Seyyare Ece Akdağ
523211023

Istanbul Technical University MBL 537 Architectural Design Futures Final Strategy Paper

Air-Pollution Reduction Strategy for Esenler

1. Vision Statement

The low quality of air in urban areas is a health-threatening factor for the citizens, and causing many problems ranging from asthma to chronic diseases. As a very densely populated and industrial city, Istanbul and Esenler face the problem of air pollution, and the air quality is found to be low-moderate level. Mobility tools or built environment are major factors, polluting the air, and a smart built environment should develop air-purifying strategies to compensate the polluting effect. In order for a city to maintain public health, the walkability of the neighborhoods should be enhanced with purified air, which is the most important source of life. Researches show that air cleaning not only is possible via expensive and high-technology machines, but also the natural lifecycle of living organisms can be used to reverse the pollution of air.

Moss is analyzed and it is found, that by its nature able to metabolize fine dust, and create natural ventilation by evaporating water from their leaves. Therefore, an urban element including living moss surface would both purify the air from the fine dust and lower the temperature in its close environment. Moss shows potential to work as an urban element in squares as gathering and time-spending areas, on building facades and road-sides to clean the air pollution created by all built environment. Plus, the biological system needs a technological support to sensor real-time data, and take care of the moss. An additional vertical moss farm building is also a need to maintain the optimal species sustainably within the smart district of Nar Project Area in Esenler, İstanbul.

2. The Approach Plan

2.1. Urban Furniture Design & Vertical Moss Cultivation Farm at Square Areas

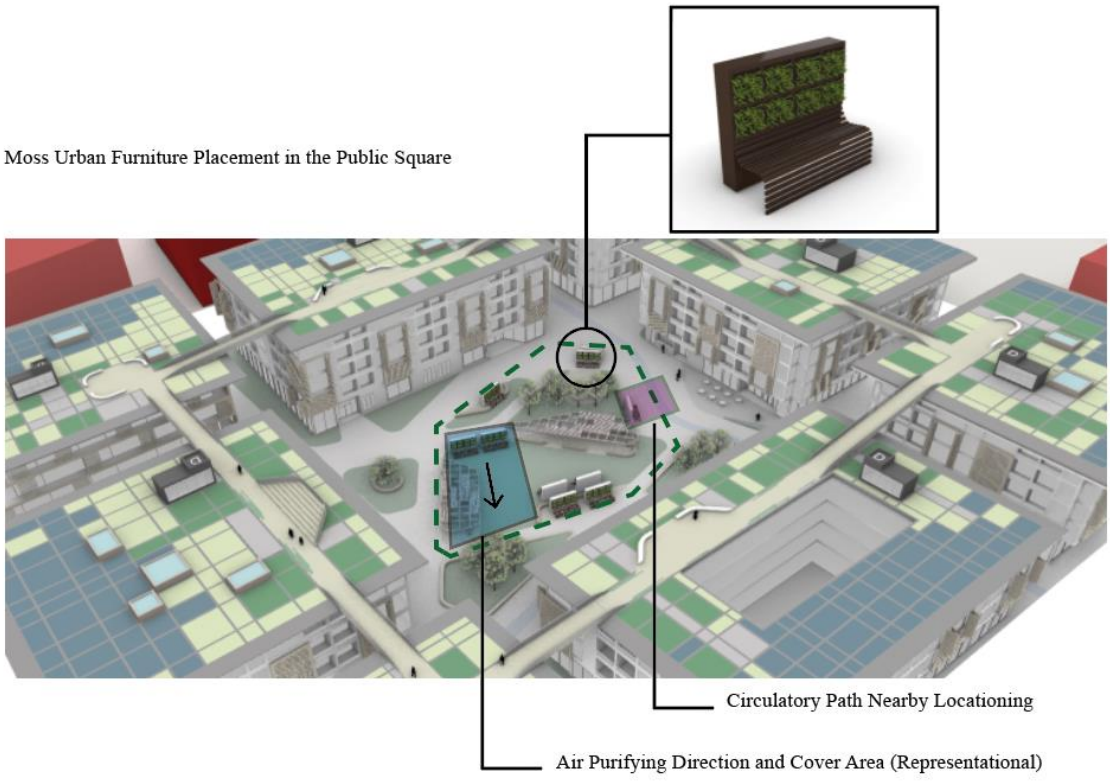
2.2. Façade Element Design on Proposed Building Walls

2.3. Installation Design on Streetlamps of Roads

2.4. Development for Real-time Data Sensors & System Automation

Seyyare Ece Akdağ
523211023

Moss Urban Furniture Placement in the Public Square



Seyyare Ece Akdağ
523211023

2.1. Urban Furniture Design & Vertical Moss Cultivation Farm at Square Areas

a. Introduction

In the form of an urban furniture, the air-purifying as the main goal is planned to achieve the collection of fine dust together with the proposing some urban use for the people in order to use the building material of the system more efficiently. Moss gives a potential to be used in a rectangular modular design, therefore for it is able to adopt other functions or forms in urban design like façade applications streetlamp design. A generative design system is planned to automate the evaluation of real-time data and to satisfy the water need of the moss. The preference of a biological material instead of more plastic and other material use together with more technology expenses is found to be a healthier solution addressing the problem. The availability of material is also considered and Istanbul and its nearby seas make the access to the material so easily and create a mutual benefit for both the strategy design and the cleaning of the sea of mosses. However, in case the optimal species of moss cannot be supplied from the nature, within the smart city system a vertical farm is proposed in order to sustain the needs with lower costs and no more transportation caused air pollution.

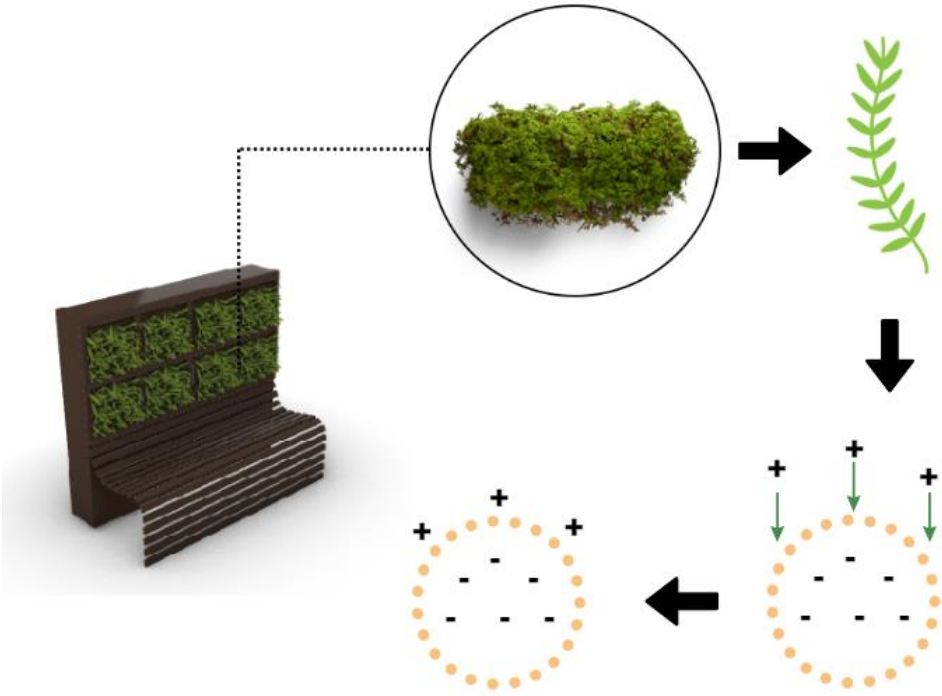
Goals:

- **i.** Sustainable regenerative fine dust cleaning
- **ii.** Cool & humidify the close environment
- **iii.** Block viruses and bacteria (also Corona Virus)
- **iv.** Unable future health problem diagnosis due to polluted air inhale
- **v.** Encourage people to prefer walking for more active and healthy citizens
- **vi.** Provide a water cycle for the plant raise

b.

i. Sustainable Regenerative Fine Dust Cleaning:

The natural electrostatically attraction of moss leaves to the dust particles and allergens is transferred into a design strategy to build an urban design element like urban furniture, façade panels or streetlamp by the help of the modular creation opportunity.



ii. Cool & Humidify the Close Environment

When the global warming and climate changes are considered, the experience of extreme hots increased in Istanbul and also Esenler site. Plus, the ventilation technologies are mostly indoor and spends vast amounts of electricity and buying costs. Even in 1-2 meters' distance experience, the natural water evaporation from its leaves, moss has observed to achieve decreasing the outdoor temperature.

iii. Block viruses and bacteria (also Corona Virus)

Even though virus and bacteria blocking seems a very minor goal in the overall project, it shows a huge importance in terms of the presenting a way without expensive and highly chemical products and cleaning machines or human beings. Plus, Istanbul and its dense urban districts like Esenler are highly affected by contagious diseases, as observed through Corona Virus.

iv. Unable future health problem diagnosis due to polluted air inhale

Urban city moderate to low degree air quality causes lung insufficiency start in children, causes asthma and many other health problems directly or indirectly. 3.8 millions of people die each year

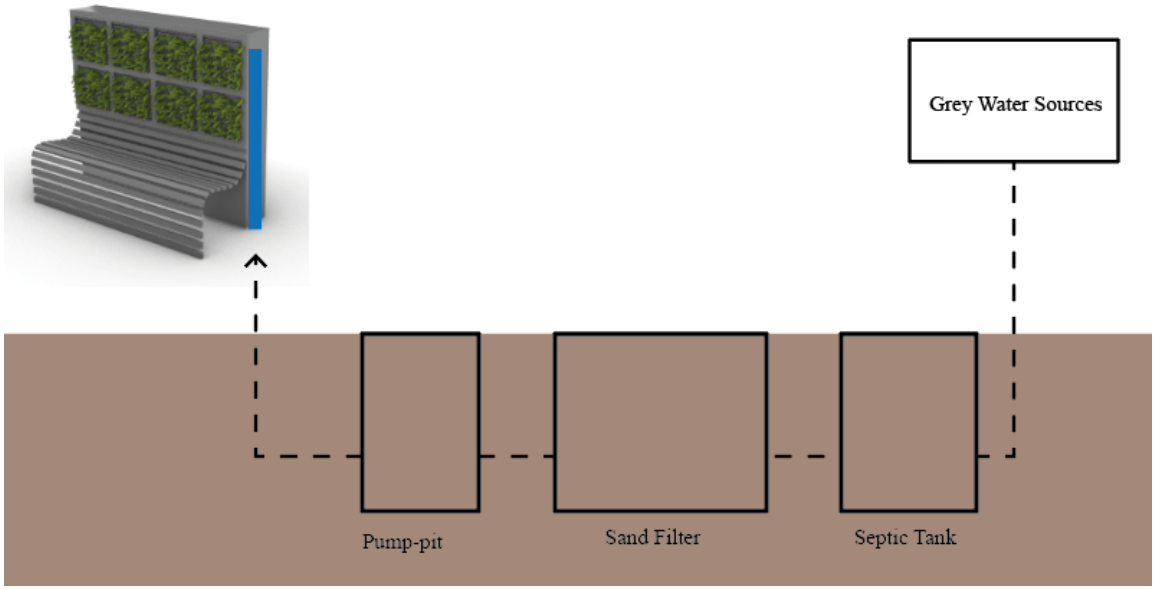
because of the quality of air. Esenler therefore will biologically clean its air and reducing the future health risks.

v. Encourage people to prefer walking for more active and healthy citizens

To sustain public health, the most important factor is walkability, however the clean air is as much important as the diversity of the close environment for people to desire to be more active than using their own vehicles for transportation. Therefore, dense areas such as squares and building facades are developed with moss bio-filter designs to provide purer air condition in the Nar Project Area.

vi. Provide a water cycle for the plant raise

Since the system uses water for plant raise, the source of the water becomes important in terms of avoiding unused water, but when a grey water treatment system is developed underground, the recycled water would be sufficient to work on the channels of the urban furniture.



2.2. Façade Element Design on Proposed Building Walls

a. Introduction

As a smart city project Esenler is expected to include many buildings to able to host the dense population and to create commercial and business environments to diversify the functional

distribution around the site. The existence of the new building proposals creates a potential to utilize the buildings in a multifunctional way. Therefore, a strategy to use the facades of the buildings as an air-cleaning aspect is developed, so that a benefit from the building facades other than just covering the interiors would be possible. The moss is planned to be designed as timber-framed panels, so that its implementation, mobility and aesthetics can be easily sustained on the building façade. The same automation and control system in 2.1. is going to be used on the façade modular moss panels to make sure the system to sensor the efficiency of air-purification process and make sure the health of moss as living organisms.

Goals:

i. Purify the Air Pollution the Buildings Create

ii. Aestheticise the Façade Design with Greenery Implementation

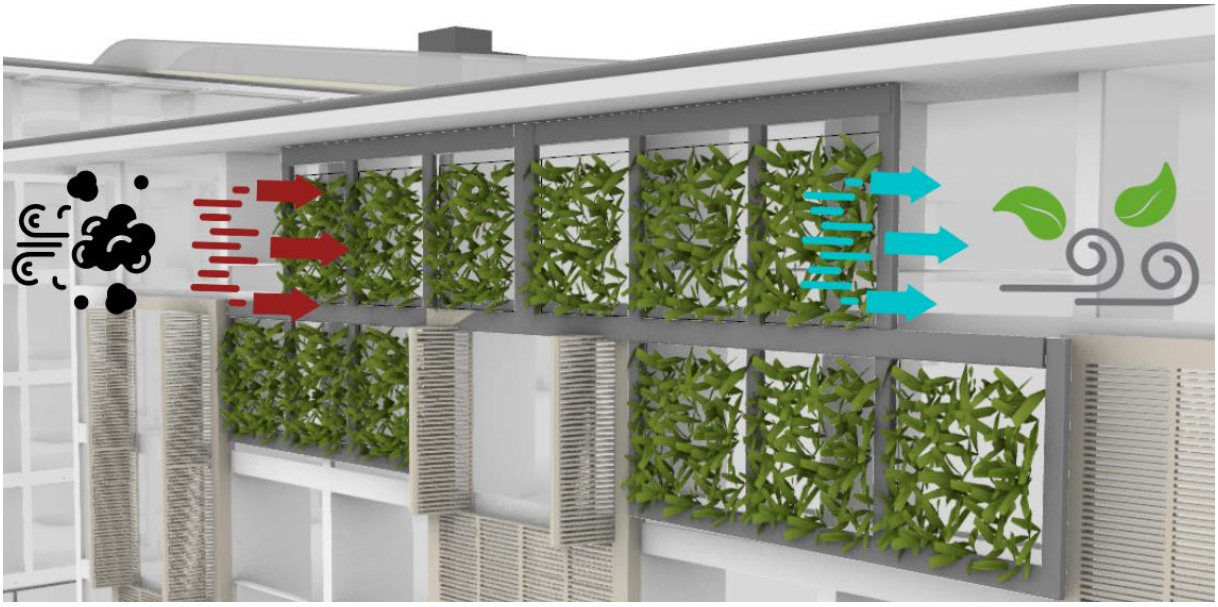
iii. Reduce Sound Pollution by the Noise Absorption of Moss Panels

iv. Create Further Insulation as an Envelop System Creating Close Cooling

b.

i. Purify the Air Pollution the Buildings Create

Most of the researches and proposals regarding the air pollution is focusing on the air pollution due to vehicular emissions. However, according to World Green Building Counsel the building operations and systems create 39% of the global energy-related carbon emissions. Therefore, the air purification due to the emissions from the buildings necessitate the use of moss panels on the facades.



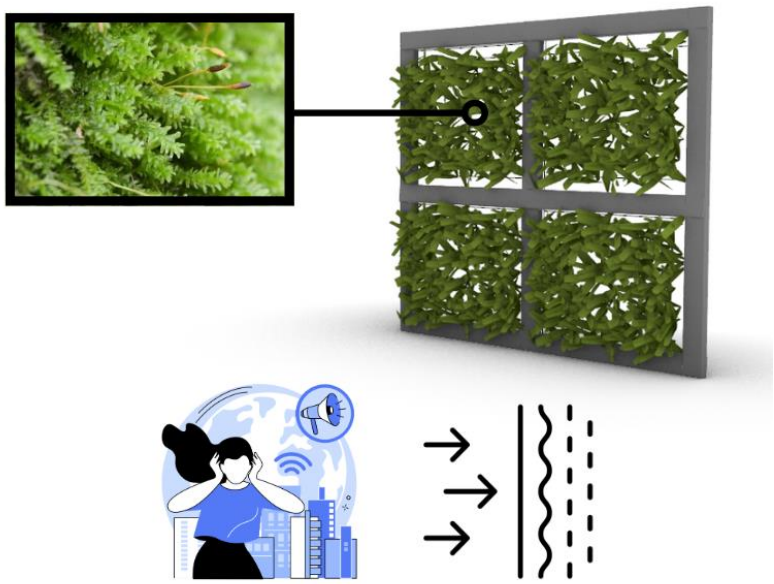
ii. Aestheticise the Façade Design with Greenery Implementation

Esenler like many other districts of Istanbul suffer from unaesthetic building designs, mostly buildings are repetitive concrete boxes spread around the built environments. Therefore, combining a pure air sustaining design element with the façade design would also enhance the exterior image of Nar area to be exemplary to revolutionize the aesthetical sustainability by using moss as a greenery vertically on facades.

iii. Reduce Sound Pollution by the Noise Absorption of Moss Panels

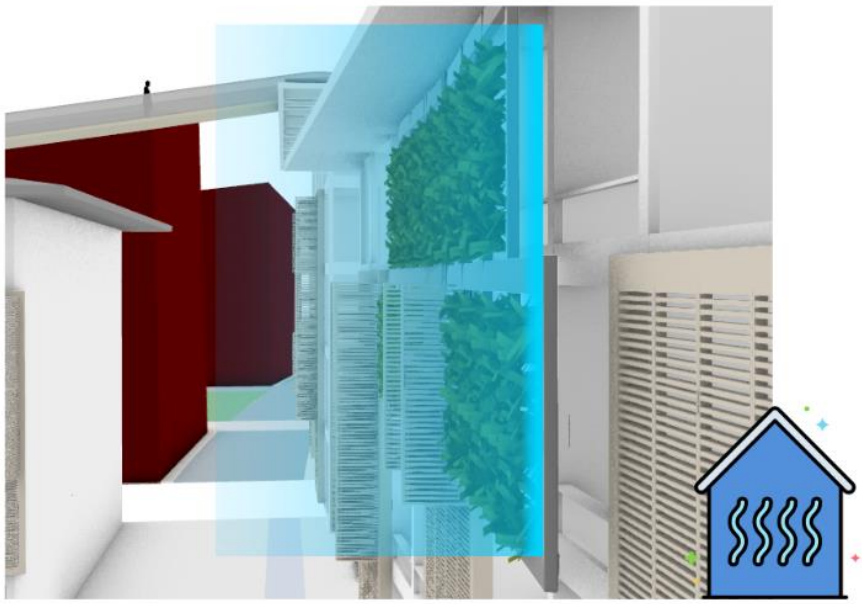
One of the properties of plants used in urban and architectural design is that they are good sound absorbers. When Esenler's crowd and dense urban layout is considered noise pollution becomes another key problem to be solved for better comfort of the residents and working people in the smart city project. Moss when used in facades is a suitable plant to absorb the exterior noise due to its fleshy leaves being effective noise absorber to an extent.

Noise Absorption by Moss Leaves



iv. Create Further Insulation as an Envelop System Creating Close Cooling

As above (2.1. ii.) mentioned, moss has the ability to cool and humidify the close environment in 1-2 meters' distance. When this property is considered on facades as panels, the moss panels would further insulate the interior from the extreme hots, which Istanbul undergoes up to 4 months a year, and decrease the energy waste to cool down the building by electricity use.



Seyyare Ece Akdağ
523211023

2.3. Installation Design on Streetlamps of Roads

a. Introduction

Since mobility is the most associated smart city factor with the air purification strategy development, the circulation of the people around the smart district is needed to be supported with the air-purifying urban design elements. People experience the low quality air and suffer from many health problems during their mobility activities. Therefore, as in 2.1. and 2.2. strategies urban squares and building exterior zones are considered to be applied with moss as urban furniture and façade designs, and a third design is needed for the circulation areas to be cleaned with moss's air purifying system. Streetlamps are proposed to be connected with moss panels to circulate the air from the vehicular emissions into clean air. Since the mobility in Esenler would be expected to be dense, the transportation harm on the atmosphere and human health is aimed to be reduced, resulting with a higher public health and more willingness to prefer walking by people.

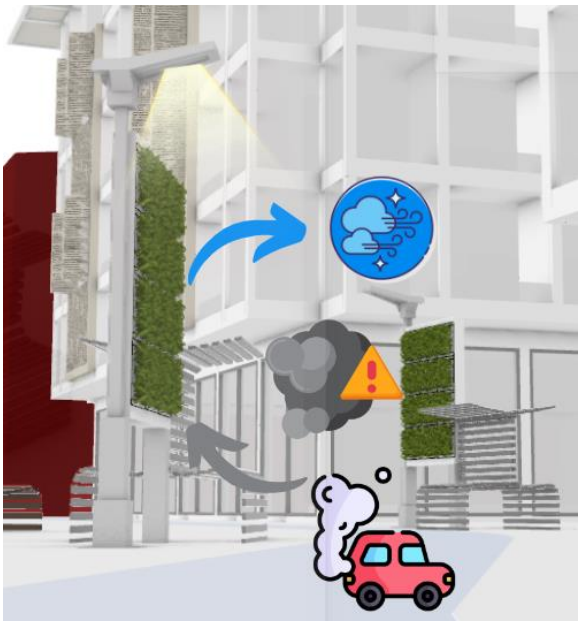
Goals:

i. Reduce the Inhale of Transportation Tools' Emission by Walking People
ii. Help People with Navigation by LED Screen Smart City Map App
iii. Create a Shade Opportunity Near Circulation Paths

b.

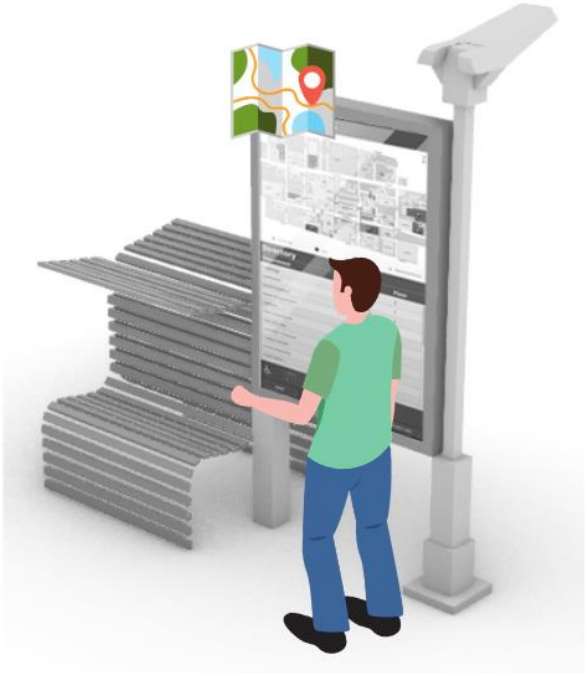
i. Reduce the Inhale of Transportation Tools' Emission by Walking People

The vehicular circulation as a vastly used must of urban life is one of the major contributors of the air pollution world-wide and also in Istanbul. Motor vehicles release serious pollutants such as carbon monoxide, nitrogen oxides, particulate matter, volatile organic compounds and benzene, and their inhale by people in Esenler smart city is aimed to be reduced by the streetlamp design.



ii. Help People with Navigation by LED Screen Smart City Map App

The design is also provided with technology for making the circulation and walking around the smart city easier for people. A navigation helping app would be included in the design for people to find where they need to go, and they can connect to their phones and navigate their route. Plus, the screens can be used for commercial purposes when not used by people to gain income for the raise of moss to sustain its own economy.



iii. Create a Shade Opportunity Near Circulation Paths

In order to enhance the comfort of outside urban design, the streetlamp design and allocation is deliberately designed to support the mobility of the smart city by providing shade and rest opportunity for people during their circulation around, especially for its use in hot seasons.

2.4. Development for Real-time Data Sensors & System Automation

a. Introduction

Even though the strategy developed for Esenler is a biology based design, in order for its system to work in the most optimal values, and in order for the mosses to continuously clean the air and survive, a technological automation system is decided as a requirement for the better of the bio-filtering natural system, too. Therefore, the moss systems either on urban furniture, façade or with streetlamps are supported with IoT sensors, so that the ventilation system is under control. Plus, the sensors allow gain data for its remote documentation and analysis for control, fixing and future enhancement possibilities about both environmental performance and the condition of bio-filters.

The system can also show the real-time condition about the pollution amount of air in Esenler district, so that the system would only be used when it is needed, not to spend extra energy.

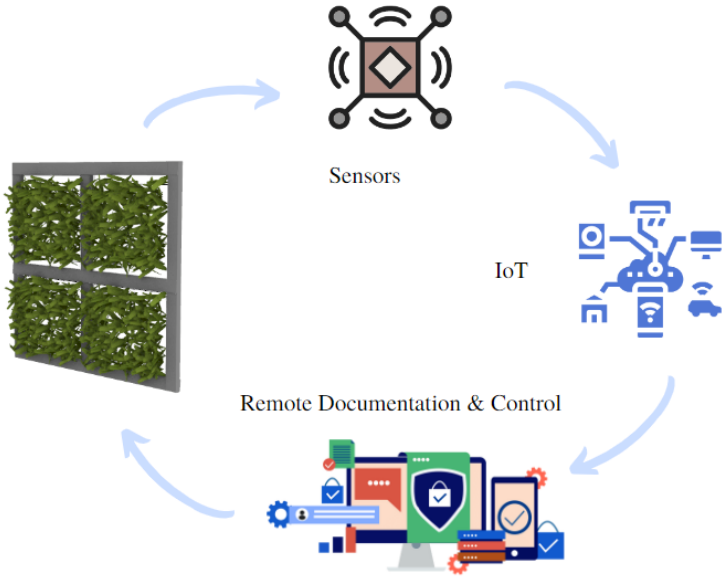
Goals:

i. Test the Performance with Real-time Environmental Data
ii. Ensure the optimal life of mosses
iii. Control the System not to Waste Extra Energy Than Needed

b.

i. Test the Performance with Real-time Environmental Data

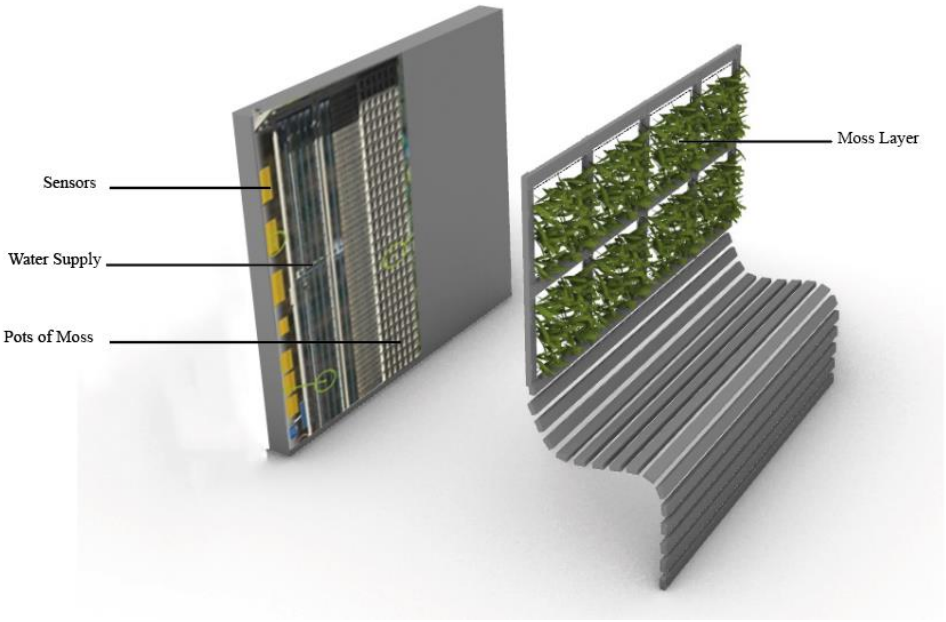
The natural set up of moss is supported with IoT sensors and activate ventilation and irrigation technology, to optimize cooling and filtering effect on the urban environment. Plus, the data generated in real-time, to be visualized on online dashboard to assess the environmental performance and the wellbeing of the bio-filters.



ii. Ensure the Optimal Life of Mosses

Even though Istanbul and Esenler is climatically suitable for moss raising as a city having Marmara and Black Seas, in order for the mosses to clean up the air in their best performance special species of mosses are selected and their lifecycle should be perfectly sustained by technological control

not to harm the species life and decrease their purifying performance. Therefore, such control requires automated watering system.



iii. Control the System not to Waste Extra Energy Than Needed

The air pollution is dependent on the time of the day and many other aspects, e.g. the map of the air pollution in Esenler shows more pollutant air in the daytime, when buildings and transportation is mostly used. Therefore, the system should not work non-stop not to waste extra energy, and should be remotely and automatically controlled according to the real-time data of amount of pollution in Esenler smart city Nar district.

3. The Effect of Implementing the Vision at Esenler

The vision of implementing an air pollution reduction system into the smart city project in Esenler, Istanbul, Turkey would be very beneficial for the physical, ecological and technological environment to be proposed. Due to the fact, that the quality of air should be moderate if a smart enough environment is aimed to be hosting a healthy public, proposing a well-designed mobility or sustainable energy efficient built environments or a circular economy would be co-working with this air-purifying strategy to unify all aspects of sustainability in smart cities to sustainable future health.

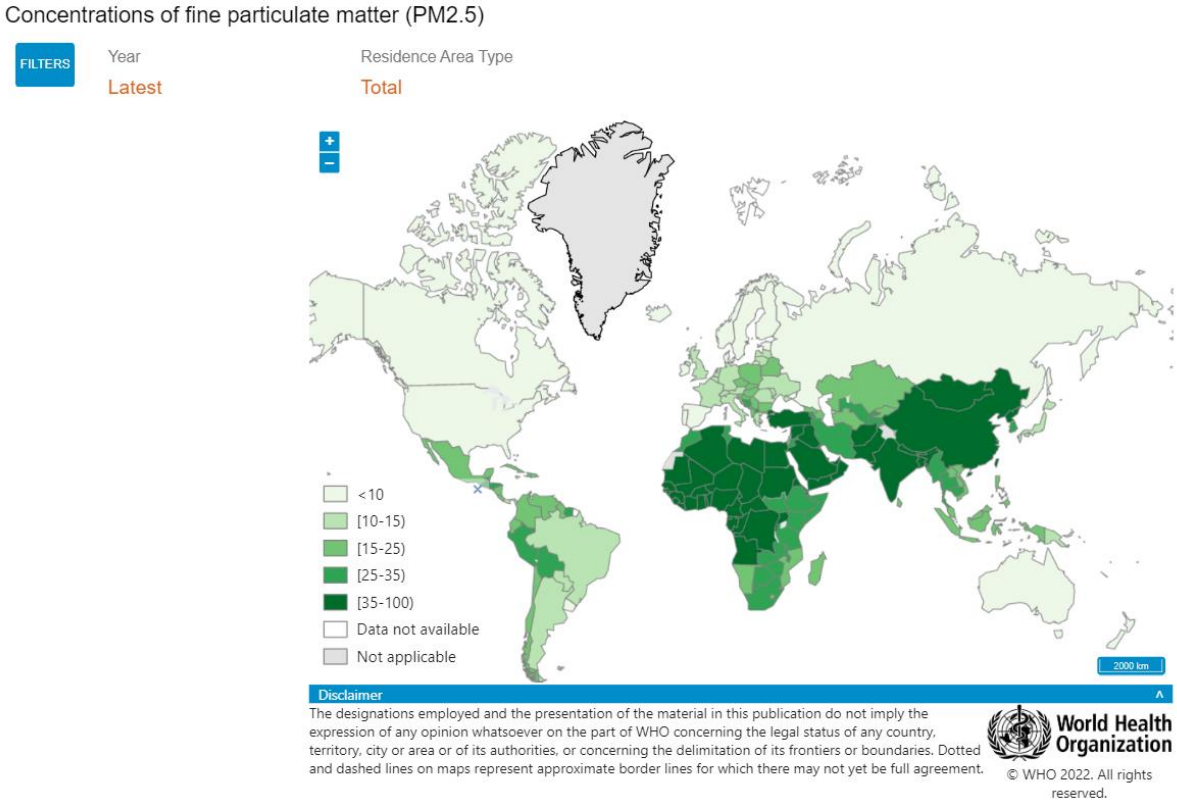
Seyyare Ece Akdağ
523211023

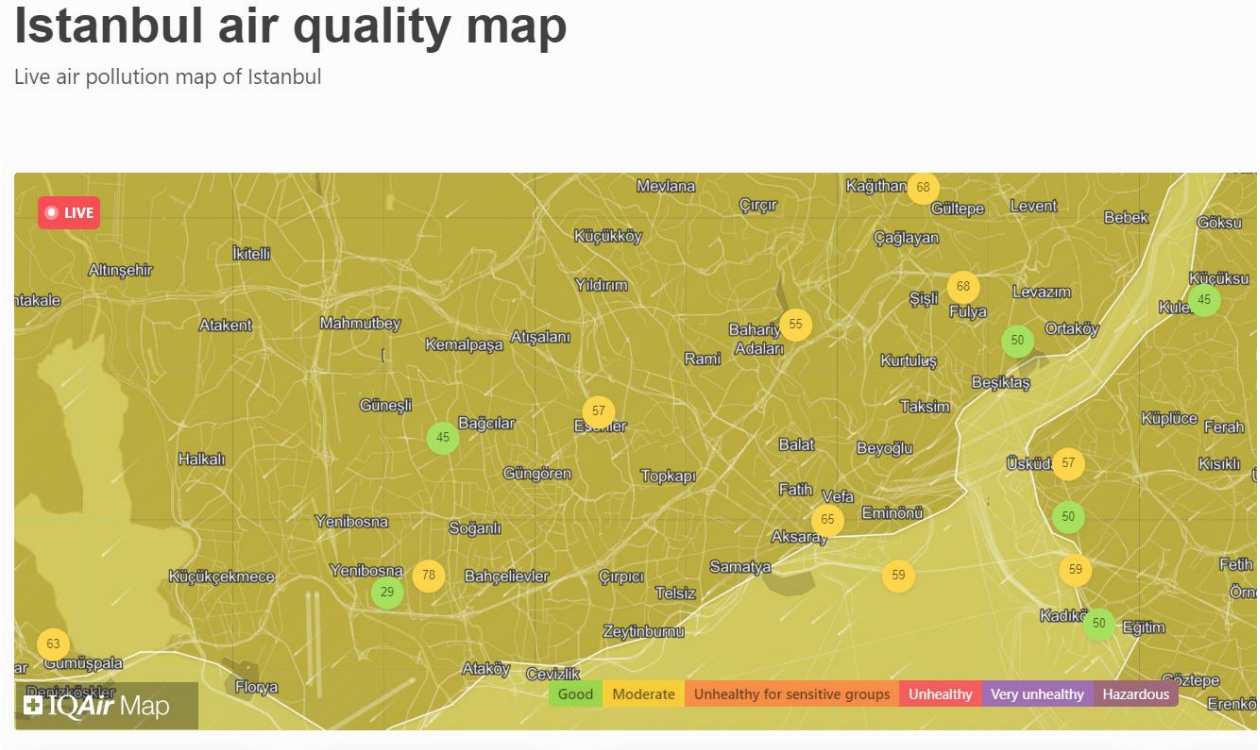
The project is developed with coexisting of a bio-filter system with moss cultivation and technological support of sensors, that are producing and using real-time data to optimize the biological system. The panels of mosses as modules of design creates a very useful design potential both because of construction simplicity and applicability to many urban and architectural elements. Therefore, the application of moss panels is exemplified with different design strategies as urban furniture, façade panels and streetlight designs, but the real-life application is not restricted with these designs and open to many other creative multifunctional urban or architectural use.

In short, a system such as air-purifying moss panels proves the fact, that the natural resources can be used to compensate the human-made harm on the earth and its urban environments when designed caringly, and save many nonrenewable energies to be spent by the use of electricity-spending machines instead of benefiting from the moss's lifecycle about consuming dust and other air pollutants.

Seyyare Ece Akdağ
523211023

Appendix:





Seyyare Ece Akdağ
523211023

References

Ambius. (2022). *How plants reduce noise levels indoors*. Retrieved from Ambius: https://www.ambius.com/learn/benefits-of-our-services/how-plants-reduce-noise/#:~:text=Plants%20absorb%20sound&text=One%20way%20is%20through%20sound,to%20their%20dynamic%20surface%20area.

Green, B. (2019). The Livable City: The Limits and Dangers of New Technology. In B. Green, *The Smart Enough City: Putting Technology in Its Place to Reclaim Our Urban Future* (pp. 15-27). The MIT Press.

Townsend, A. (2014). Cities of Tomorrow. In A. Townsend, *Smart Cities* (pp. 93-114). W. W. Norton & Company.

We Grow Fresh Air with Moss Naturally . (2022). Retrieved from Green City Solutions: https://greencitysolutions.de/en

What are the causes of air pollution in inner cities. (2021). Retrieved from The Health Effects of Air Pollution : https://gsttcharity-uk.shorthandstories.com/thecausesofairpollutionininnercities/index.html#:~:text=The%20sources%20of%20air%20pollution,and%20traffic%20related%20to%20it.

WHO. (2022). *Air Pollution* . Retrieved from World Health Organisation: who.int/health-topics/air-pollution

World Green Building Council. (2022). *Air Quality in the Built Environment*. Retrieved from WGBC: https://worldgbc.org/clean-air-buildings/causes#:~:text=Causes%20of%20outdoor%20air%20pollution,cooling%20and%20lighting%20%5B4%5D.