- Uses Ionisation of particle and water for cleaning air
- Require less maintenance
- Cost effective in long run
- The product won 2<sup>nd</sup> price in Abhuday action plan competition



*A prototype developed by Airth which can clean a room*

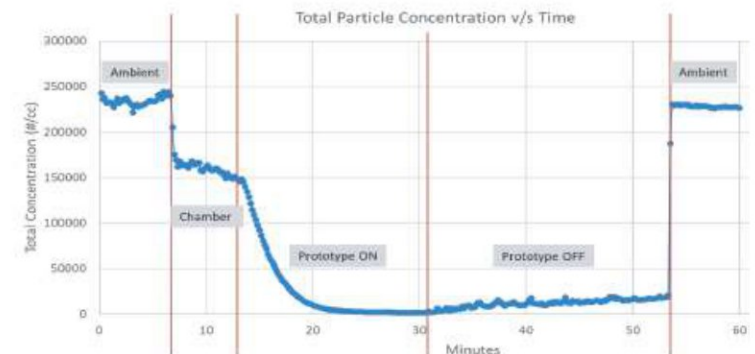
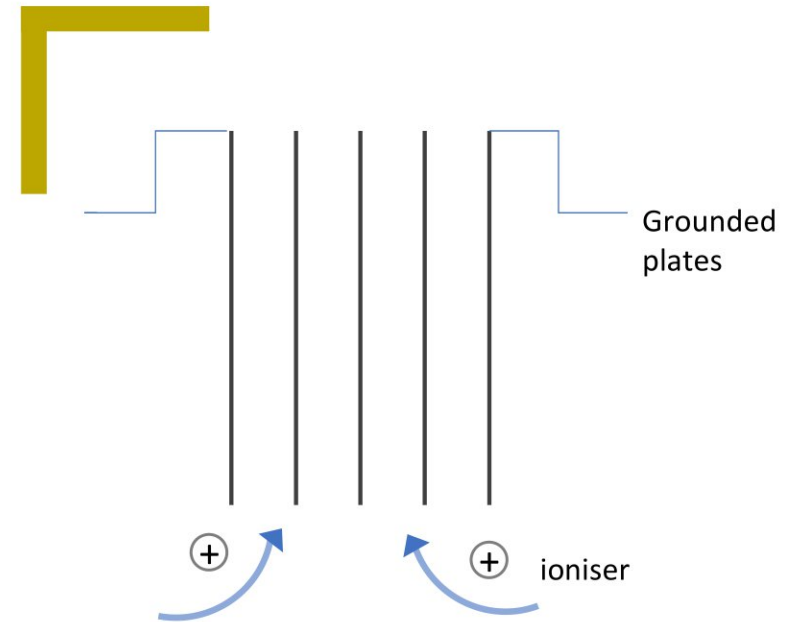
# Airth's Technology

## Working principle

Interfacial interaction and adsorption of particulate matter on conductive surface via enhanced charge allocation. Geometric optimization by staggered flow and multi pass model helps in achieving higher efficiency.

## Test results

The prototype that was tested in a chamber test using Optical Particle Sizer (OPS). The test result shows that 99% of particles were removed in 15 min in 8 cubic feet box.



Test result showing the concentration of PM particles reducing over time

# 05 Delhi Visit

Delhi is a ground zero on air pollution problem. This project will be incomplete without going there and talking to people first hand. The Delhi visit helped me to understand the ground reality and contextualize the project. The visit also help me to interview a scientist of Centre for Pollution Control Board (CPCB). I also did a survey of Anand Vihar (a high pollution area in Delhi) to know about the population concentration and probable deployment areas.



*An exhibition was held in IIT Delhi where all the IIT's presented their prototypes on clean air tech.*

# Exhibition on clean air tech

IIT Delhi organised an exhibition where they called all the IITs work on clean air tech. The Airth represented IIT Bombay in this exhibition . The exhibition acted as a platform for all the stakeholders, almost all the stakeholders were present there. It helped me to conduct one on one interviews. I was able to interview the scientist form CPCB and NEERI. I will be discussing the findings in the later pages.



*Airth represented IIT Bombay in the exhibition and presented two of their prototypes*

# Insight form CPCB and NERRI interviews

## The design should be temper proof

Currently installed in Anand Vihar ISBT, ITO  
The project is not able to reduce the air pollutions in the vicinity  
The filters gets chocked within 3 days and proper maintenance is not been carried out  
The design is not temper proof, they later on redesigned the product



*WAYU air purifier installed with a fence to protect it form public tempering.*

# Insight from CPCB and NERRI interviews



## Maintenance of the air purifier

WAYU required constant monitoring and maintenance. Earlier the maintenance was done by NERRI engineers, which later on handover to municipality of Delhi. Proper training is required for the maintenance



*Test result showing the concentration of PM particles reducing over time*



# Insight form CPCB and NERRI interviews



## Robust Design.

Delhi weather is harsh with extreme cold in winters and heat in the summer. The outdoor air purifier should have ability to tackle harsh weather of Delhi. Public abuse and general wear and tear

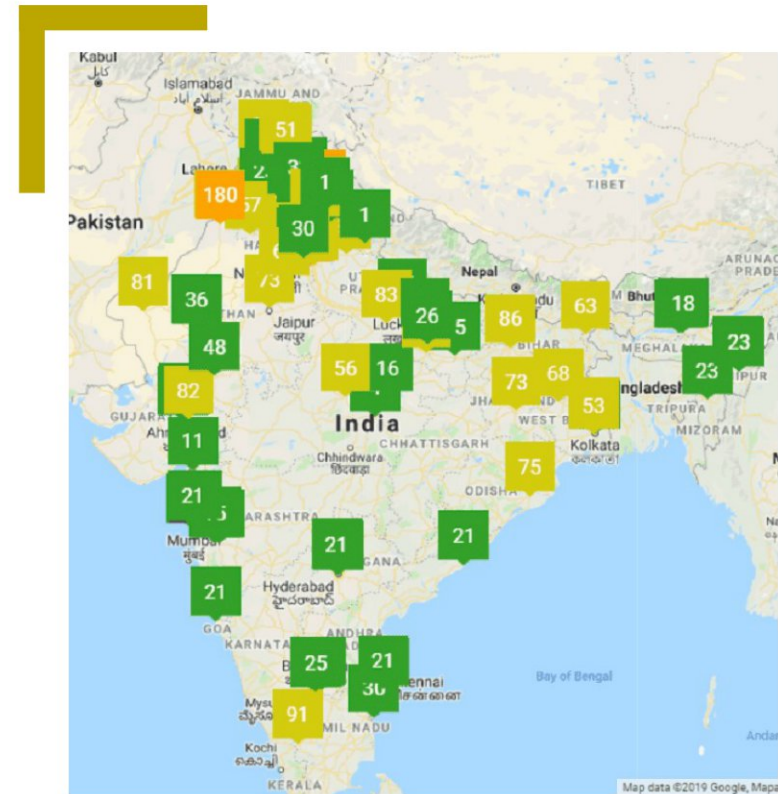


*Lajpat Nagar Air purifier is made up of steel which makes it a robust installation.*

# Insight form CPCB and NERRI interviews

## Make the technology data driven, using elements of IOT

Government is investing heavily on air quality monitoring. Using the data currently available can help us coming up more ways to tackle the problem. I was advised to use the current data and use it in a way to solve the problem. This also gave the project an angle of IOT device.



Air pollution monitoring stations in India installed by CPCB.

# Insight form CPCB and NERRI interviews



**Placements of the towers should be such that it provides direct air flow to the user**

Government is investing heavily on air quality monitoring. Using the data currently available can help us coming up more ways to tackle the problem



*WAYU air purifier installed on the divider of the road.*

# Insight from CPCB and NERRI interviews



## Capacity of outdoor air purifier

Government is investing heavily on air quality monitoring. Using the data currently available can help us coming up more ways to tackle the problem



# Insight from CPCB and NERRI interviews

**PM 10 and PM 2.5 are the main pollutants in Delhi air.**

Government is investing heavily on air quality monitoring. Using the data currently available can help us coming up more ways to tackle the problem



*PM particles size scale*

# Insight form CPCB and NERRI interviews

## Focus is on major policy changes to curb air pollution

Delhi already closed down its two powerplants and implemented rules on stubble burning. The result is they are already expecting to be less average AQI this year.



*Man burning stubble in Punjab*

# Insight form CPCB and NERRI interviews

Delhi is heavily investing on tried and tested technologies.

Failure of the above two project has brought skepticism to the CPCB. They will not be investing in any project without a prior trial.



WAYU air purifier next design iteration

# 05 Ideation



The above research can be very exhausting, showing only the problems. In this section I will discuss about the solutions and contextualizing them to the grass root.

I did a survey of Anand Vihar one of the most air polluted locality of Delhi. The survey help me to gather design directions for the probable solutions. Then further detailed out the design direction to create concepts





# Design Attributes

PM10 and PM2.5

Robust

Temper proof

Weather resistant

Flexibility in deployment

Aesthetics

Proper water handling

Direction of clean air towards the user

Smart controls

Feedback of clean air

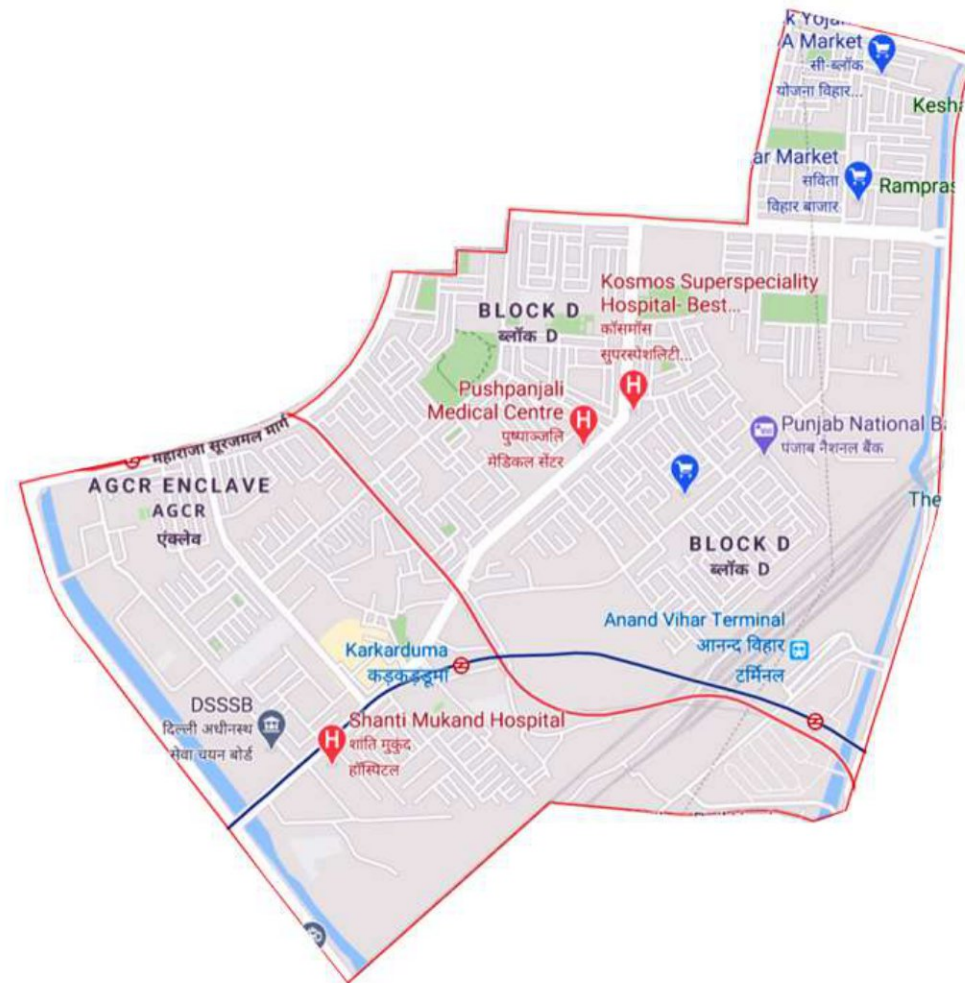


WAYU air purifier next design iteration. Is a good demo of design attributes.

# Persona Location

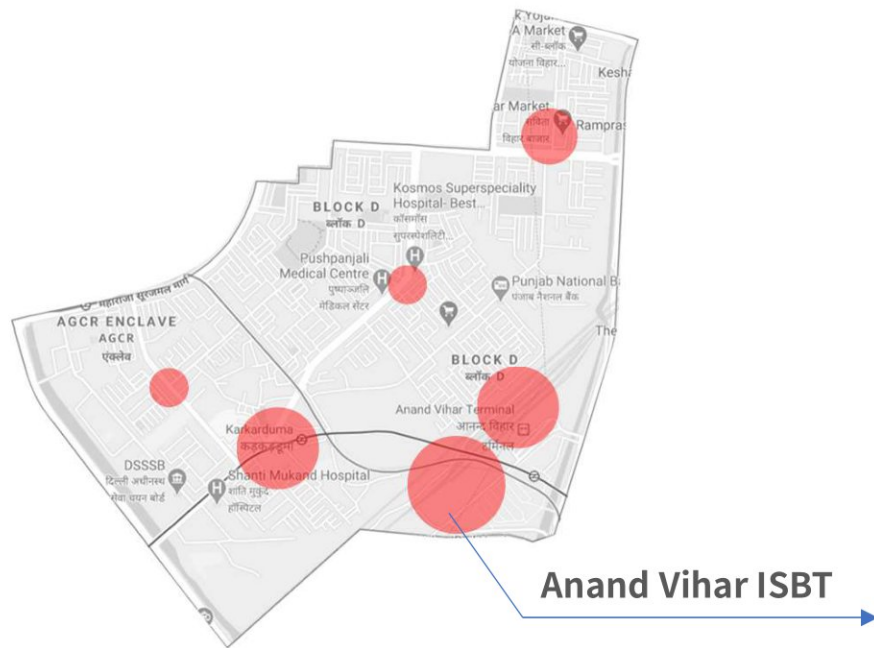
**Delhi is heavily investing on tried and tested technologies.**

Failure of the above two project has brought skepticism to the CPCB. They will not be investing in any project without a prior trial.



Anand Vihar map.

# Design Direction



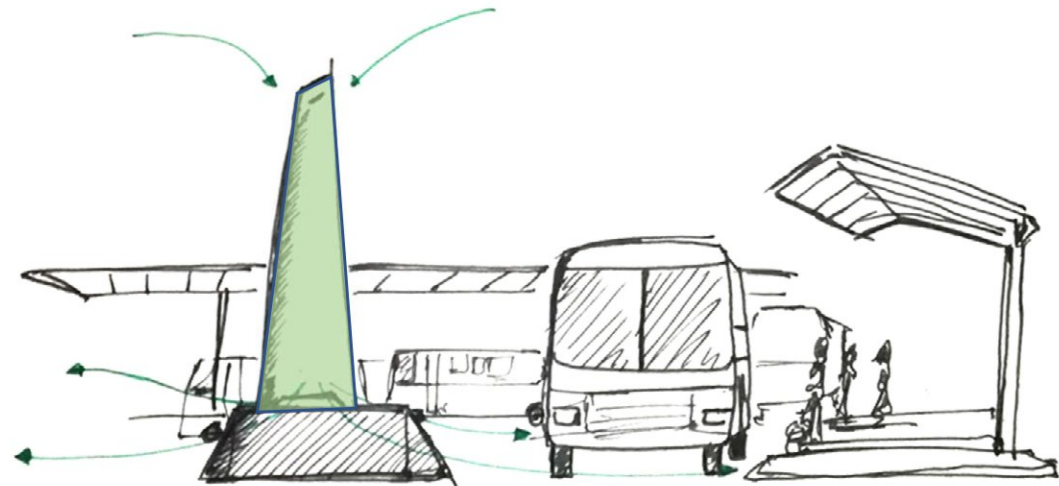
Anand Bihar bus stand is a place of high footfall and high air exposure.

# Design Direction

## Design Direction 1

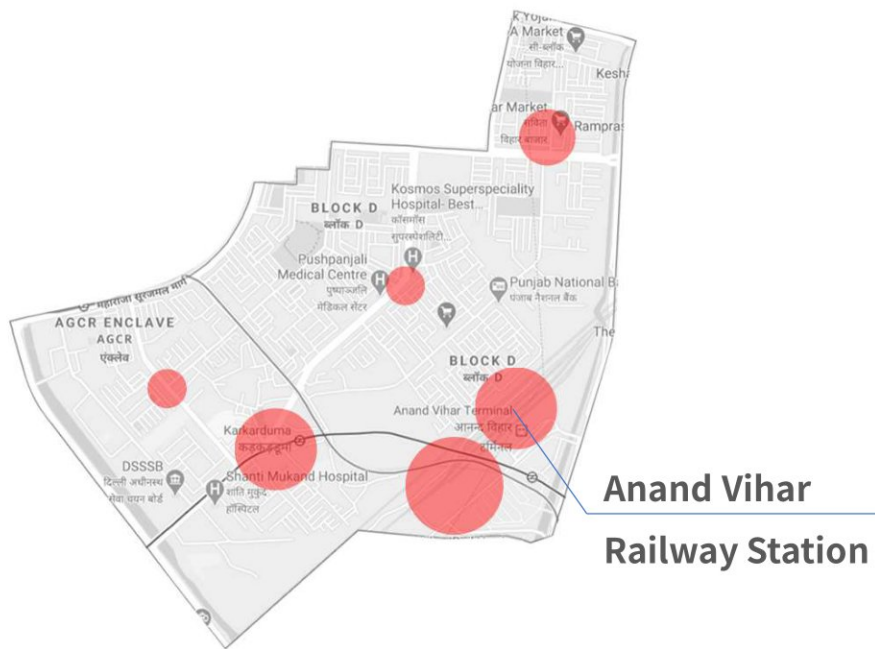
### Smog tower

ISBT offers huge open space, so for an area effect a smog tower is suited



*In this case a smog tower is well suited. As it has an area effect.*

# Design Direction



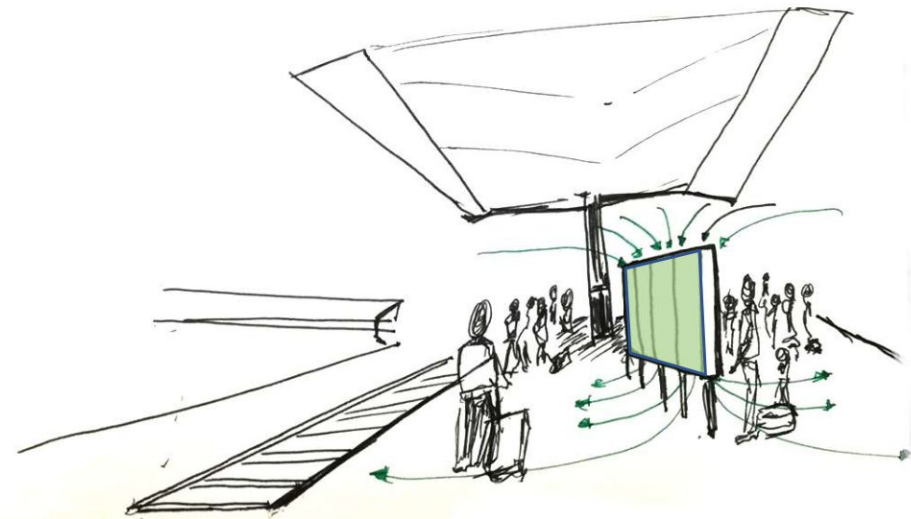
*Millions of people travel using the Indian railway. These people are exposed to the polluted air*

# Design Direction

## Design Direction 2

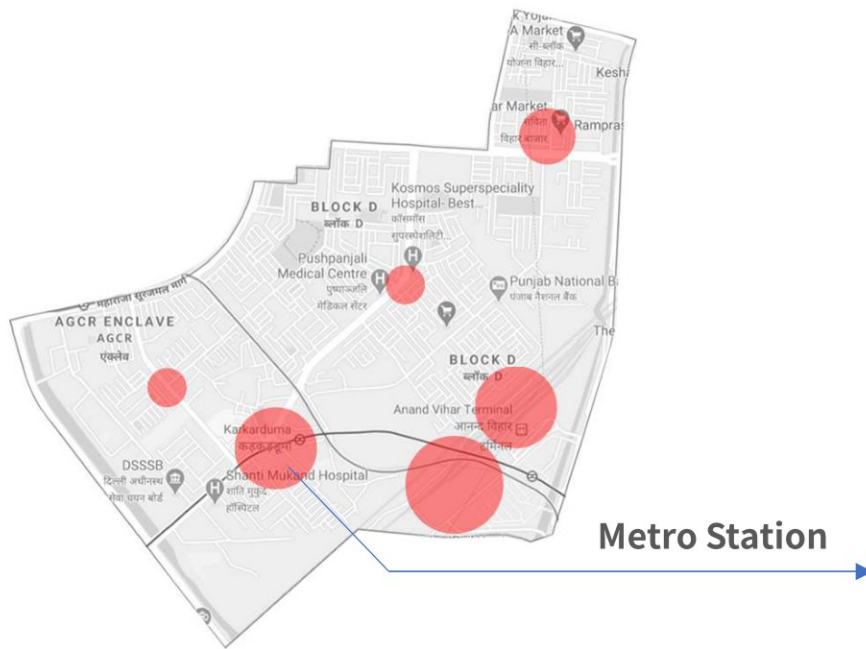
### Flat air cleaning panels

ISBT offers huge open space, so for an area effect a smog tower is suited



*The flat panels which are mounted as a divider on the platforms of station.*

# Design Direction

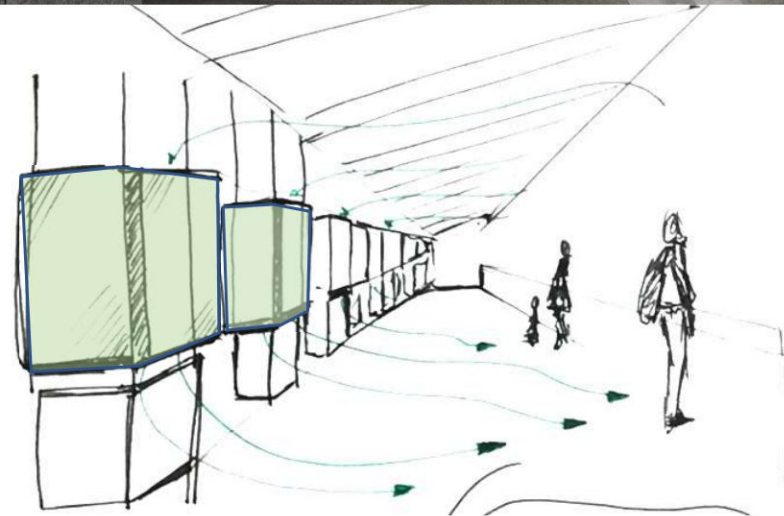


# Design Direction

## Design Direction 3

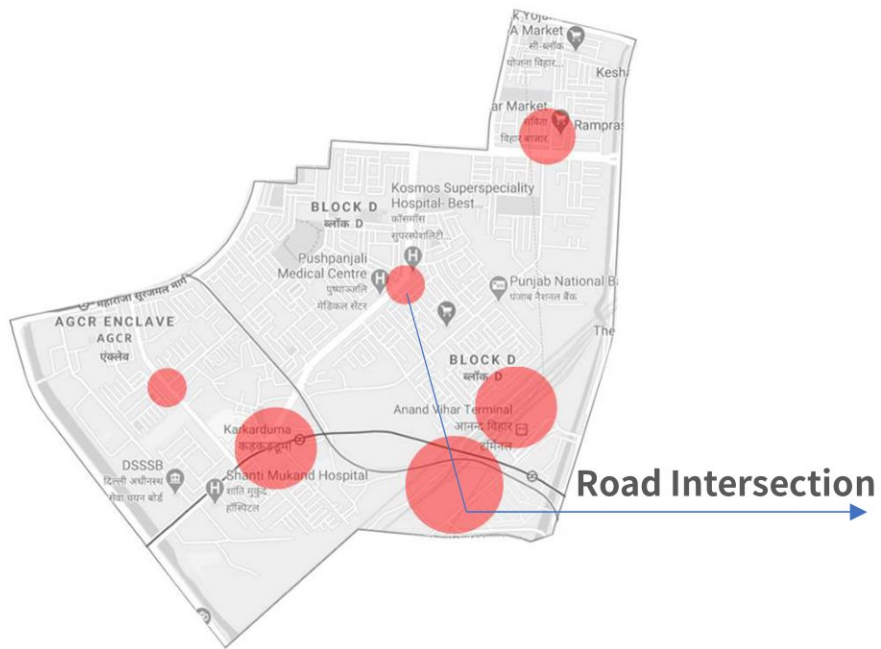
### Modular panels

For open metro stations, the pillars can be used to mount flat panels of air purifiers can be used





# Design Direction



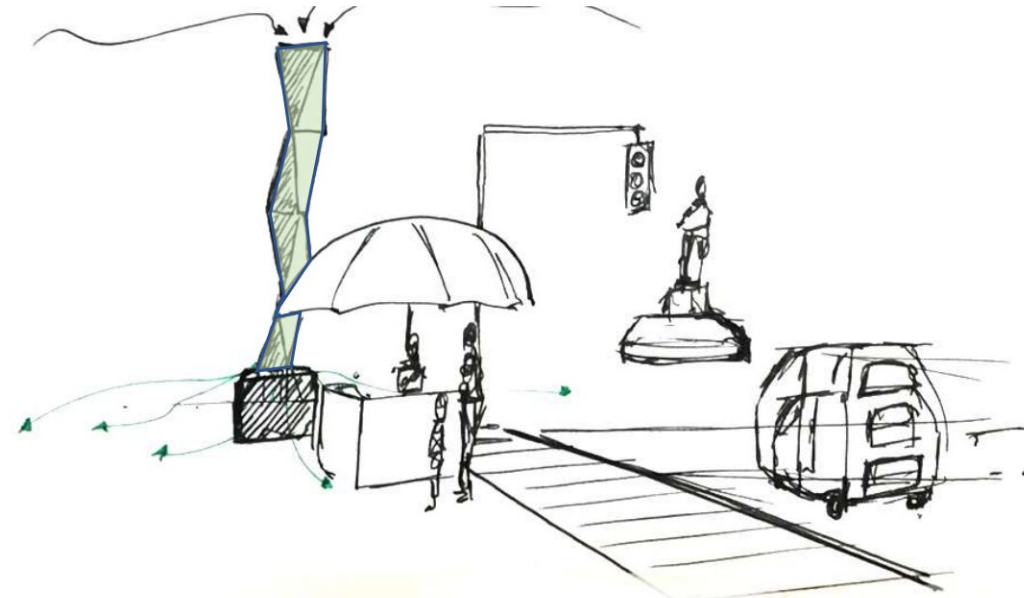
Traffic areas have a high concentration of polluted air

# Design Direction

## Design Direction 4

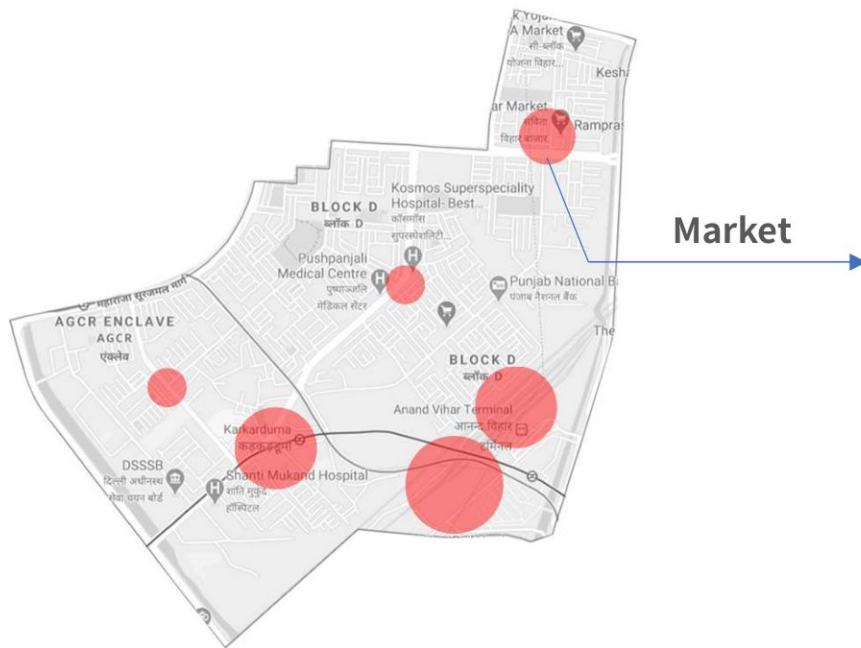
### Modular Deployable structures

Intersections have a limitation of space so we can combine multiple utilities of the intersection into single vertical structure



*Deployable structures can create an area effect and clean the air in and around road intersections*

# Design Direction



# Design Direction

## Design Direction 5

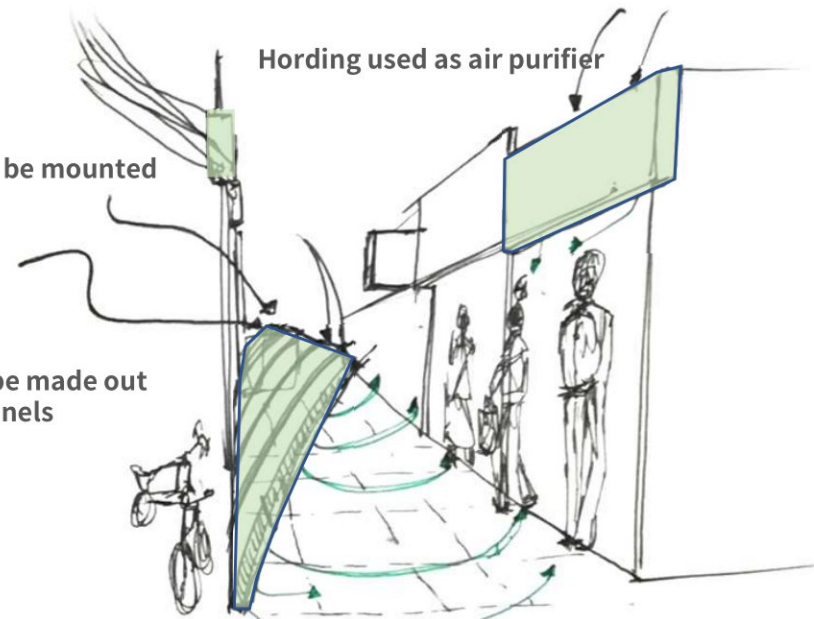
### Air cleaning partitions

There is a space crunch in the market, so we will have to be creative while placing the air purifiers.



Air purifiers can be mounted on the pillars

A partition can be made out of air purifier panels



# Selected Scenarios



*Intersections*



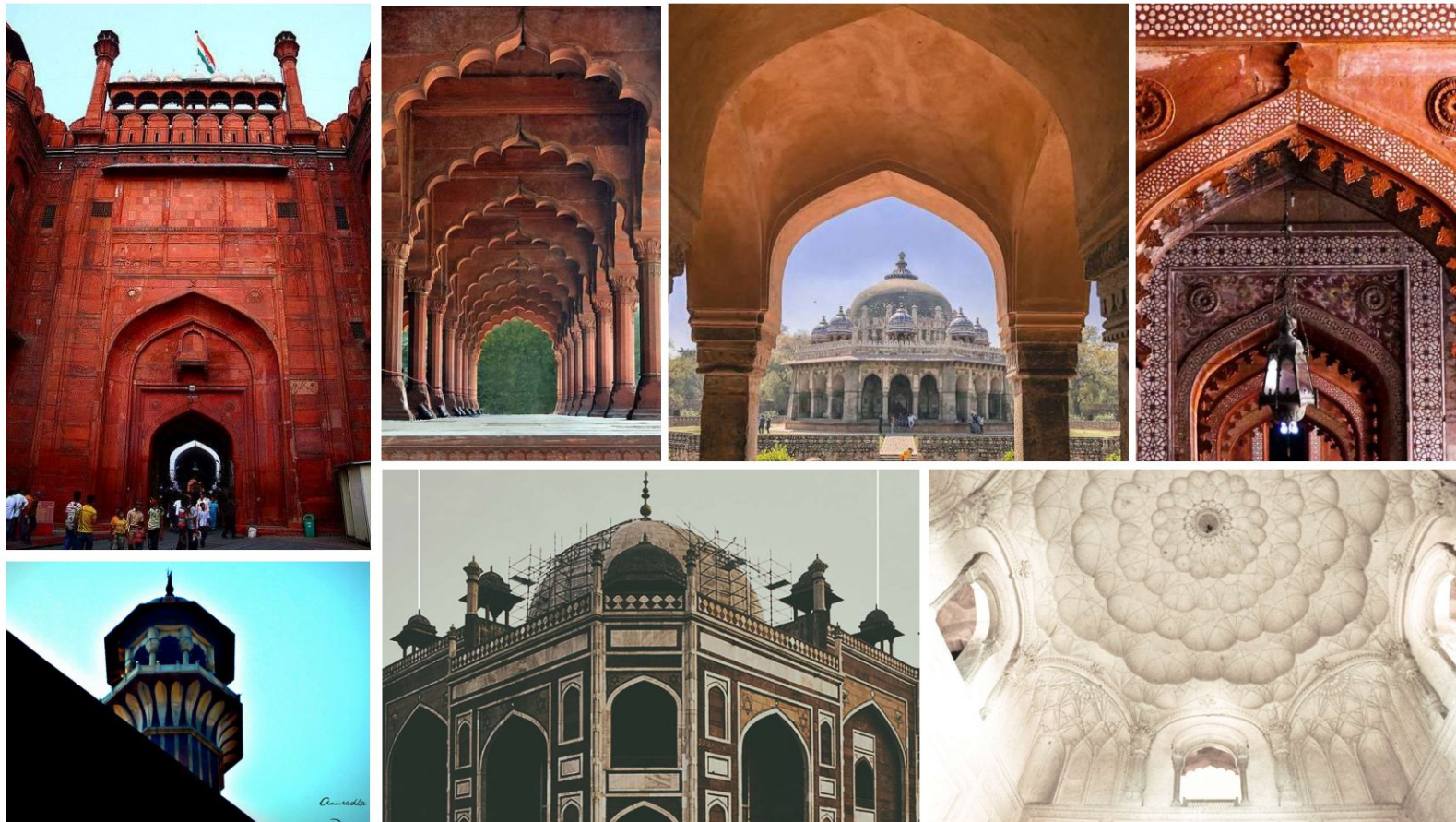
*Market + Residential areas*

To design an outdoor air purifier which can clean the air in the vicinity of 100 meters focussing on intersections, market areas and public spaces.

# Moodboard



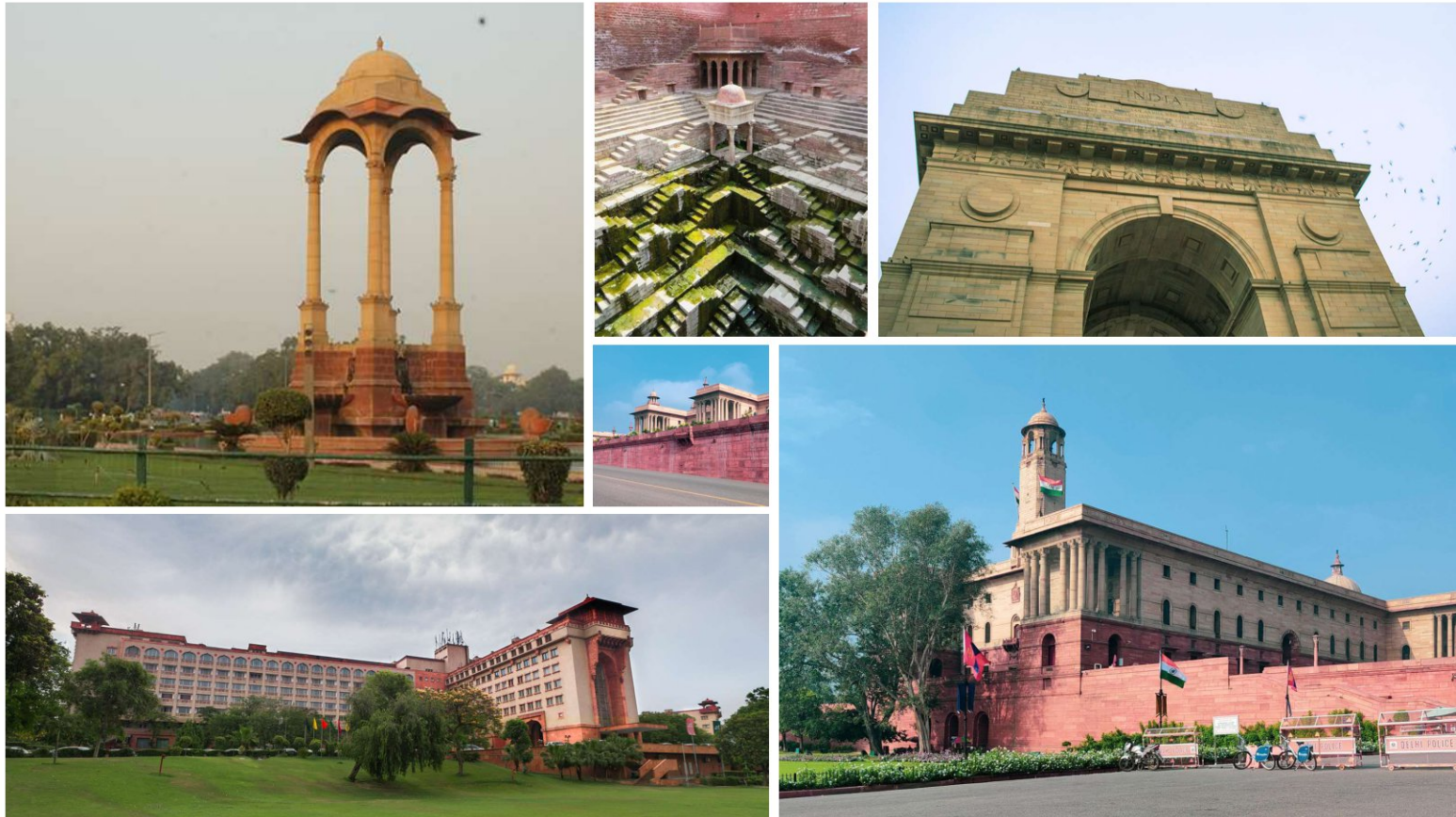
Delhi is rich in heritage and its architecture is gem for India. We can extract some of the patterns from the architecture and use it in our design to contextualize more.



# Moodboard

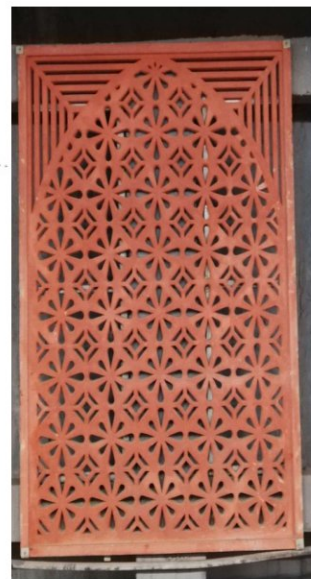


The architecture acted as a trigger point to design the product in such a way that it adds to the beauty of the city



# Moodboard

I was able to observe, some of the elements of the architecture is being used in current beautification of the city. This further proves that, applying these elements will make the product more rich. These can be applied in the form of decals.

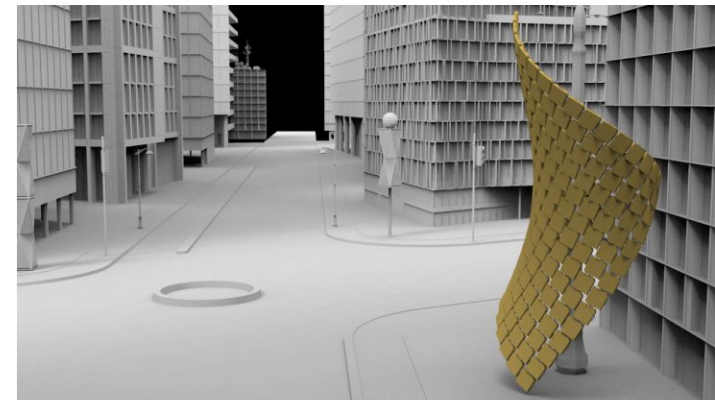
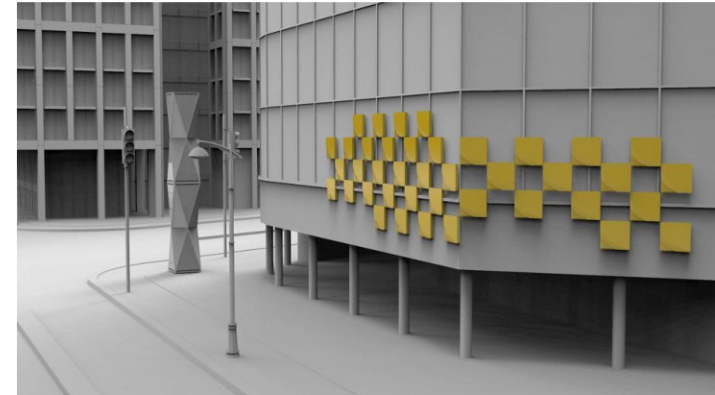
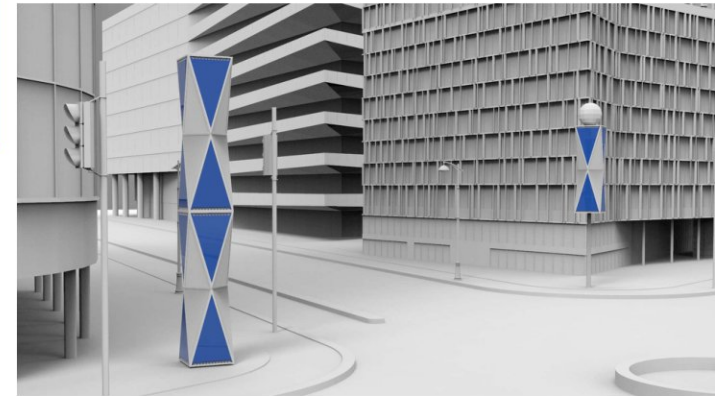




# 06 Design Concepts

The initial design directions lead us to develop three concepts. The design attributes helped us to detail the concept design and then we evaluated them in terms of Versatility, space efficiency, maintenance, manufacturing, ease of installation and aesthetics.

Then we further developed a final concept to its finest details to present the final design.

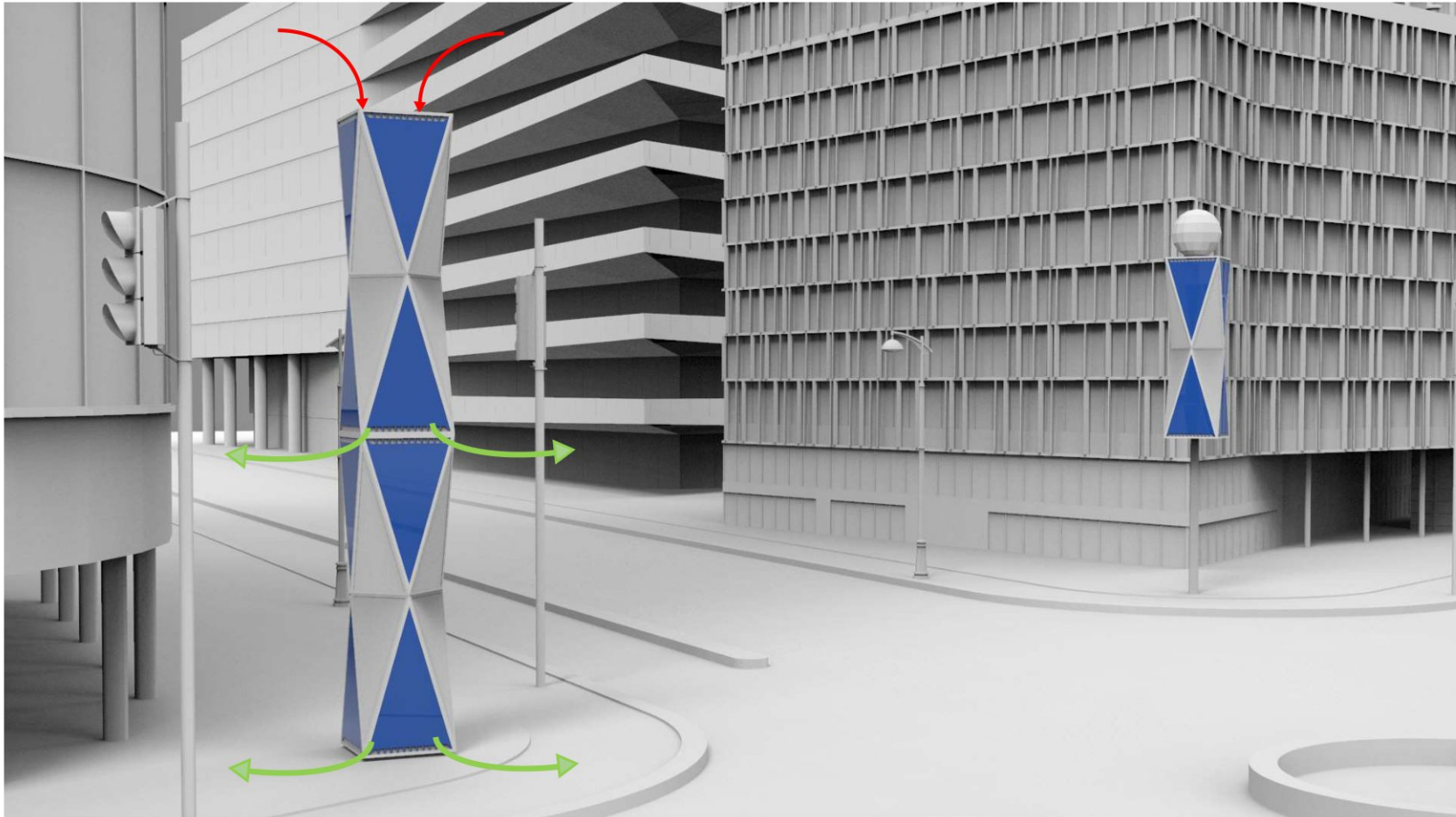


*3 Design concepts*

# Concept 01

## Modular air cleaning structures

A modular deployable structure where each module stacks on each other to make a deployable smog tower. The modular feature makes it a very versatile design.



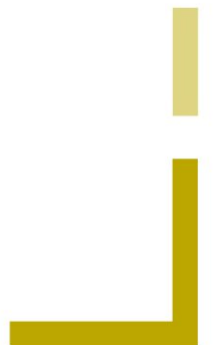
# Concept 01



## Modular air cleaning structures



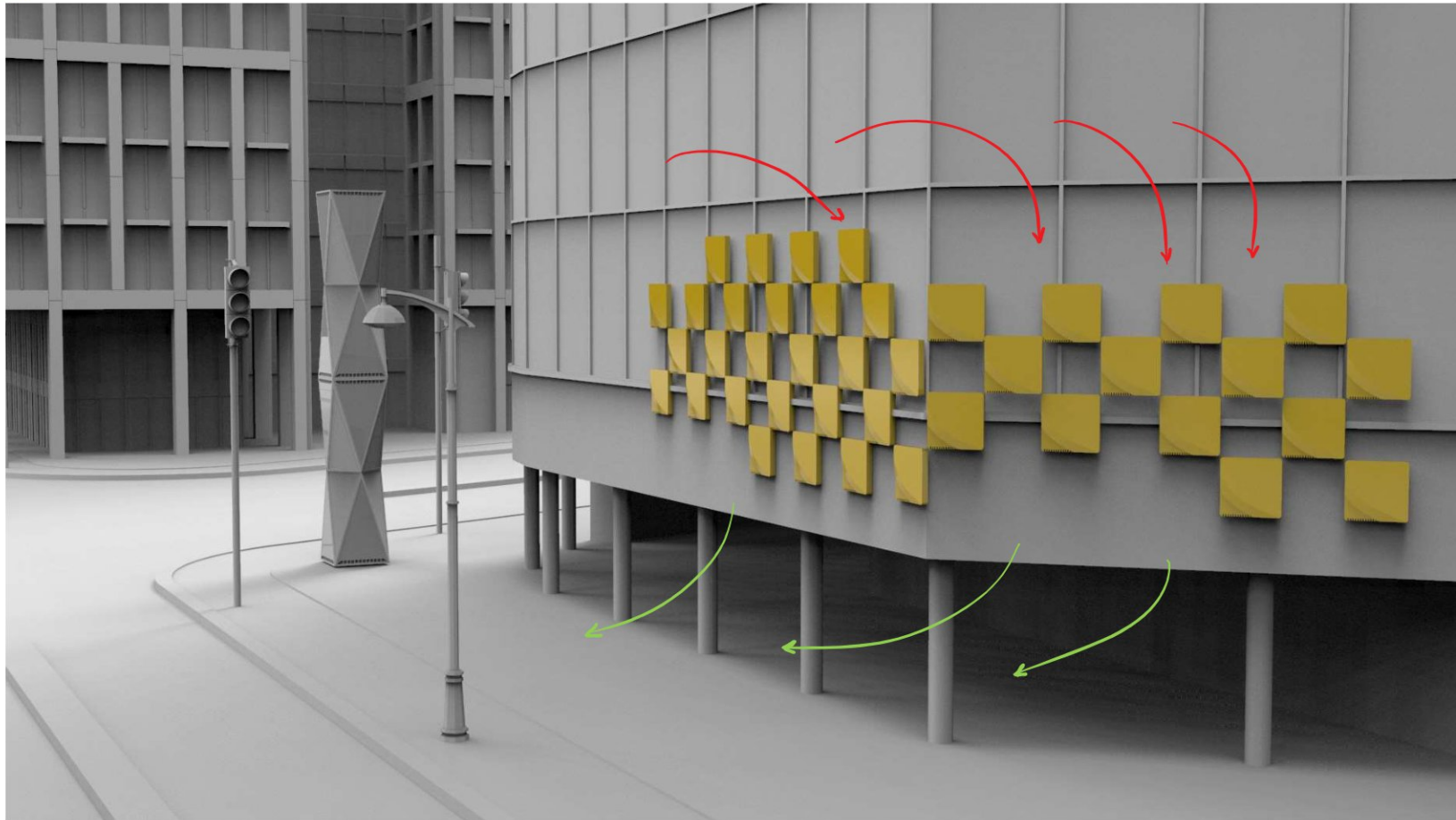
A modular deployable structure where each module stacks on each other to make a deployable smog tower. The modular feature makes it a very versatile design.



# Concept 02

## Air cleaning wall panels

A wall panel design, which is mounted on the wall of building. The design reduces space requirement and ease of installation.

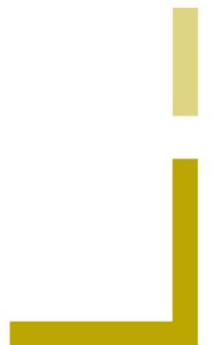


# Concept 02

  
Air cleaning wall panels



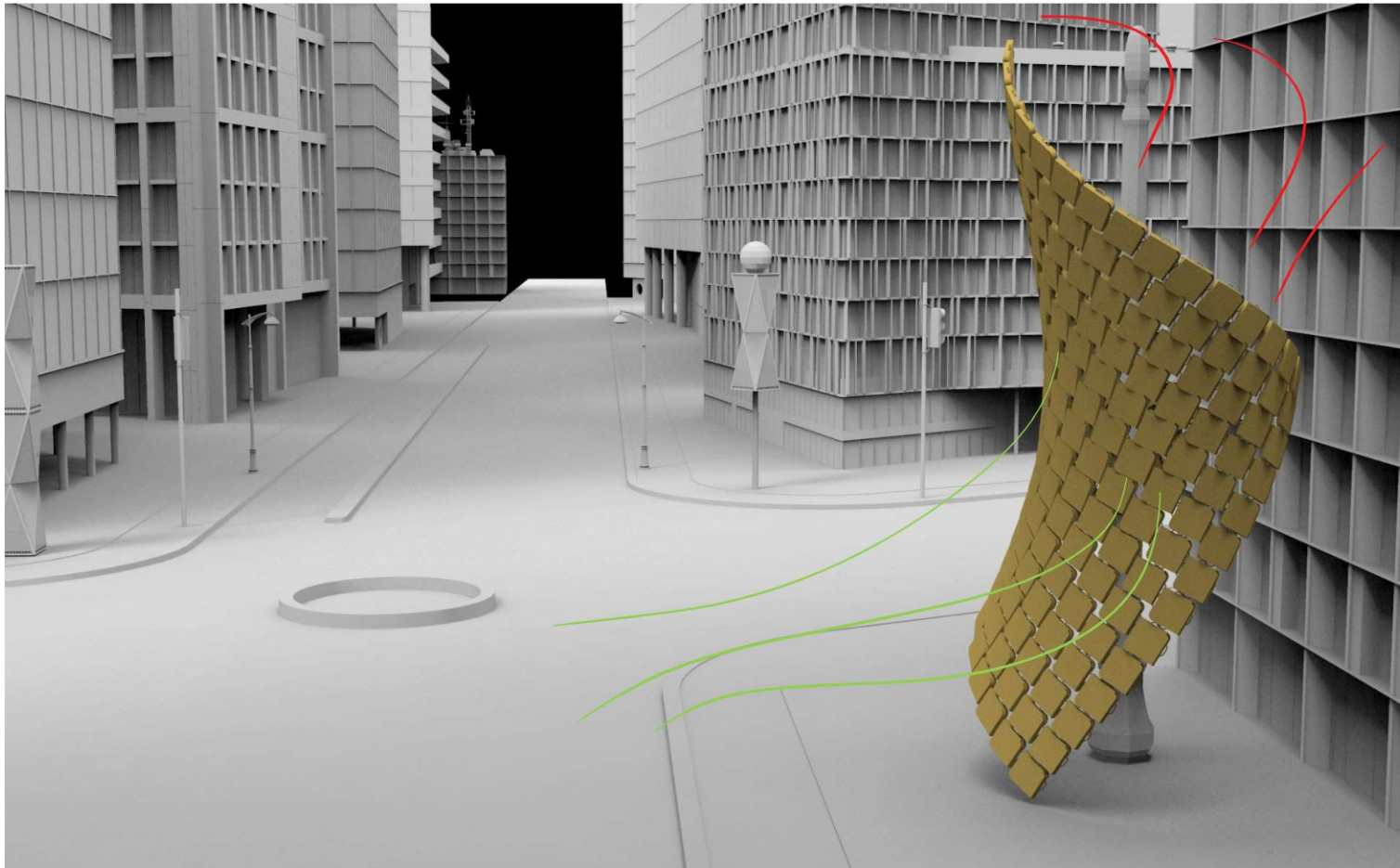
A wall panel design, which is mounted on the wall of building. The design reduces space requirement and ease of installation.



# Concept 03

## Chainmail structures

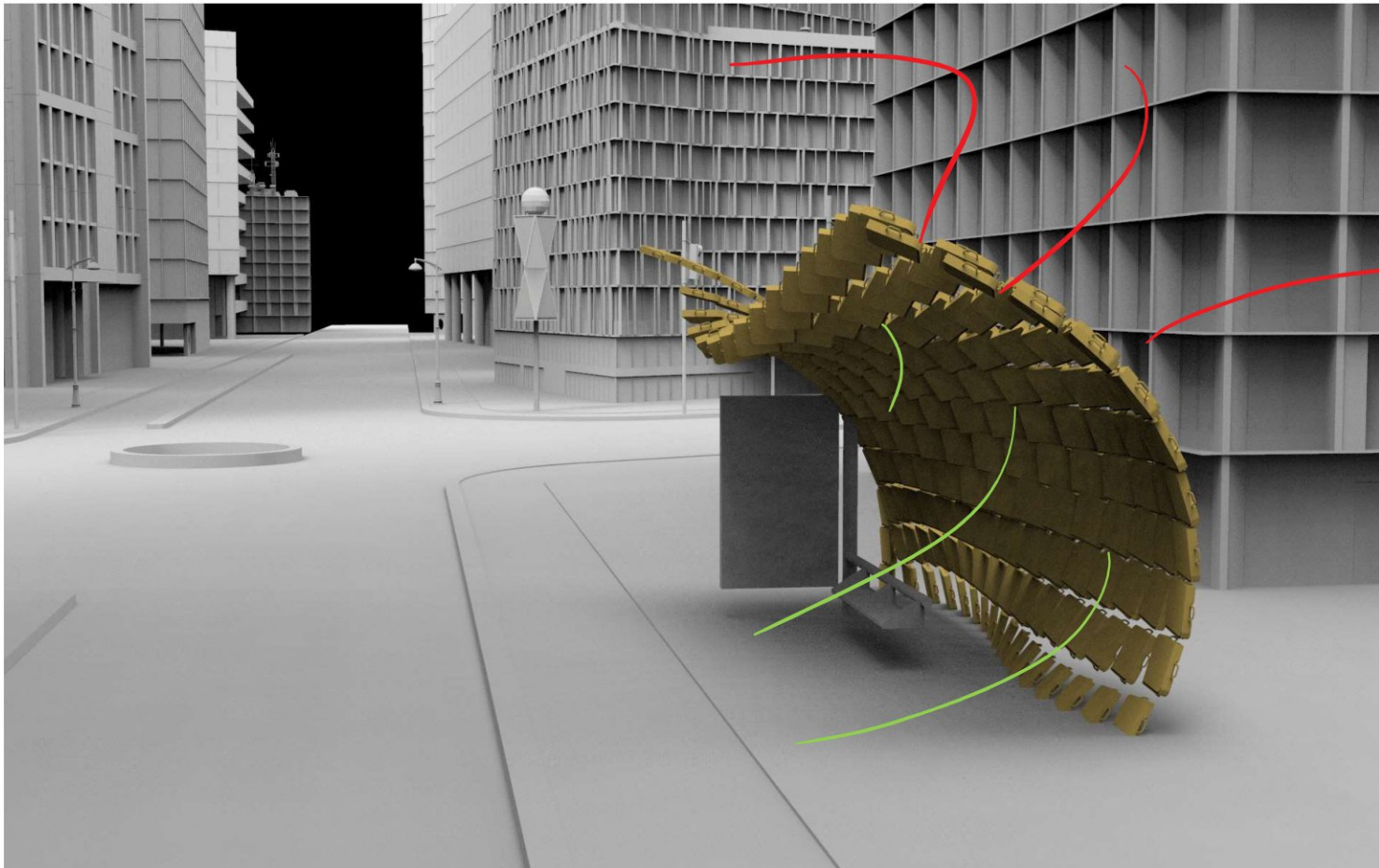
The design was inspired by chainmail. In this each panel cleans the air and is connected to the other panel. This creates a 3d structure.



# Concept 03

## Chainmail structures

This chainmail design can take any shape. In the below example the a permanent 3d structure is made using this panel. Each panel takes in polluted air from back and give out clean air in front.



# Concept 03



## Chainmail structures



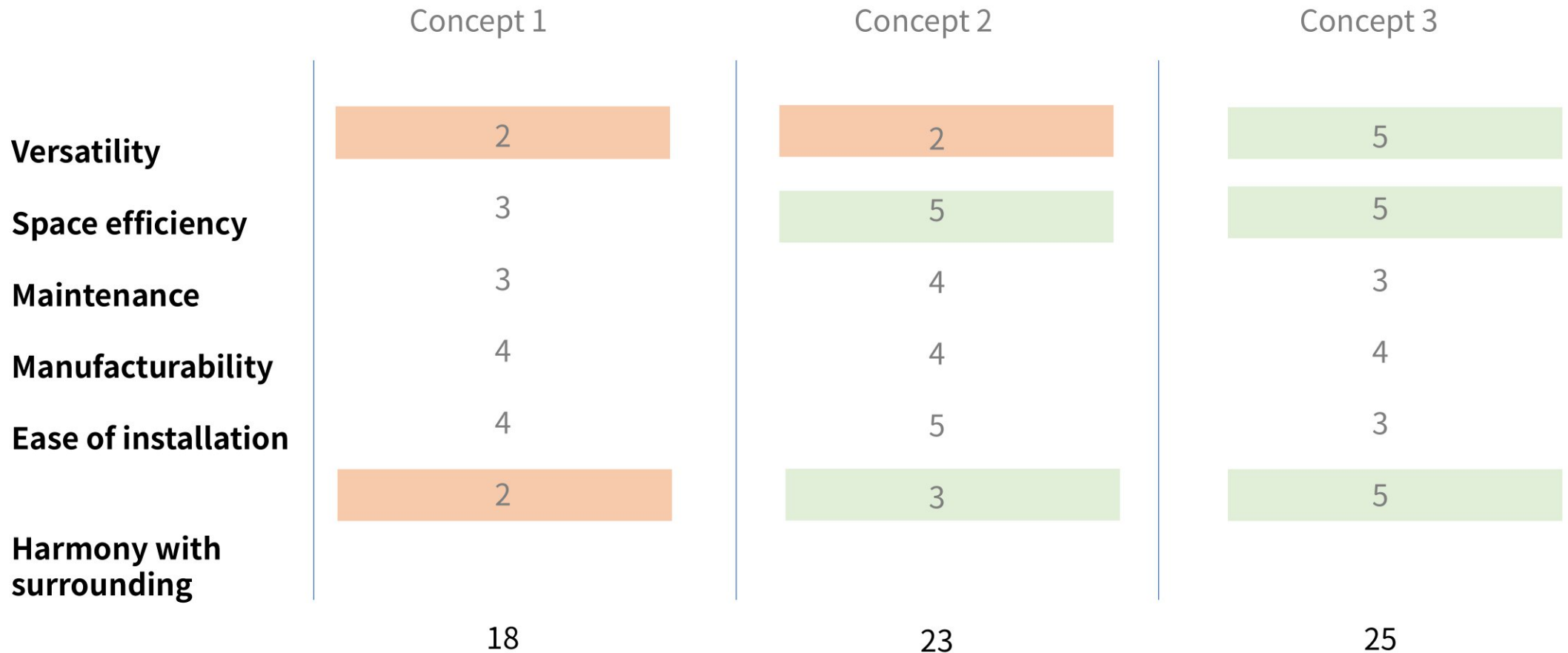
This chainmail design can take any shape. In the bellow example the a permanent 3d structure is made using this panel. Each panel takes in polluted air from back and give out clean air in front.





# Concept Selection

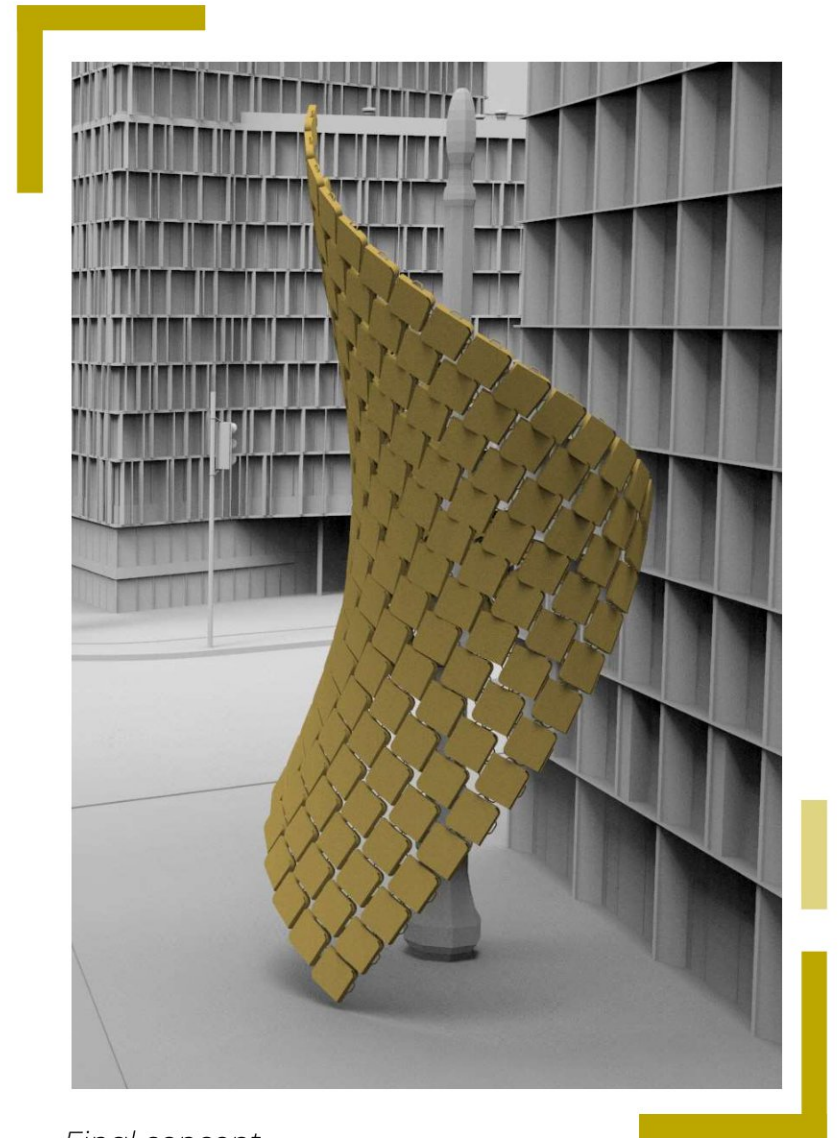
We evaluated all the 3 concept based on the six parameter and scored them on the scale of 5. We did this using peer review and consulting directly to the guide. We found the concept 3 scores the highest and is novel approach.



# 07 Final Concept

We started with three concepts, after the concept evaluation we decided to work on the third concept and build the details on it. Here worked around the details required for the Airth technology to work. We already did 3 iterations of the final concepts and worked on the panel design.

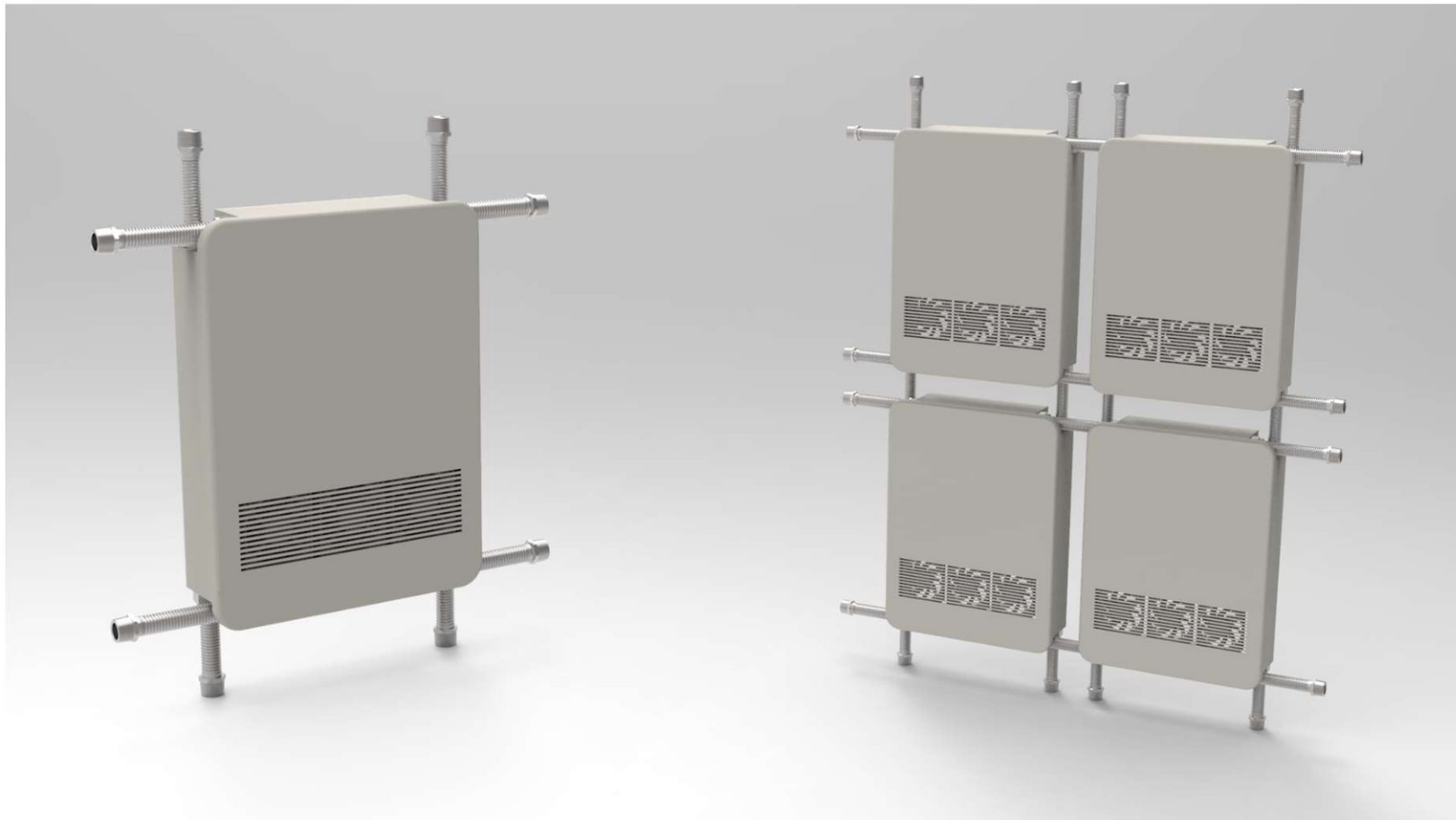
This section covers all the design details, assembly and installation of the product.



*Final concept*

# Single panel design

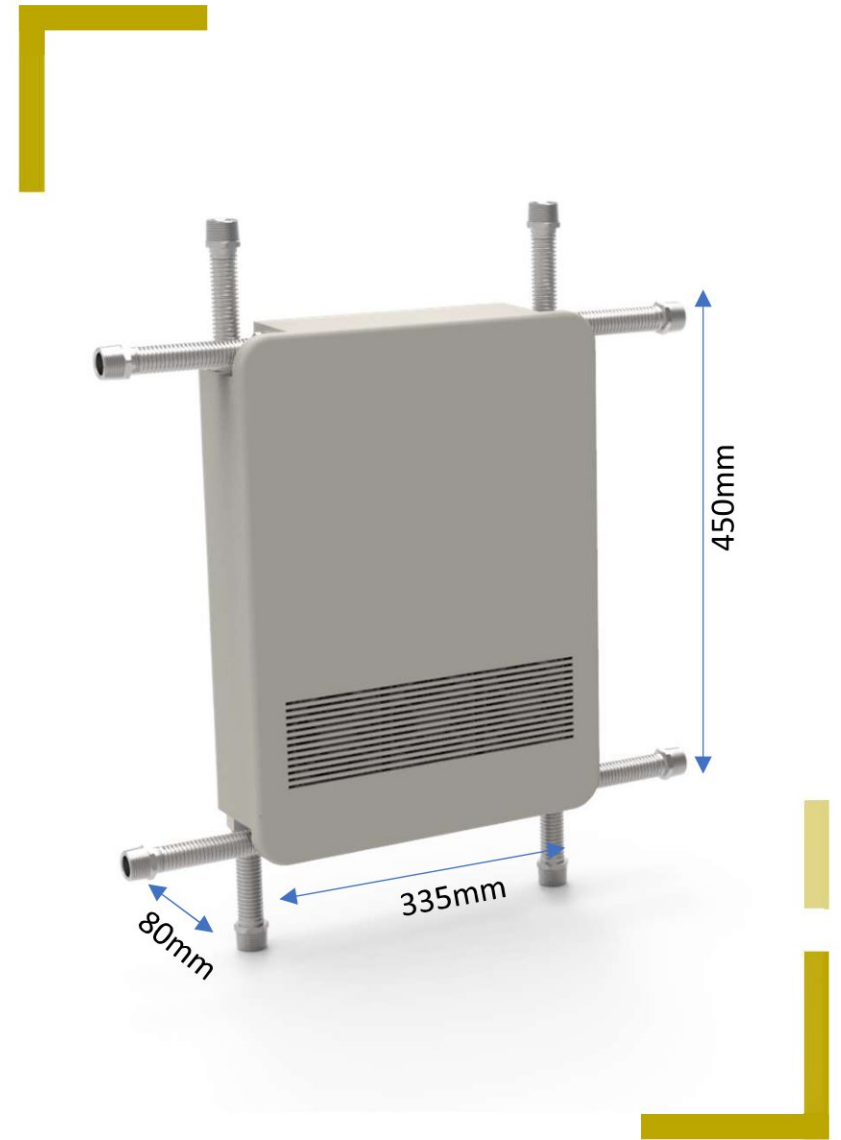
The permanent 3d structure is made using this panel. Each panel takes in polluted air from back and give out clean air in front. Each panel is connected to the other using stainless steel flexible hose.



# Single panel design

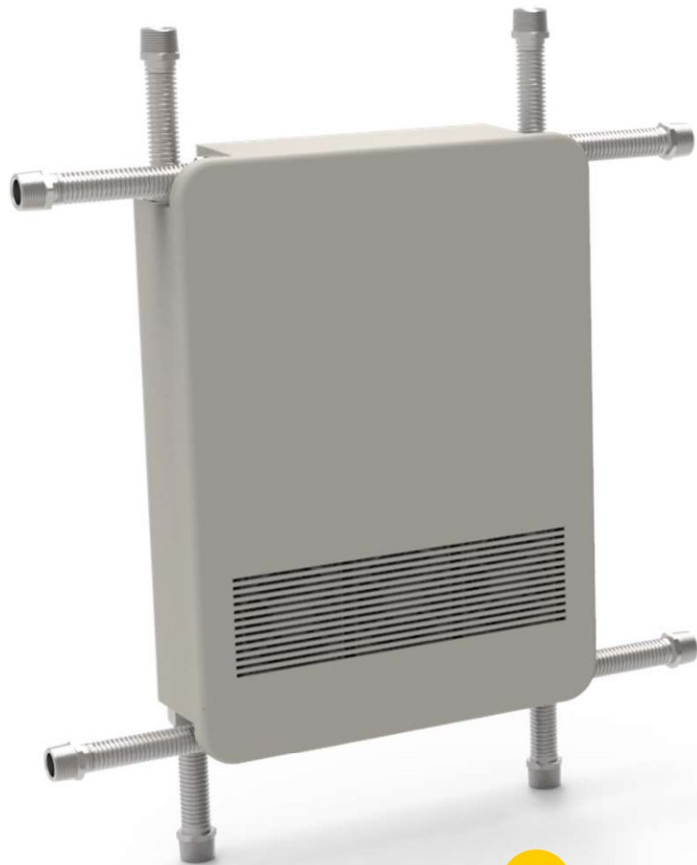
## Specifications for a single module

- 1 m<sup>2</sup> active surface area
- 20 bipolar carbon brush ionizers
- 1000 CFM clean air supply
- 80\*335\*450mm size



# Single panel design

Each panel takes in polluted air from back inlet and give out clean air in front. The design of the each panel is such that it can be opened easily for maintenance.



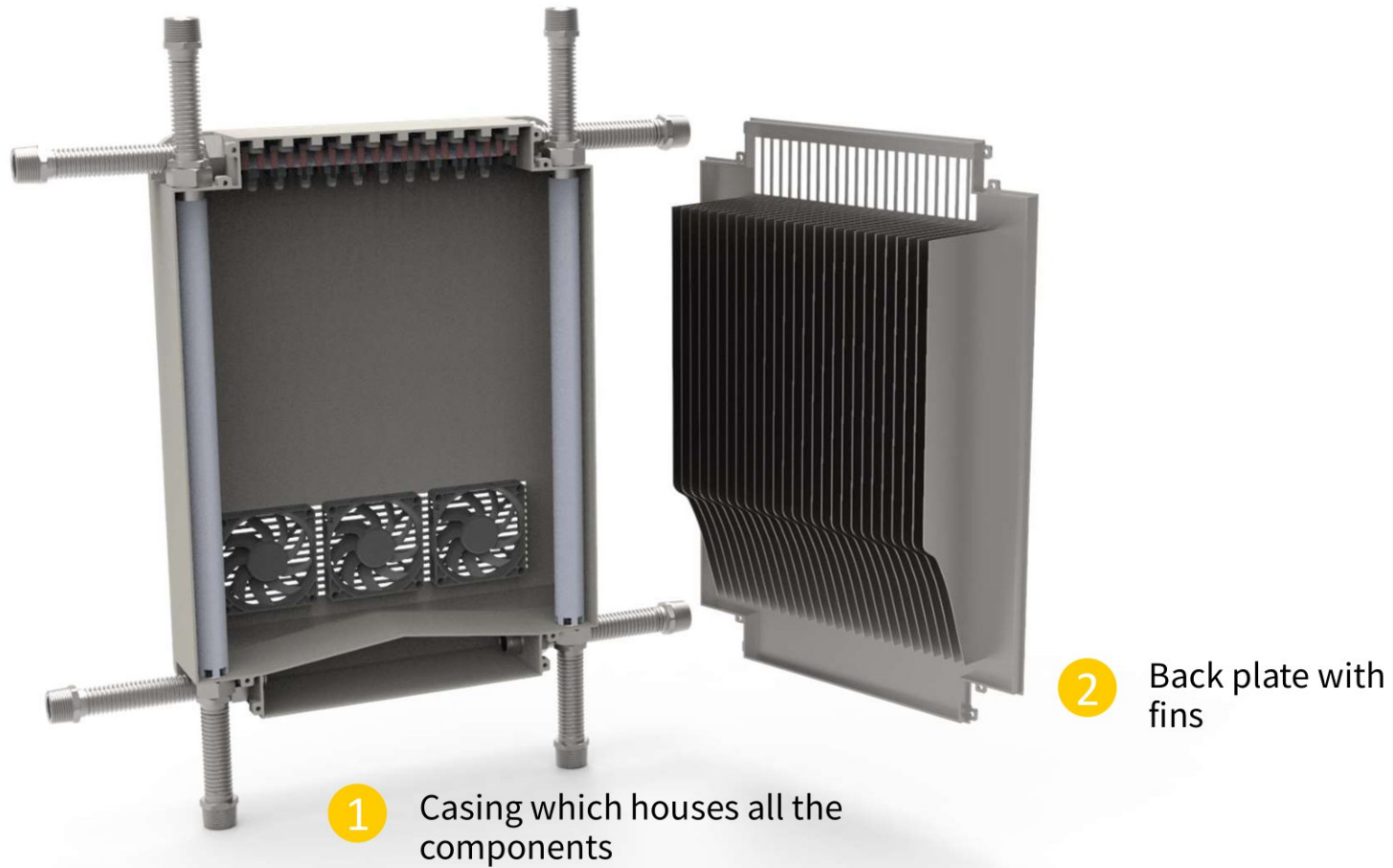
Front view **1**



**2** Back view

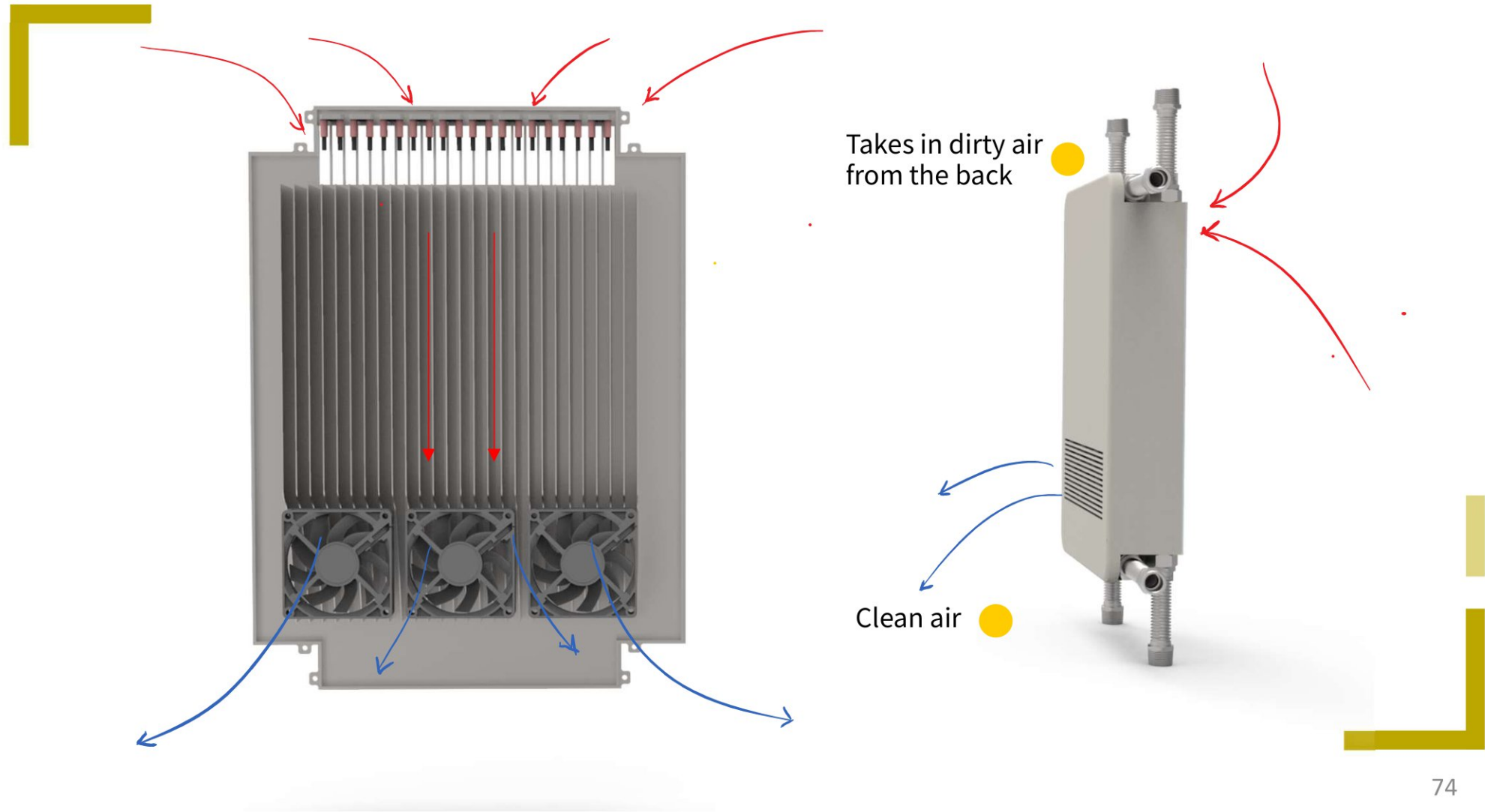
# Single panel design

Each panel is made up of two parts, one is the casing and the other is the back fin plate



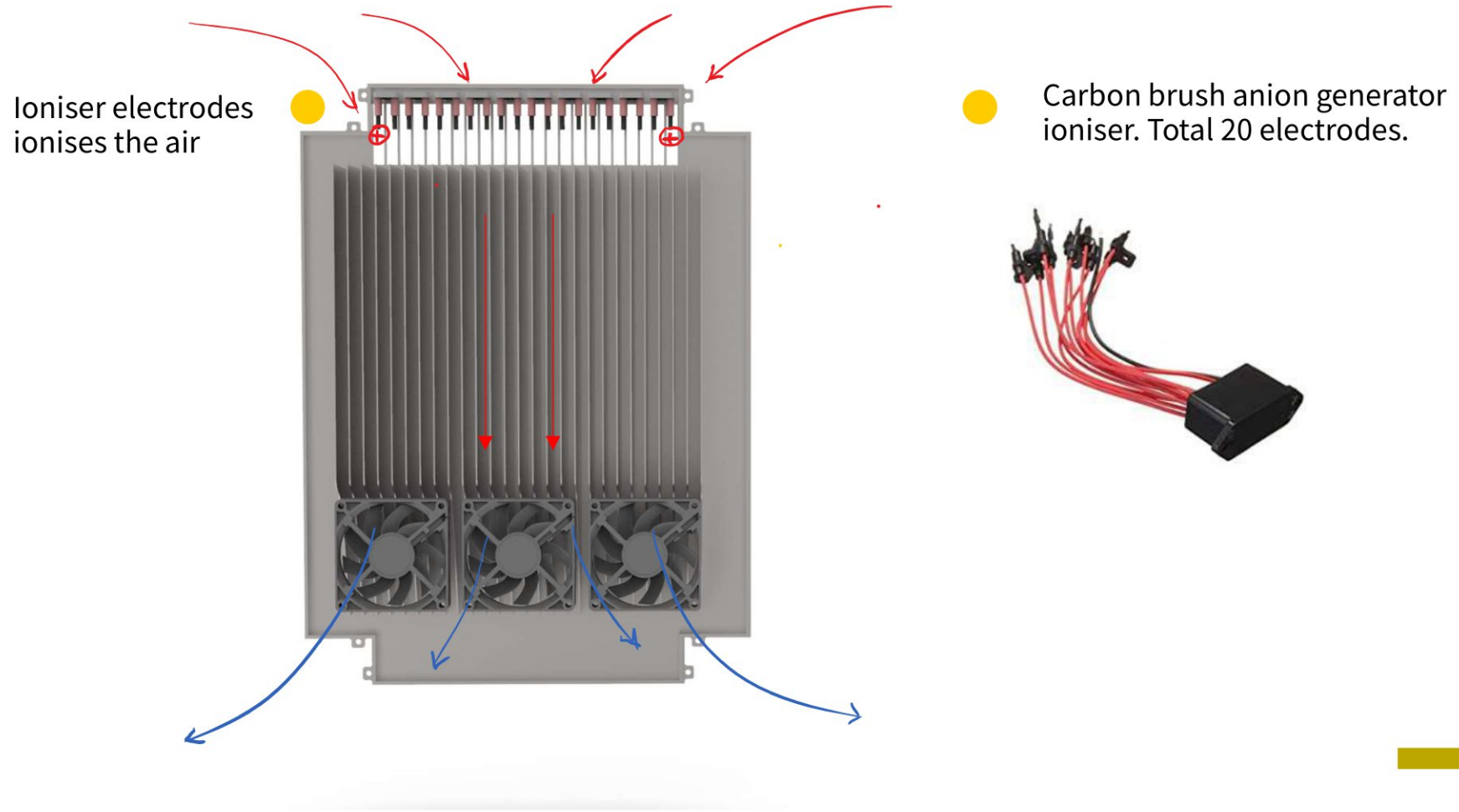
# Working of each module

The module takes in polluted air from the back and gives out clean air from the front. The back plate of the module has fins. The air passes through the fins and is forced out by the fans. It is a four step cleaning process which will be explained in the subsequent steps in the coming pages.



# Working of each module

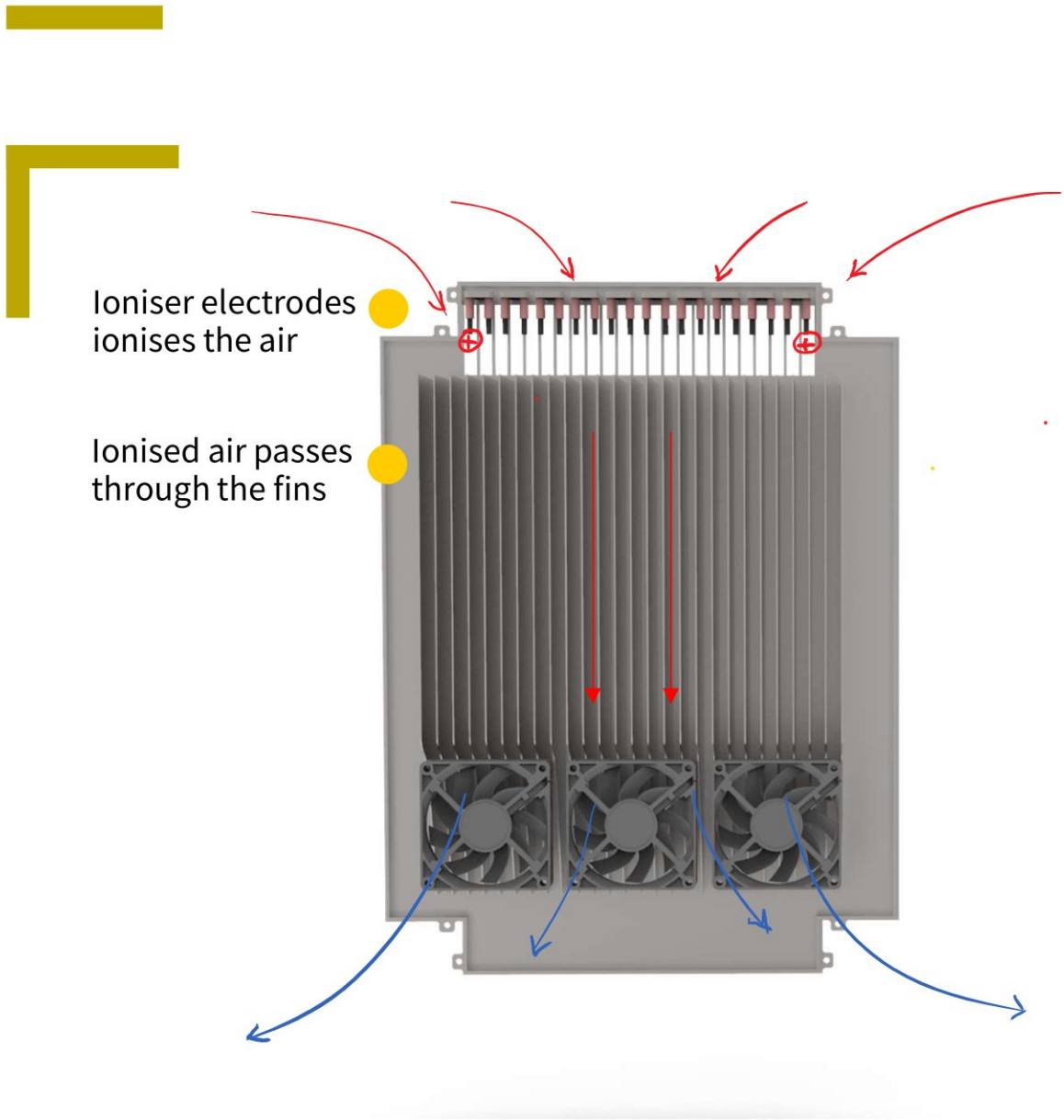
When the air enters the module it gets charged by the ioniser electrodes. This charges the dust particles and then passes through the fins.





# Working of each module

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# Working of each module

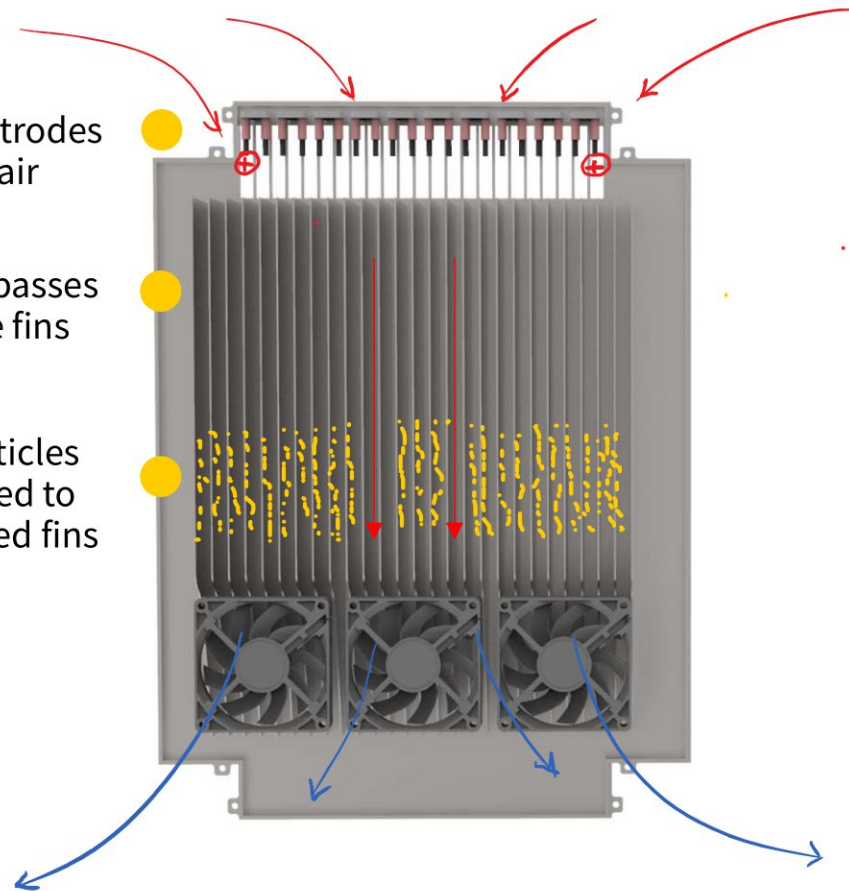
The charges the dust particles gets attracted to the fins as they are grounded, this creates adsorption on the surface of the fins.



Ioniser electrodes ionises the air

Ionised air passes through the fins

Ionised particles gets attracted to the grounded fins



# Working of each module

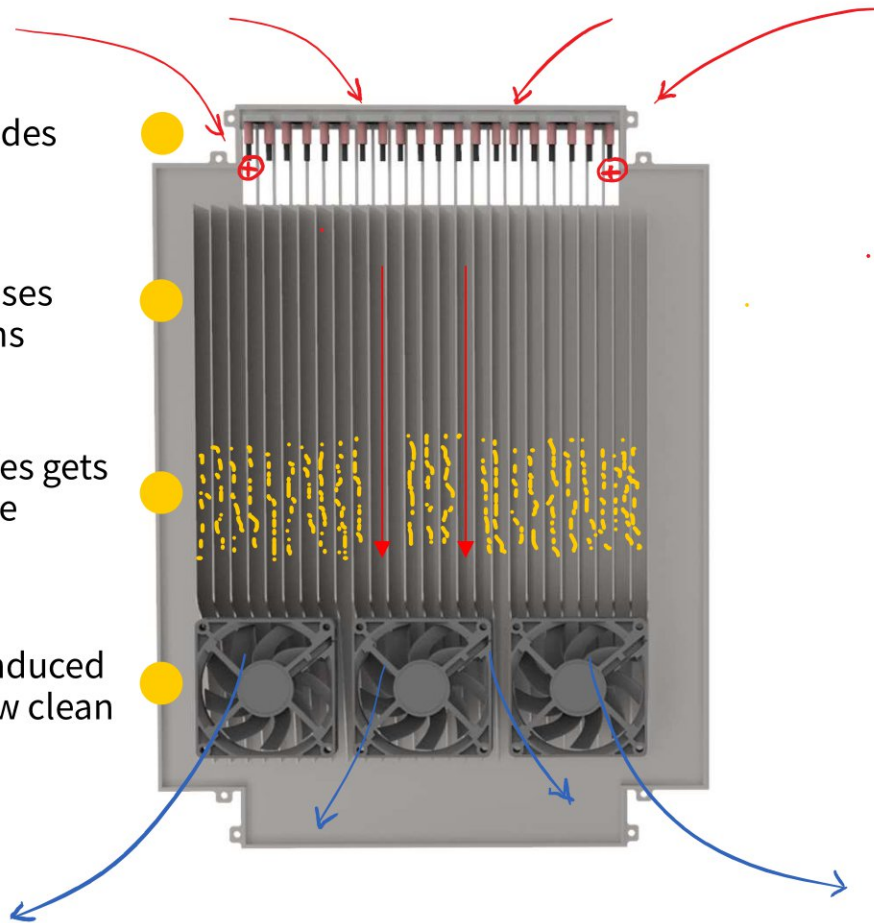
When the PM particles are adsorpted on the plate, the remaining clean air exits the module form the front with the help of fan. We selected an IP55 fan which is resistant to dust.

Ioniser electrodes ionises the air

Ionised air passes through the fins

Ionised particles gets attracted to the grounded fins

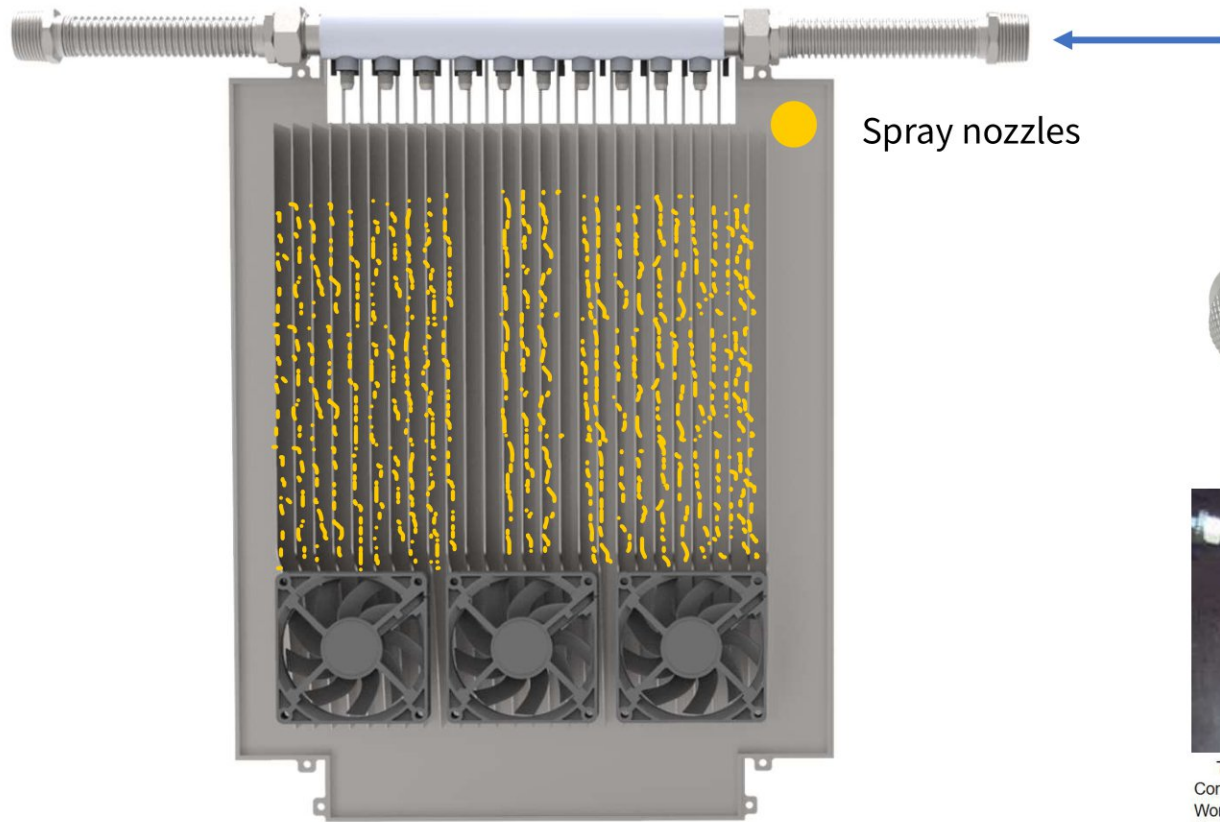
Fans creates induced draft and throw clean air out



● Delta Electronics IP 55 brushless fan.

# Working of each module

After 12 hours of operation the fins surface is saturated with PM particles. To remove them we use high pressure water spray . All the flexible hose is connected to each other and have a high pressure water flow.



High pressure water inlet.  
( 5- 10 Kg pressure)

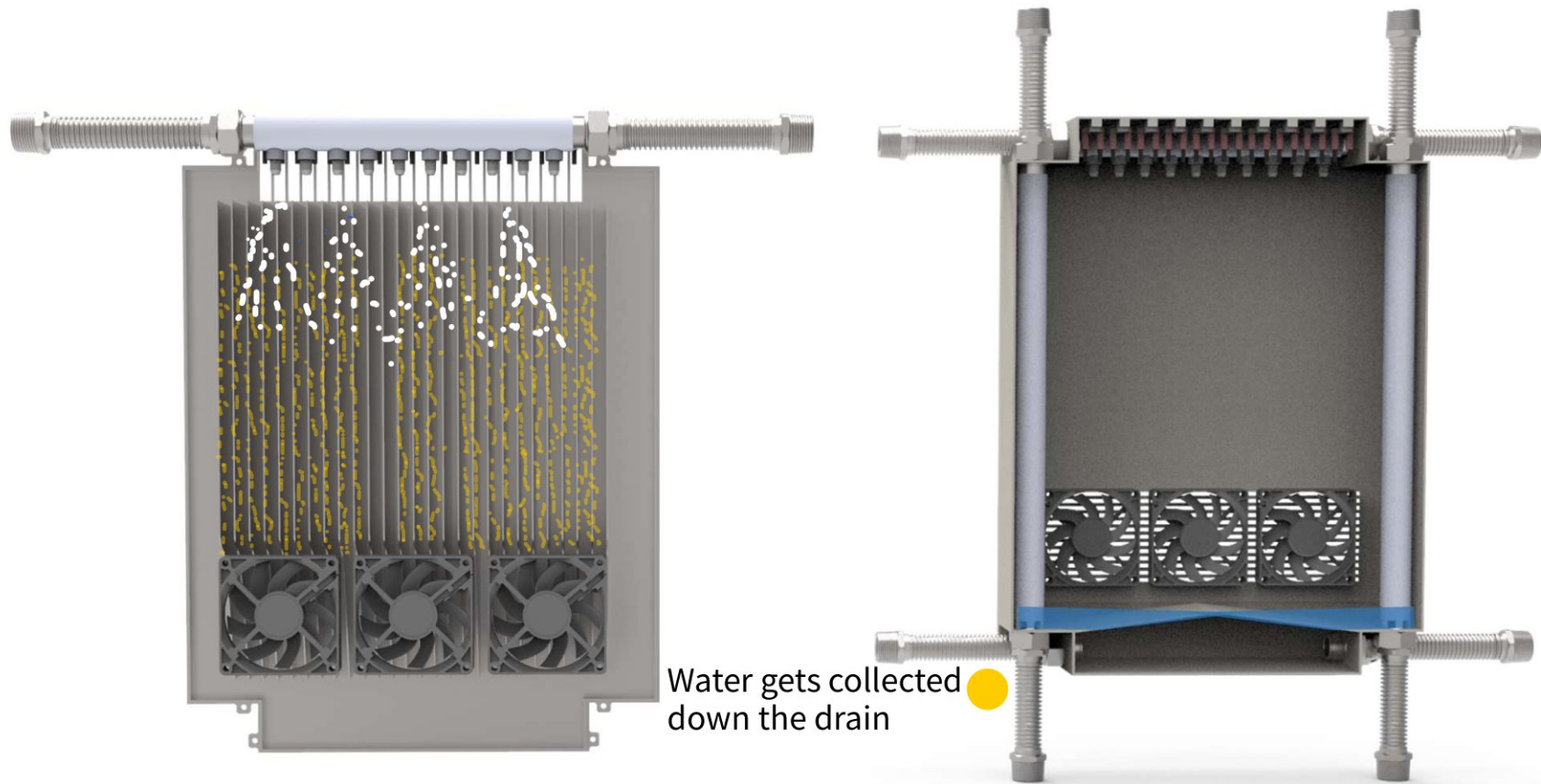
Spray nozzles



Technical parameters:  
Connection size: 1/4"(Female thread).  
Working pressure: 2-35kg.  
Sprinkler diameter: 0.5-2m(depending on hydraulic pressure).  
Water Flow: 0.1-0.5 cubic meters per hour.

# Working of each module

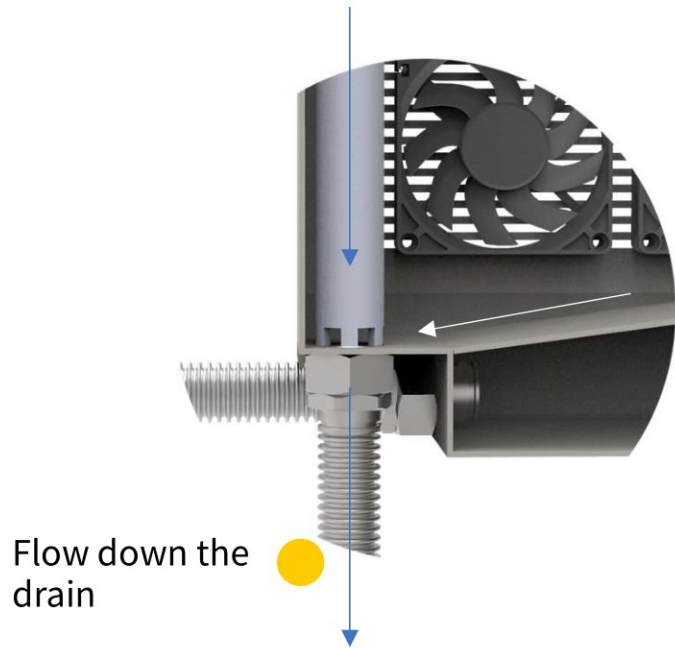
When the water is sprayed down the fins. The water collects all the pm particles and gets collected in the drain, designed in the details of the each module



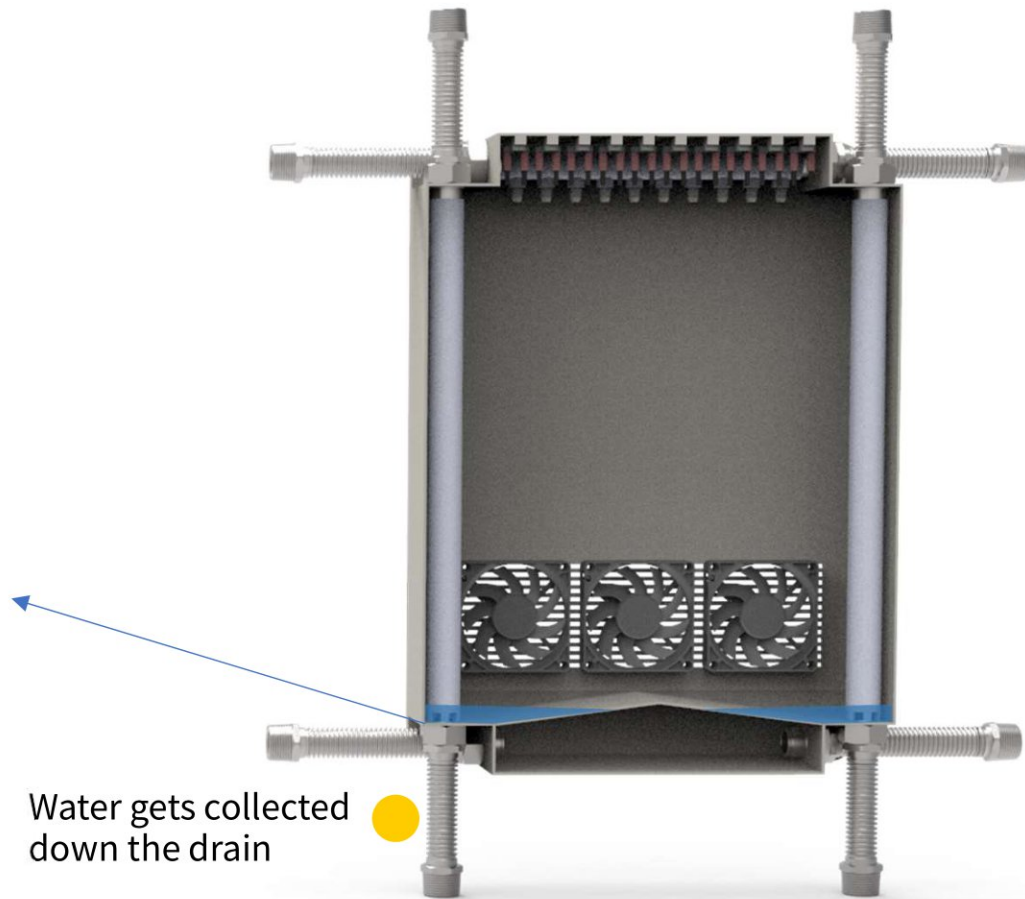
Water gets collected down the drain ●

# Working of each module

When the water is sprayed down the fins. The water collects all the pm particles and gets collected in the drain, designed in the details of the each module



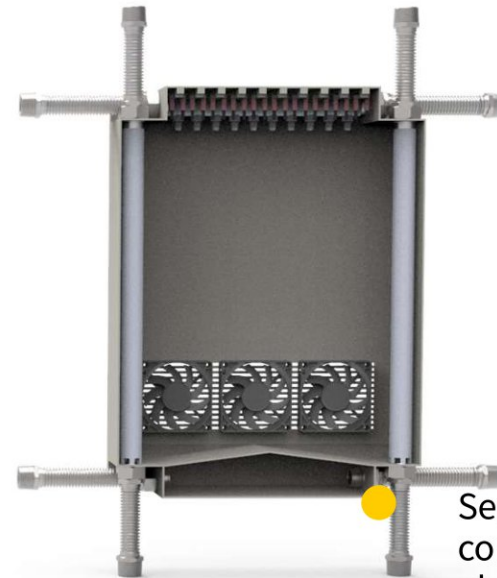
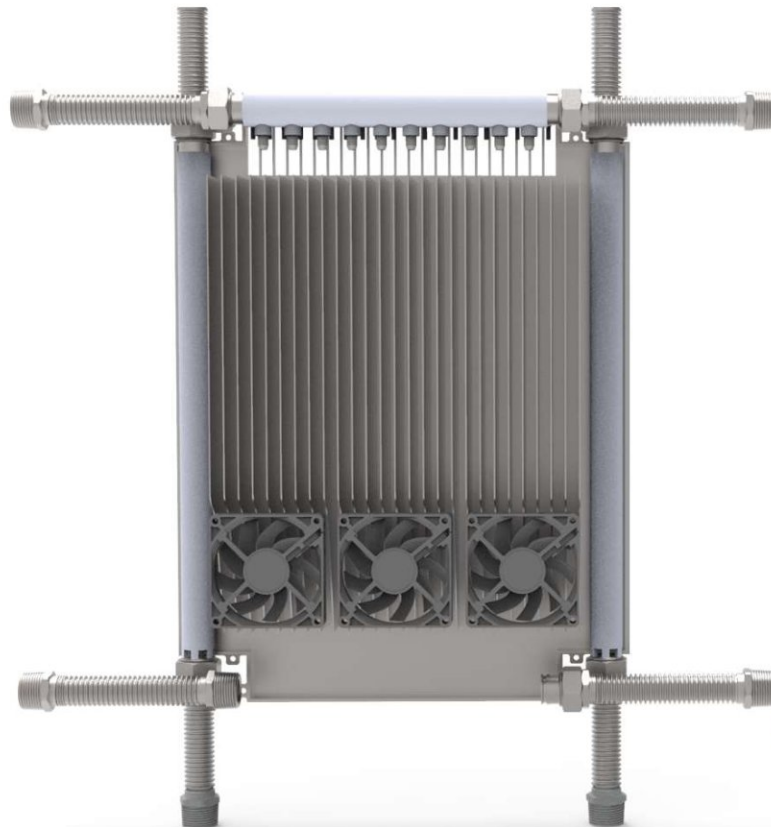
Flow down the drain



Water gets collected down the drain

# Working of each module

Each of the hose pipe is connected to the adjacent module. Each connection has their own function. There is separate compartments that houses all the electronics and doesn't come in contact of water



● Separate flexible hose for electric wires

● Separate compartment for electronics

# Working of each module

Parts inside each module

Flexible hose connectors

Ioniser electrodes

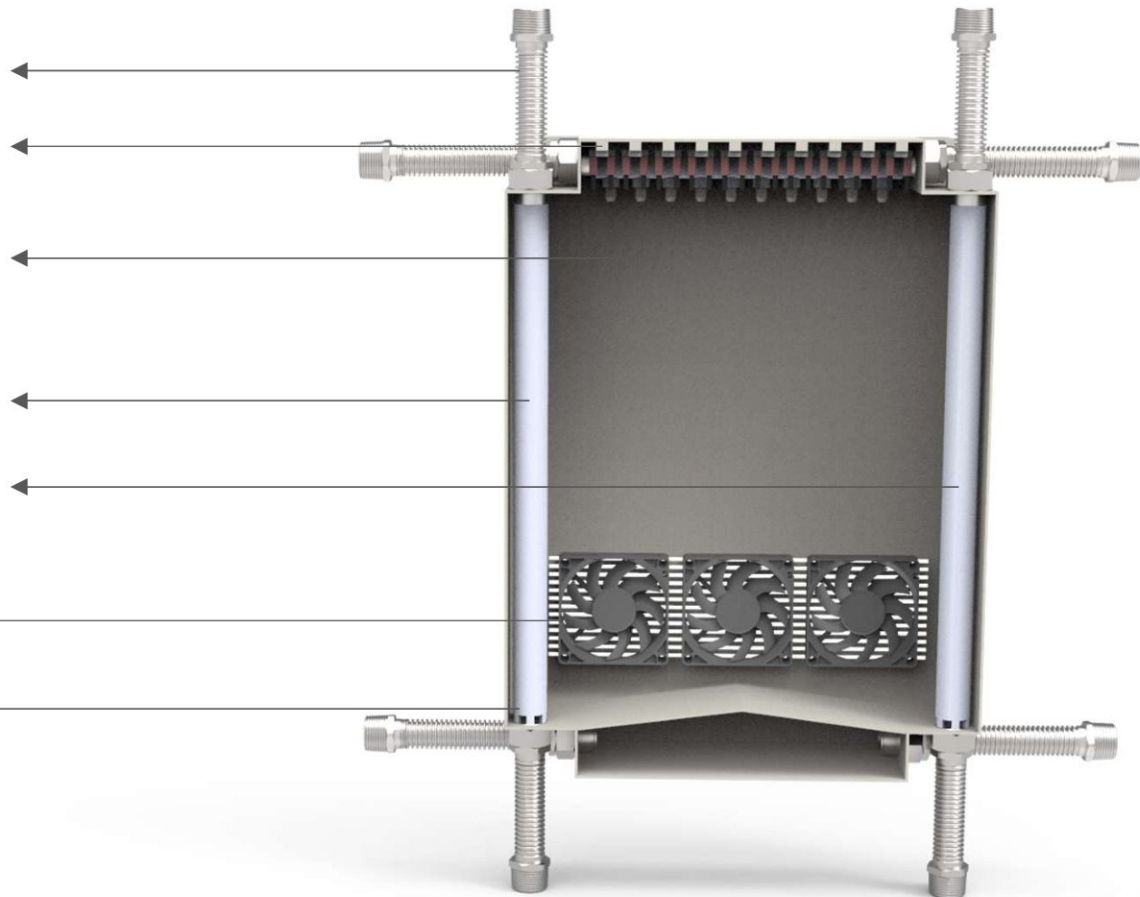
Spray nozzles

Drain pipe line

Drain pipe line

Fans

Drain

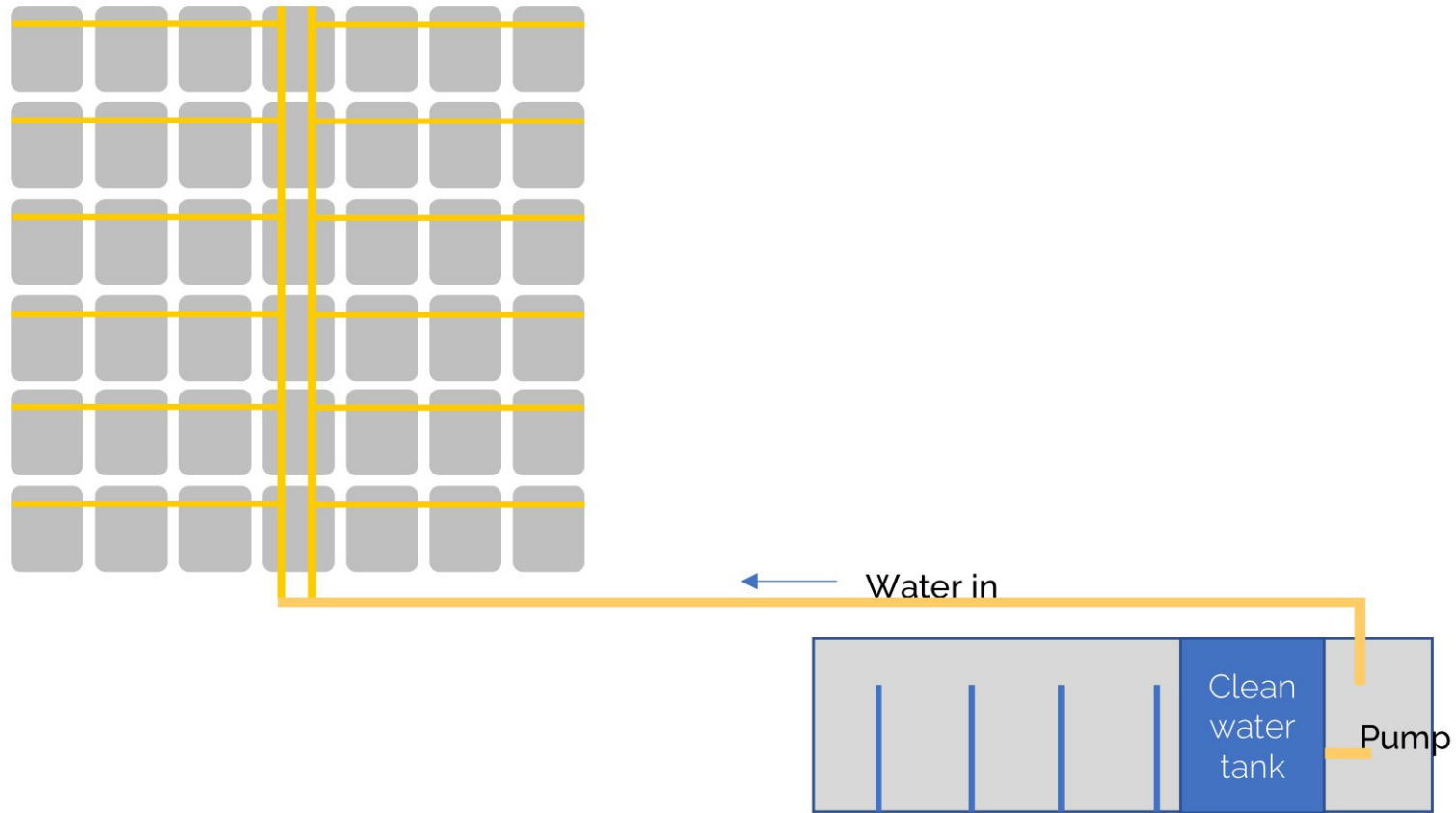




# Schematic diagram of plumbing

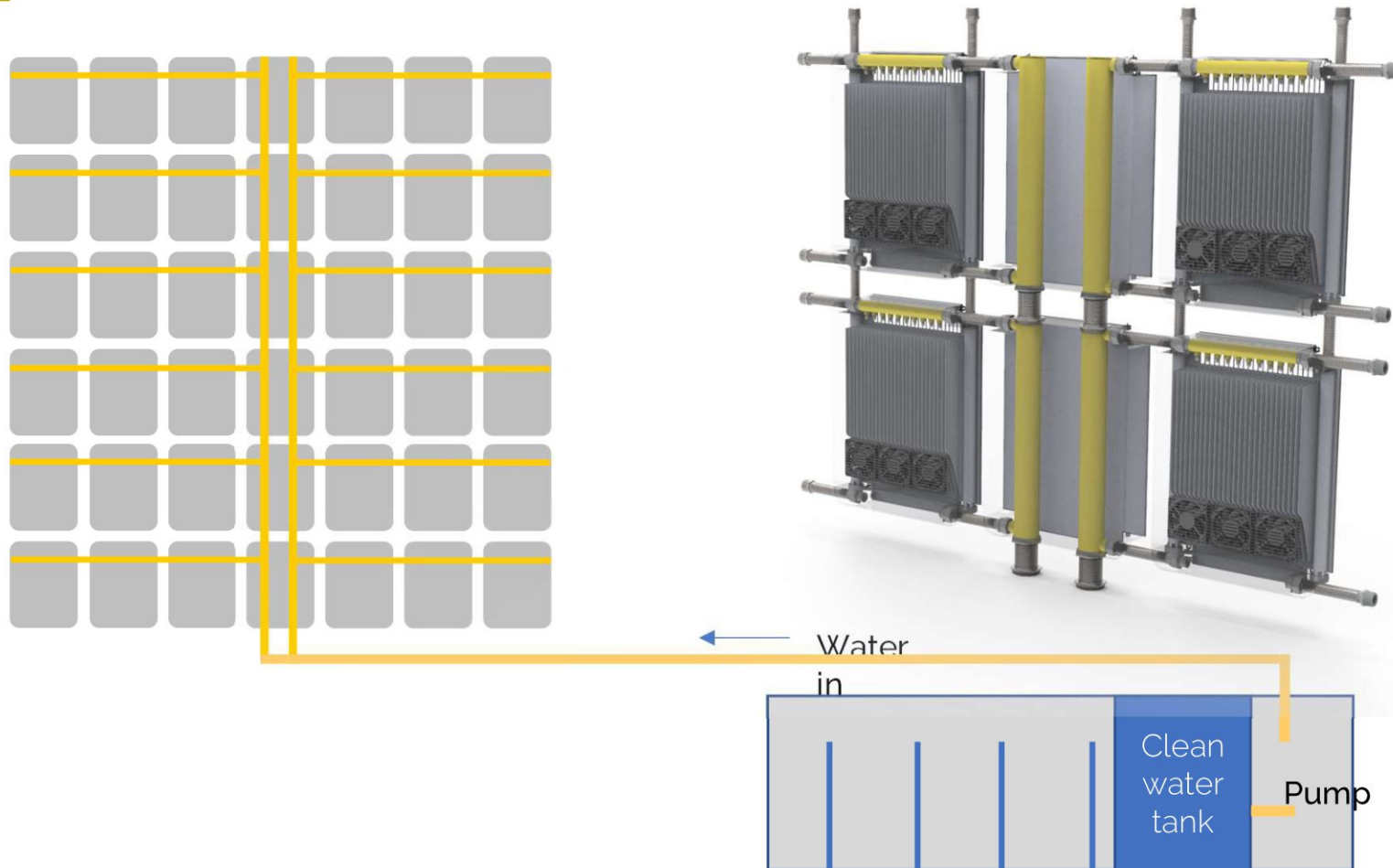


The schematic diagram show how the plumbing of water is done between the modules. The yellow line shows the high pressure water line. The central modules act as a central hub to distribute the water evenly to each of the rows. This maintains an even pressure and good flow



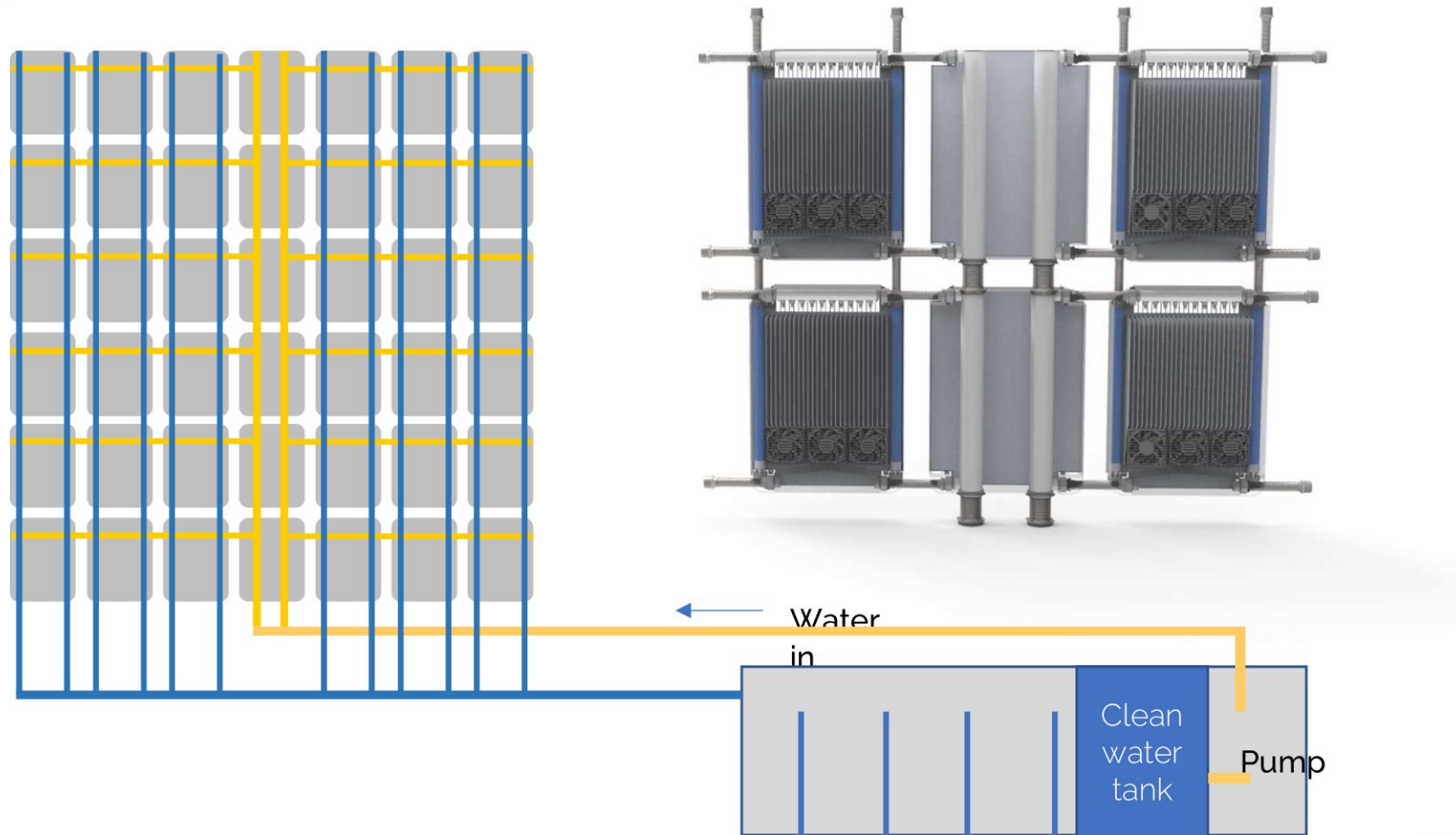
# Schematic diagram of plumbing

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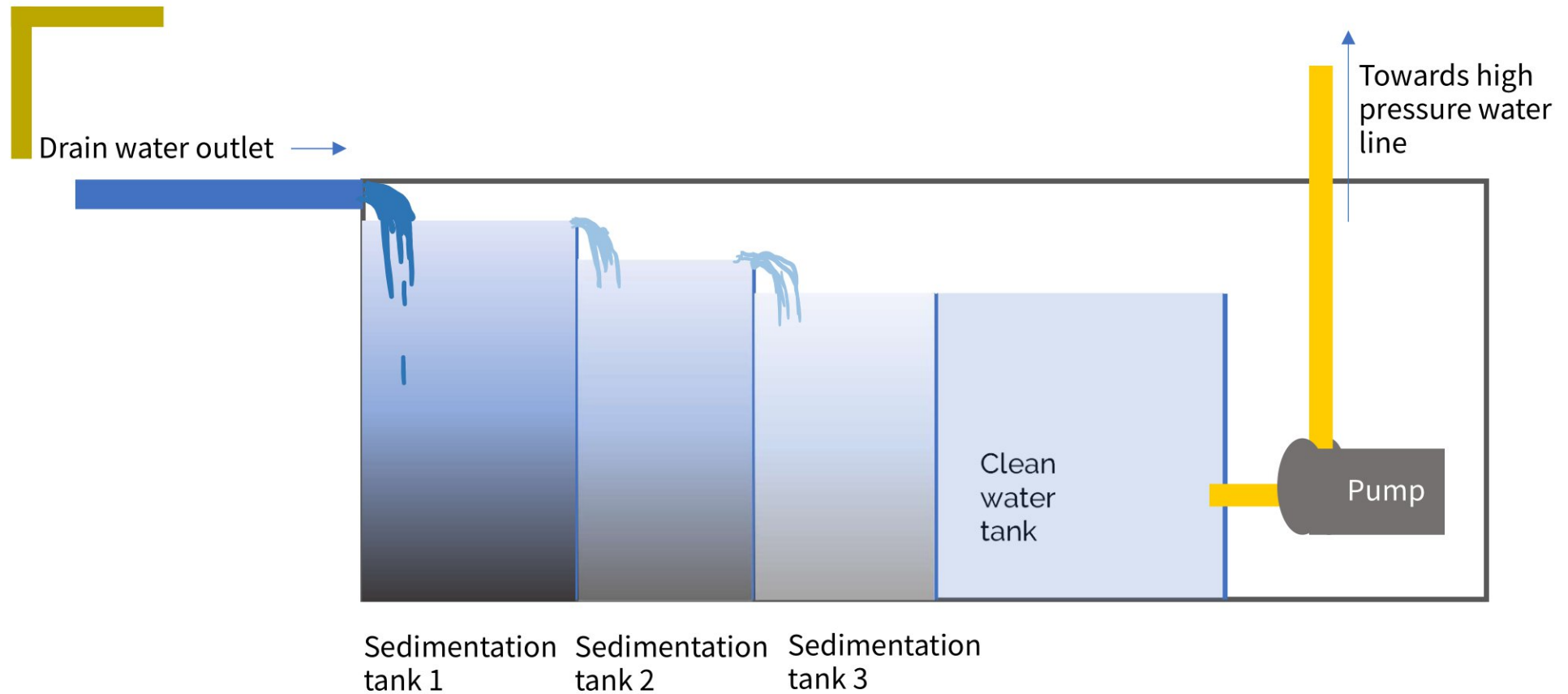
# Schematic diagram of plumbing

The schematic diagram shows the working of the drain pipeline plumbing. The blue line is the drain line. These run parallel in columns of the modules. The water flows down the each module, to the water treatment tank.



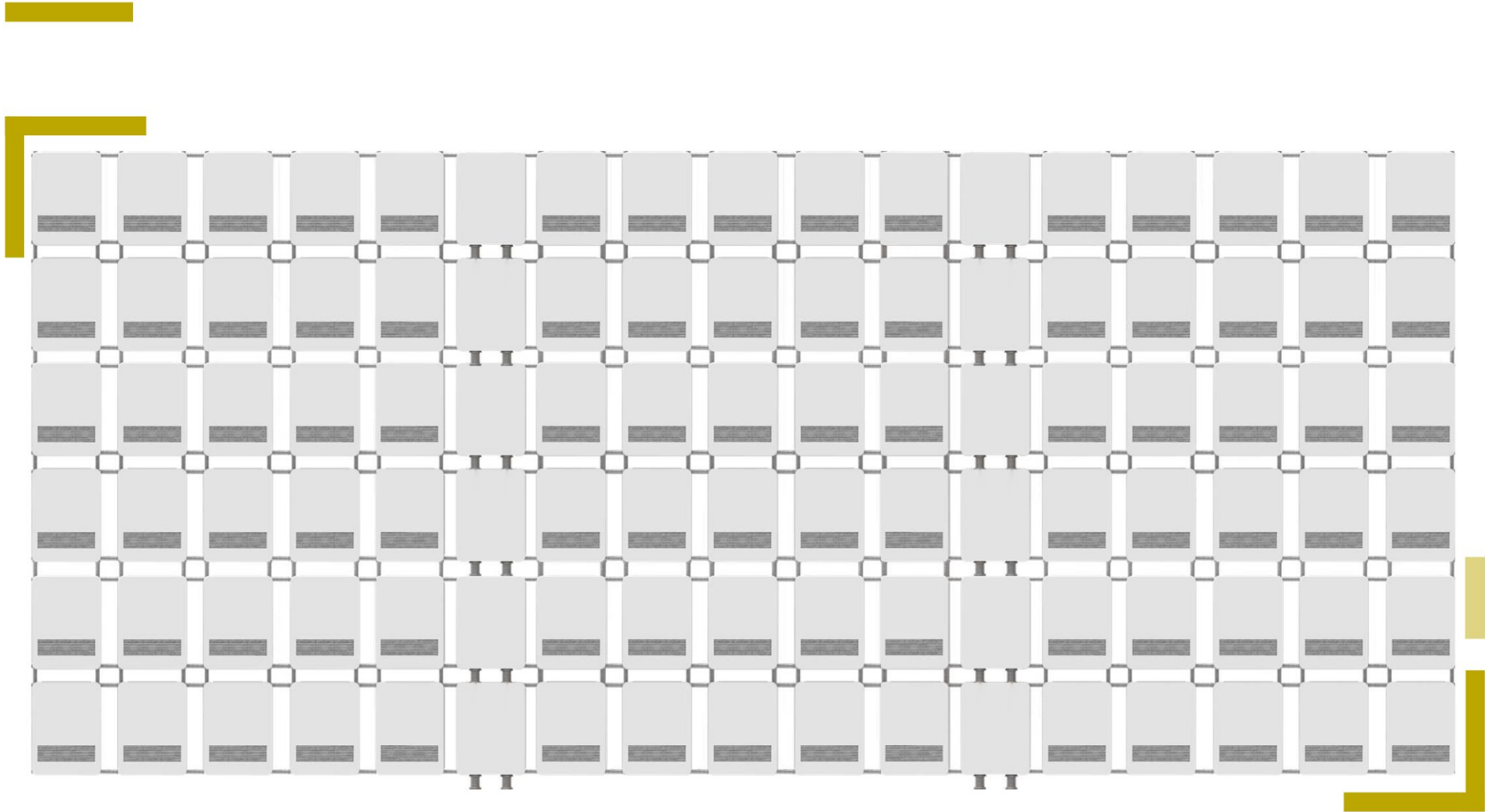
# Water cleaning system

The water cleaning system is a sedimentations tank which has three stage sedimentation. When the water flows down the module it carries all the PM particles with it. These are suspended in the water. The three sedimentation tank removes this PM particles and settles them at the bottom of each tank.



# Installation

The figure shows how the modules are connected to each other. These is a modular arrangement inside the module , with two or more central modules.

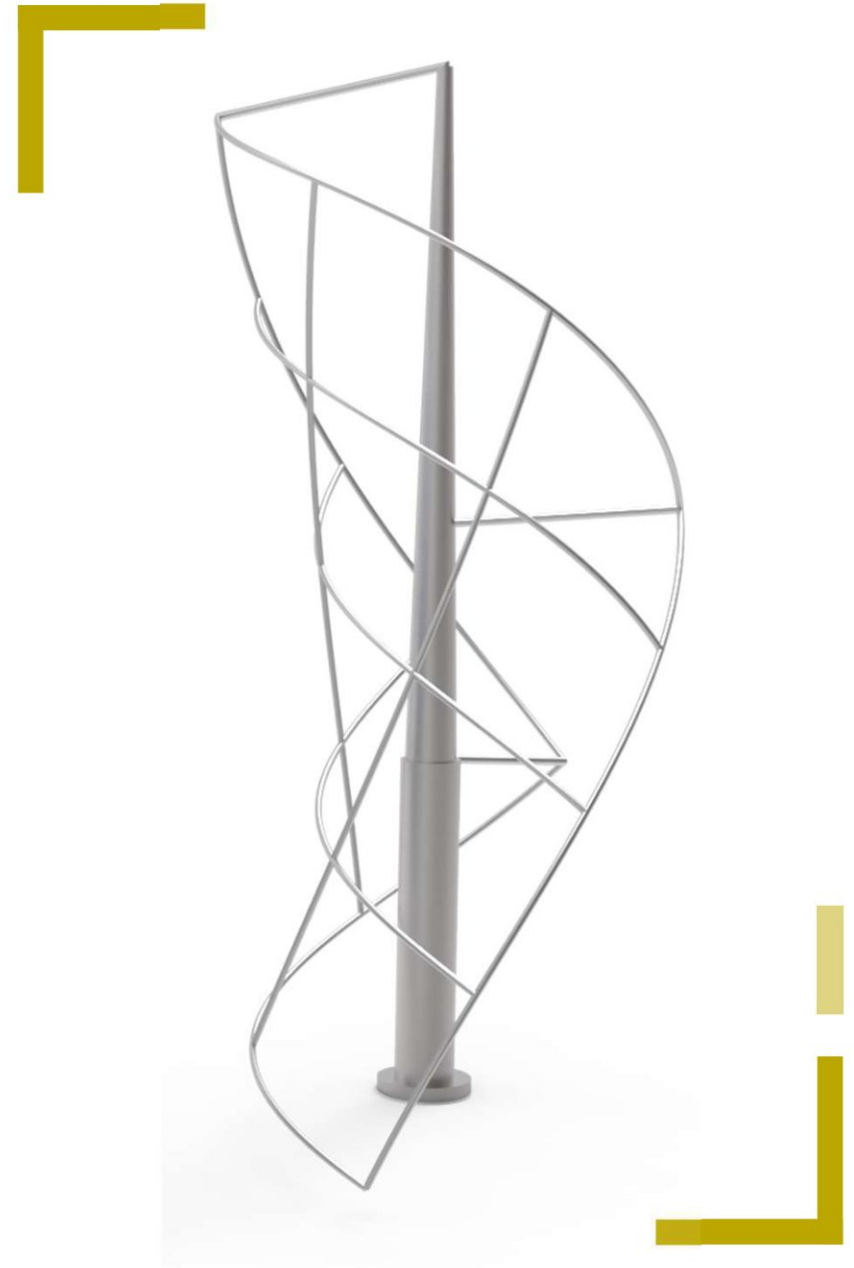


# Installation



The diagram shows the frame which gives the shape to the chainmail. We know that the chainmail is a flexible structure which takes shape of anything on which it is places.

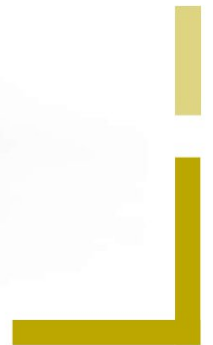
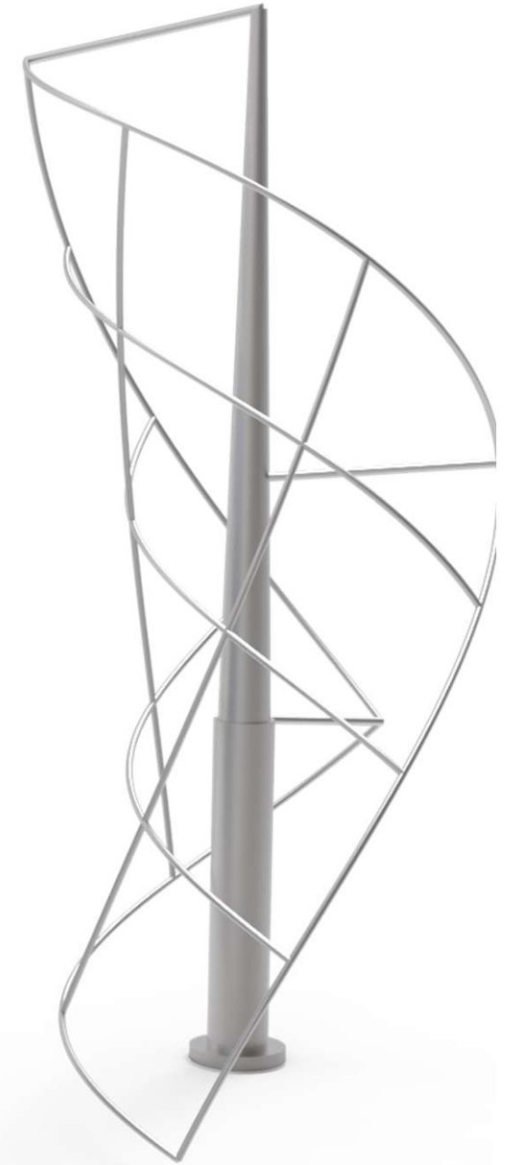
The frame acts as a guide to the modules and the modules are snapped on to the rails of the frames in order to control the shape.



# Installation



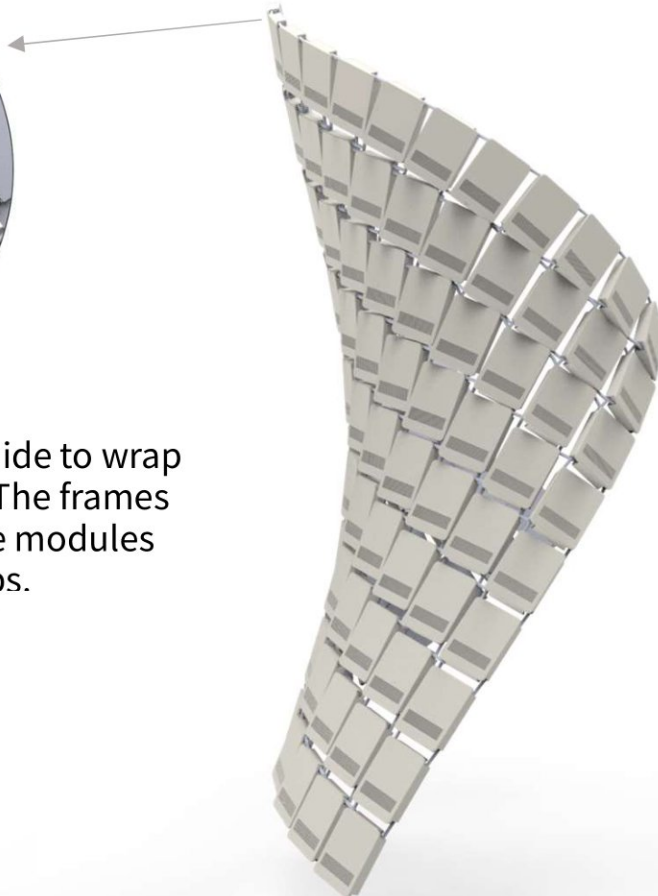
The frame giving the shape to the modules interlinked to each other.



# Installation



- The frame acts as a guide to wrap the modules around. The frames are mounted on to the modules using snap able clamps.





# Installation

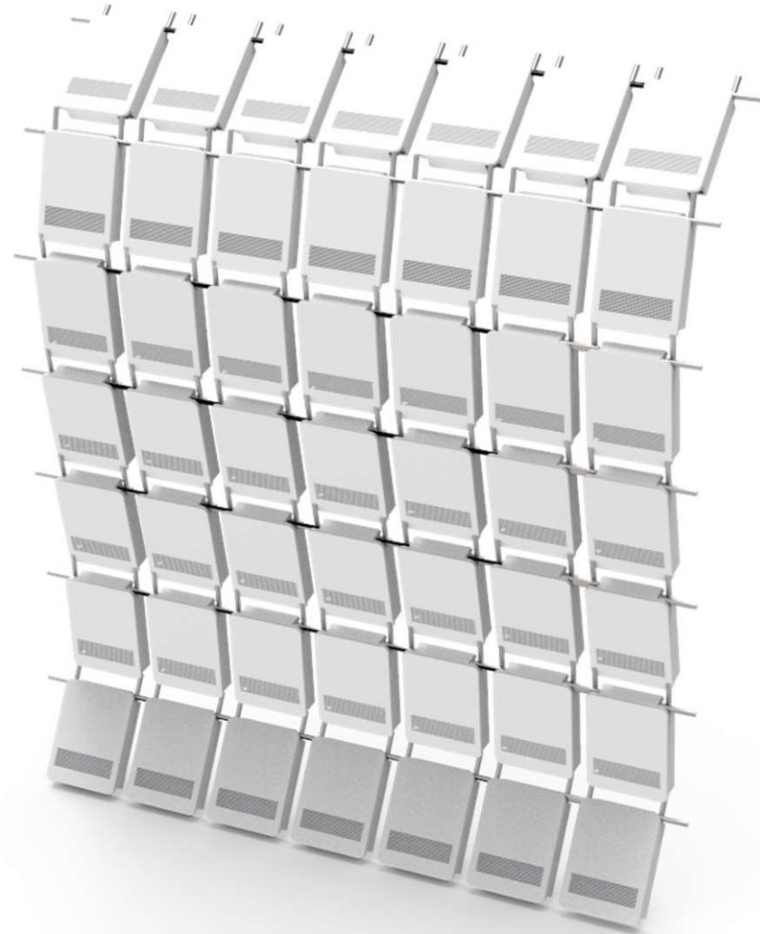
The whole structure has 108 modules, Giving 62000 m<sup>3</sup>/hr of clean air, which can effectively cover 500m<sup>2</sup> of area



# Configurations

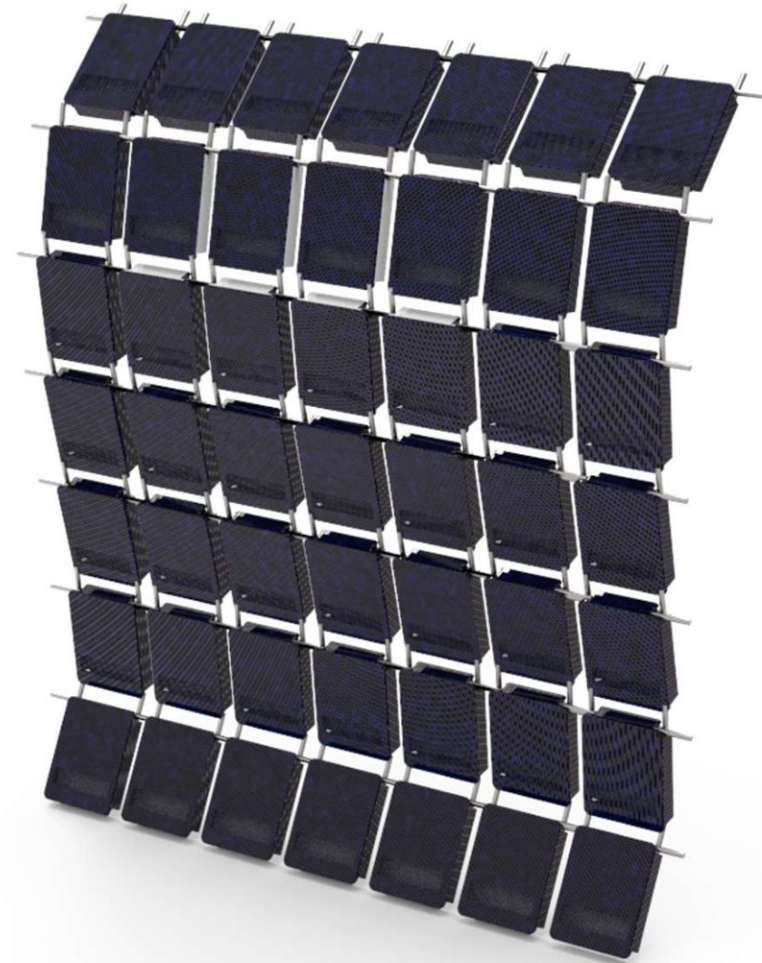
Chain mail design enables it to take any surface, which increases the possibility of installation. In this configuration it can be installed as a façade of the building.

There is a plane surface on each of the module this real state space is huge. They can be used to place graphics, advertisements or photovoltaic cells



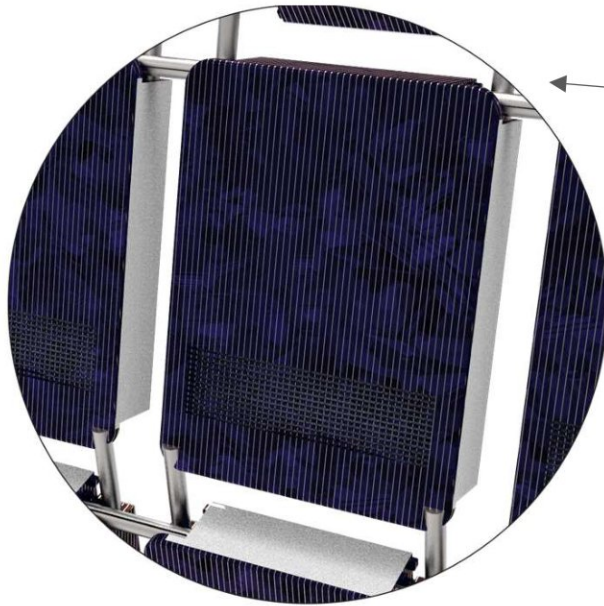
# Configurations

The real estate can be used to mount the PV cell on each module



# Configurations

This PV system is grid bind. Generating electricity when not in use and supply it to grid to get credit. Then again using that credit to get electricity.



PV surface on the front part of the module



# Cost

One of the advantage of a modular design is that it is cost effective. Here each module cost 3300 rupees with the whole installation cost around 4 lack rupees. Similar capacity air purifier that is installed din Lajpat nagar cost 12 laks.

## Bill of material

Parts	Quantity	Price(in Rupees)
Ioniser	2	1400
Fan	3	600
Front Casing	1	200(assumption)
Back Plate	1	500(assumption)
Plumbing	1	500
Spray nozzles	10	100

Cost per module = 3300 rupees

Cost per installation(108modules) = 4,00,000 rupees

# Ownership



Privately owned

- Owned as a utility
- Added service to the existing infrastructure
- Self Maintained or AMC
- Revenue sources

Electricity

PM Clay

While we were researching we found that the current ecosystem is very complicated. Any service like this if privately owned is maintained properly. So we tried to create incentives to buy such a air purifier. We tried to create some other sources of revenue. If the owner uses a PV system then he can generate electricity and get credits for that. The other revenue source could be the PM clay. Which is the left over from the water cleaning system where all the PM particles gets collected.

# Ownership

## Municipality owned

- Owned as a utility
- Covers an area of 500 meters
- Self Maintained or leased to a company
- Revenue sources

Electricity

PM Clay

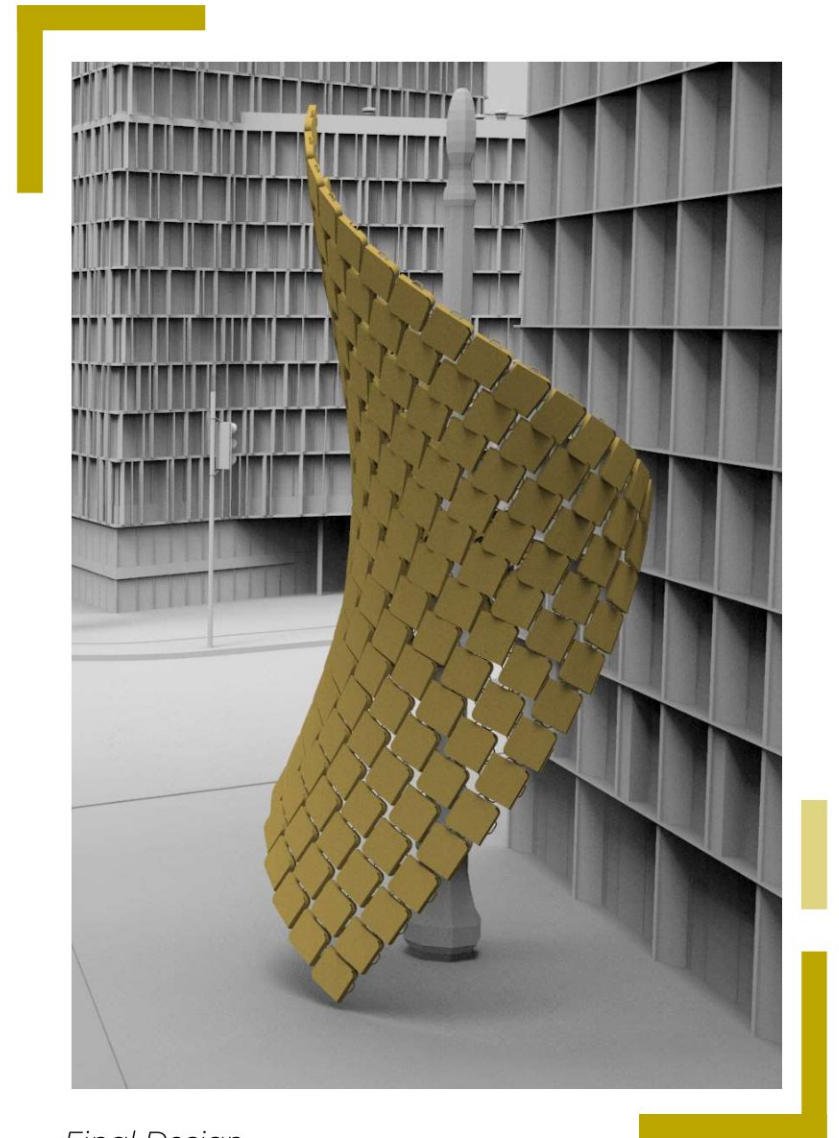
Advertisement

When the same system is owned by municipality, a big question of maintenance arises. In this case the air purifier is owned by the municipality, it can lease the air purifier to a company and all the revenue generated by the air purifier can be used in the operation and maintenance of the modules. This makes the air purifier self reliant and can be operational for long durations.

# 08 Conclusion

This project began with a very simple intention to understand the current air pollution problem. As I dug deeper into the problem I realised the requirements and attributes of the product. I didn't direct myself to a normal approach of just designing a smog tower but my guide helped me to understand many creative ways to solve the same problem.

The final design is a modular design, where each module is cleaning air. These modules are connected to each other in such a way that it makes them flexible chainmail structures which can take any form. The design is very versatile and easy to deploy as permanent structures with multiple configurations.



*Final Design*



# 09 References

## Paper

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- Air pollution in Delhi an analysis by CPCB\
- Air quality assessment and its relation to potential health impacts in Delhi, India Sanjoy Maji<sup>1</sup>, Sirajuddin Ahmed<sup>2,\*</sup> and Weqar Ahmad Siddiqui<sup>1</sup>
- National air quality index by CPCB
- CEEW what is polluting Delhi air issue
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- An Analysis of the Annual and Seasonal Trends of Air Quality Index of Delhi Manju Mohan & Anurag Kandya

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