Propelling Change:

Implementing a Zero-Emission Zone in the Canals of Copenhagen

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Sponsored by Marianne Spang Bech

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WPI

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This report was submitted to:

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Abstract

We partnered with Miljøpunkt Indre By & Christianshavn to collect data and create materials to support a zero-emission zone for tour boats and seaplanes in Copenhagen's harbor. We measured air pollution and noise levels from canal tour boats and seaplanes at high-traffic locations. Our data demonstrates that air pollution and noise levels exceed safety thresholds set by the NIH and Danish EPA. We featured this information in multiple resources, including a website, informational flyers, email list, and articles. We presented our recommendations to Miljøpunkt and the local committees for Indre By and for Christianshavn, and the issue was featured by local media. Our recommendations outline steps for stakeholders to create the zero-emission zone through a citizen's initiative.

Figure 1: The Nyhavn Canal (Photo credits: Zach Chan, June 18, 2025)

Executive Summary

Copenhagen is considered one of the most sustainable cities in the world and plans to become carbon positive by 2035 (Climate Plan 2035, 2025). Despite strict restrictions on emissions in city streets, canal tour boat companies—namely, Stromma and Netto-Bådene—have a contract that permits the use of diesel engines until 2037, hindering progress towards a carbon-positive city.

In addition, Nordic Seaplanes operates sightseeing flights from Langelinie, where noise and air pollution impact an adjacent playground, “The Little Mermaid” statue tourist zone, and wider areas of the inner city and Copenhagen harbor.

The risk posed by these tourism vehicles in the harbor has made the removal of diesel engines a priority of Miljøpunkt Indre By & Christianshavn, an environmental organization dedicated to the environment and the health of citizens in the area.

Therefore, the goal of our project was to provide Miljøpunkt Indre By & Christianshavn with data about the pollution from tourist boats and flights as well as the materials to support public action to implement a zero-emission zone for these tourism vehicles in the harbor of Copenhagen.

To accomplish this goal, our group identified three objectives:

1. ***Collect and Interpret data*** on the extent of the tour vehicles’ air and noise pollution to build a concrete argument for change.
2. ***Identify and connect*** with target communities to build social support for our cause.
3. ***Create resources*** to encourage social and political change and empower community stakeholders.

Data measured during our project indicate that noise and air pollution reach levels high enough to pose health risks such as hearing damage, respiratory illness, and cardiovascular problems. Similar preliminary findings were found reported by a previous WPI project (Carroll, et al., 2024). The restrictive nature of the tour boat contract and the slow nature of political progress indicate that the city could take deliberate steps to solve this problem.

In Amsterdam, a zero-emission zone was adopted for commercial and recreational boats in 2019, and boat owners were given about five years to convert to electric power. Amsterdam's experience in building social support, political support, and infrastructure for electric vehicles provides a model for action in Copenhagen.

In Denmark, change can be spurred through a citizens' initiative—a proposal that can be made by a Danish citizen seeking signatures from 50,000 Danish voters. Upon reaching the required number of signatures, the Danish Parliament (Folketinget) is required to debate and vote on the initiative. Parliamentary action could create a zero-emission zone in the harbor and override the tour boat contract but requires significant

public support. Therefore, we pursued our objectives in two phases, first collecting data and second, strengthening the social and political resources to advance further changes.

Phase One: Collecting and Updating Data to Build Persuasive Stances

First, we collected data needed to gain support for the latter phase of this project. Ultrafine particle (UFP) and sound level data were collected at areas where high populations of people are most likely to be affected. Locations for data collection were the following:

- **Langelinie Park** playground next to seaplane dock
- **Refshaleøen** waterfront near Reffen food court
- **Nyhavn canal** entrance near harbor boat dock

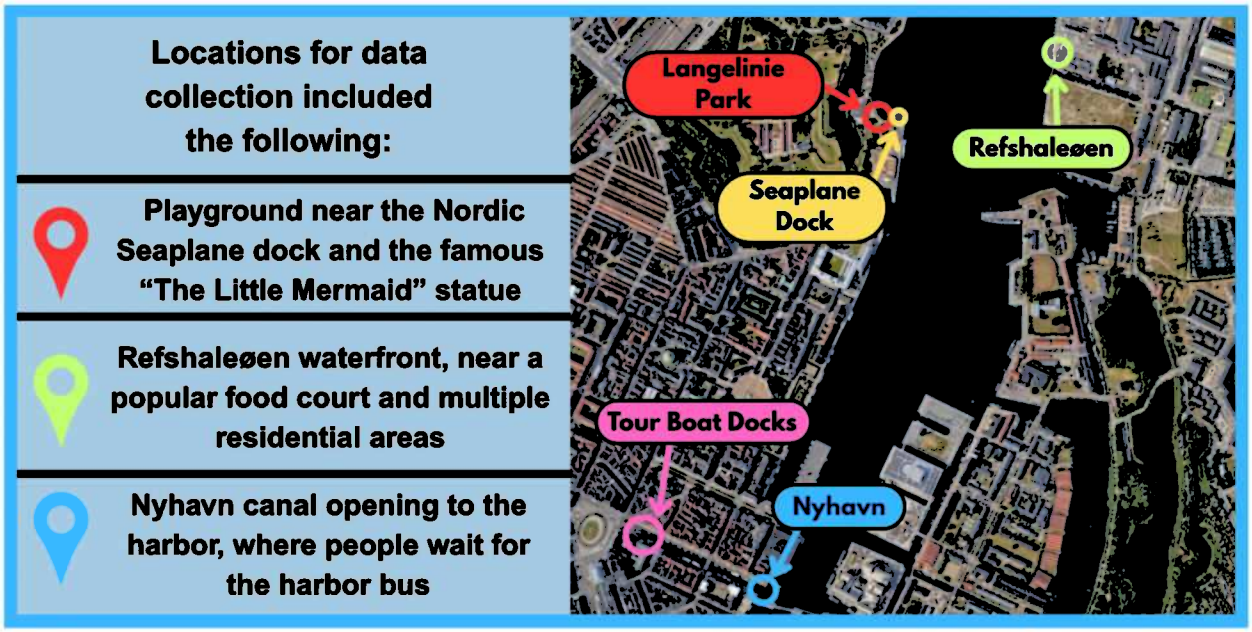


Figure 2: Map of measurement locations (Adapted from Google Maps, 2025)

Air pollution at Nyhavn and Refshaleøen

Refshaleøen was selected for measuring UFP emissions from the seaplanes due to its downwind location from the canal pathway where the seaplane taxis for arrival and departure, as well as its close proximity to high-traffic areas such as the Reffen food court and the nearby residential complexes.

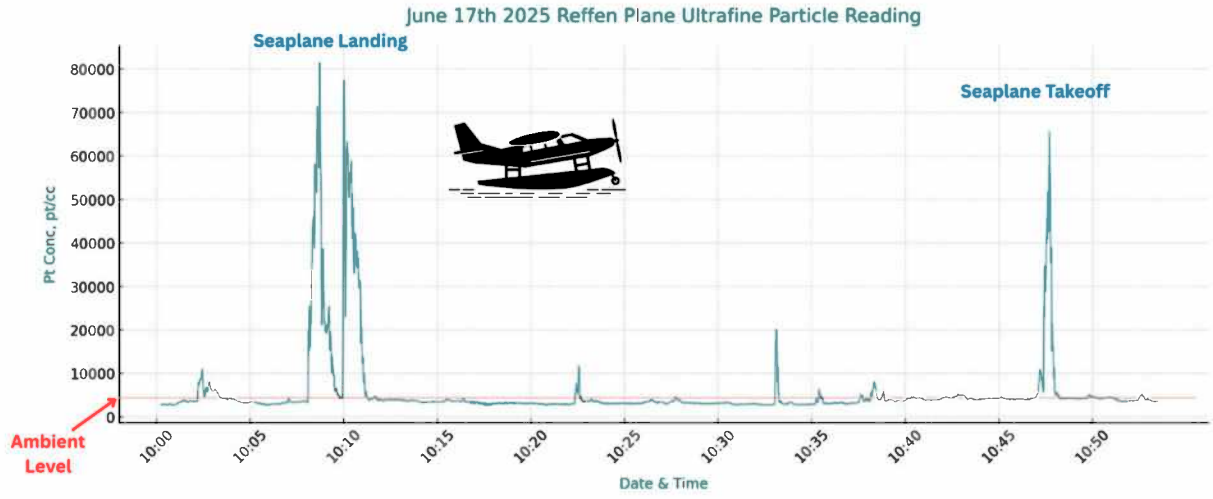


Figure 3: Seaplane emissions in the northern harbor, Refshaleøen, over a one-hour period

Figure 3 above displays the emissions readings taken from the side of the harbor at Refshaleøen during a seaplane departure and landing sequence. Throughout the hour-long recording, the ambient UFP levels were below 5,000 pt/cc (identified by the dotted red line) but increased to over 80,000 pt/cc, over 16 times the typical levels that passersby are exposed to, as the plane passed by about 100 meters away in 6m/s winds (14mph). During the takeoff sequence we experienced a spike of 65,000 pt/cc. elevated UFP levels were sustained for almost 5 minutes during both the takeoff and landing sequence.

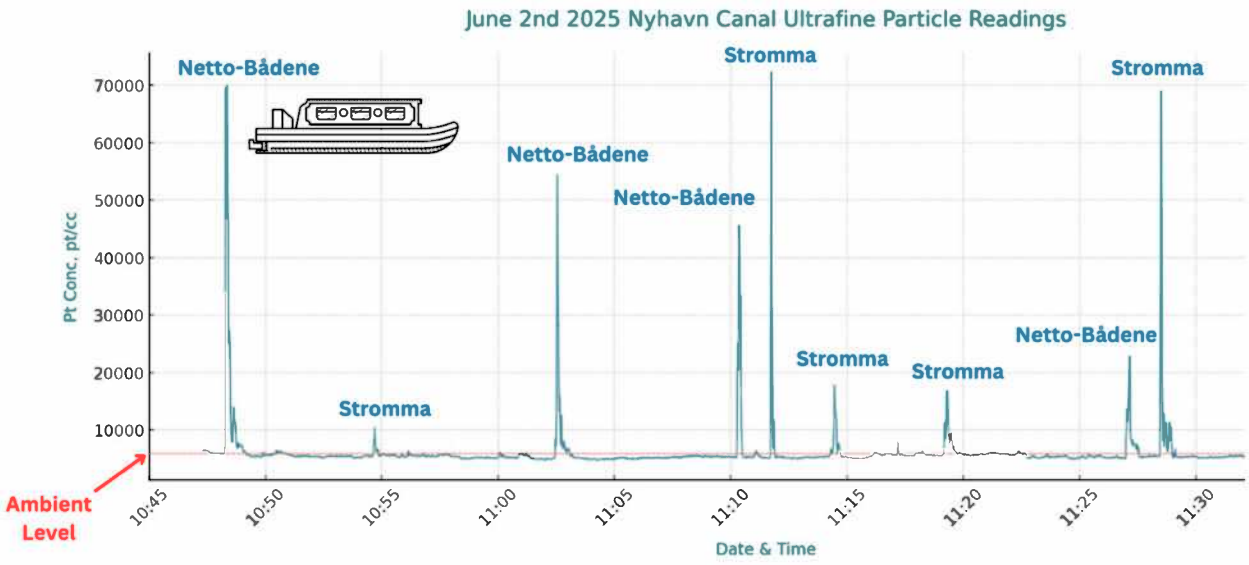


Figure 4: Tour boats in Nyhavn Canal emit excessive ultrafine particles

Figure 4 displays the emissions readings taken from the harbor bus dock in Nyhavn. We selected this location due to Nyhavn's popularity as a tourist attraction, its proximity to the frequently passing tour boats, and to simulate the potential exposure for those who regularly wait at the dock for the harbor buses during their daily commute.

Over the span of an hour, several spikes reaching over 70,000 pt/cc occur when either Stromma or Netto-Bådene boats accelerate to exit the Nyhavn canal. The potency of UFP readings varies depending on acceleration from each boat driver. Also, the hydrotreated vegetable oil (HVO) used by Stromma boats shows no significant improvement in UFP emissions in comparison to typical diesel fuels used by Netto-Bådene. In all cases, the spikes caused by tour boats increase the surrounding air by up to 15 times the ambient level of 5,000 pt/cc.

Noise Pollution in Recreational Areas

We recorded noise levels during seaplane takeoff and landing sequences that reached dangerous levels. As shown in Figure 5 on the following page, the raw noise from a 90-second docking sequence not only exceeded the 50 dB limit guideline for airfield sound levels at non-overnight recreational areas recommended by the Danish Environmental Protection Agency (EPA), but it also exceeded 85 dB, where, according to the National Institute of Health (NIH), hearing damage can occur. The maximum level we recorded

was around 94 dB, which is significantly above the 85 dB threshold where hearing loss may occur. Additionally, there wasn't a single point throughout this sequence where the sound dropped to or below the Danish EPA's 50 dB standard for this area.

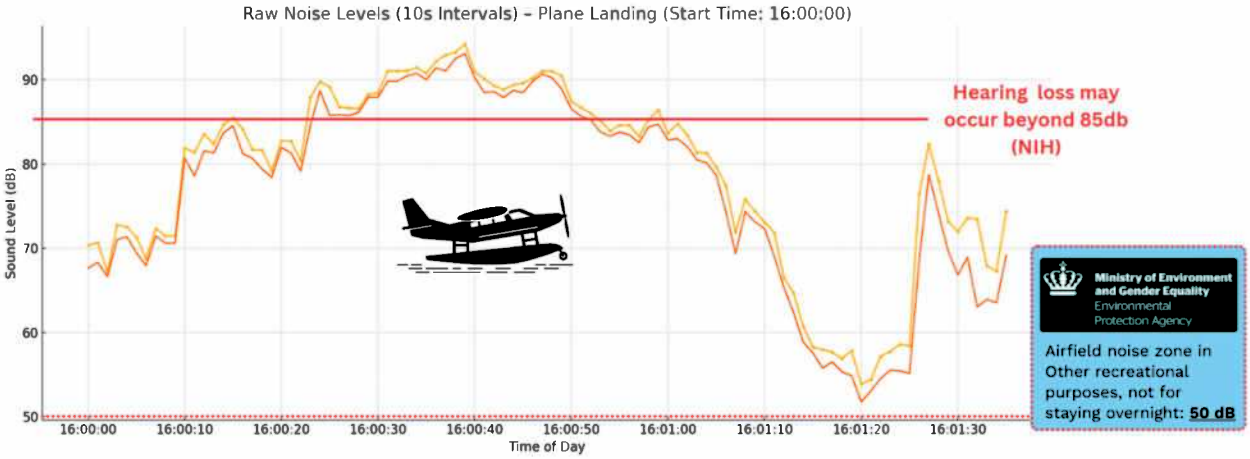


Figure 5: Noise pollution at Langelinie Park exceeds recommended levels. May 21, 2025.

Sound levels recorded in Refshaleøen did not result in a graph that displayed consistent spikes above ambient levels. However, sound levels of up to 77 dB were reached on the sound meter, and the sound was reported to have echoed throughout the harbor by group members in different locations of the area, which is disruptive enough to interfere with passersby in Reffen, a popular food court and recreational area, or the residents living in Urban Riggers, a floating apartment and housing complex in Refshaleøen.

Throughout the data collection process, the graphics were continuously revised using feedback from regular meetings with the Miljøpunkt work group, and experiments were run often to gather data at different locations and dates in order to optimize the strength of data correlation while avoiding confounding variables such as weather conditions, ambient noise, and other factors that could lead to noisy data.

Some of the data collected was inconclusive due to external factors. UFP readings were initially taken at the Stromma tour boat dock by the Little Mermaid, but variable wind speed and direction dispersed emissions unevenly, making it difficult for our instruments to accurately measure. Additionally, city noise and other nearby vehicles may have influenced measurements at Stromma tour boat dock, Nyhavn, and Refshaleøen,

causing variability in data. It should be noted that inconclusive findings are not indicative of a lack of impact, but rather may indicate technical and confounding variables.

Phase Two: Building Social and Political Support for Change

Phase Two focused on the execution of objectives 2 and 3, as we used our data, knowledge, and messages to gather support from target audiences.

Figure 6: A flyer posted around Copenhagen

Flyers and Website

Interviews were held with a communications professional for Indre By and Christianshavn from city hall, and Suzie O'Hair, a marketing professional with campaigning experience in California, USA. These interviews gave us insight regarding strategies to attract interest by creating messages that resonate with target communities. The questions used in these interviews can be found in Appendix A.

Following the advice from the interviews, we developed flyers, a short-form website, and a website with our findings to attract attention and share information about diesel-engine tourism vehicles. The flyers were designed to capture the attention of onlookers and were placed in areas of high population, such as schools or restaurants, and included QR code to a shortened website to quickly inform readers of the greatest issues posed by the major tourism companies using diesel engines, where users can choose to also visit a link to a more in-depth page with the findings of this project. The websites contain a link to a form where viewers could join an email list, leaving Miljøpunkt with a communication line to a group of people who wish to be kept in the

loop of future action taken, such as a citizens' initiative. Our other flyers can be found in Appendix A, and our website can be reached by scanning the QR code on our flyers.

Articles in Kosmopol and Christianshavneren

We authored an article to convey our message to more interested viewers. Addressed in the article are the health risks posed by the diesel engines in tourism vehicles, the current progress being taken to resolve the issues, and how readers can help by staying in contact. The article was submitted to Christianshavneren and may be included in the July 2025 issue. Our article can be found in Appendix A.

Kosmopol, a leading source for local news in Copenhagen, also released an article in June reporting on a Nyhavn resident's complaints about the tour boats. Following this, Marianne Spang Bech, our lead sponsor and the center manager of Miljøpunkt Indre By & Christianshavn, reached out to Kosmopol to tell them about our project. Following this, the news source interviewed Marianne. The interview resulted in an article covering information regarding our findings and presentations at the local committees and highlighted our recommendations for a citizen's initiative (Bruun, Juul, 2025).

Presentations to Local Committees

Objective 3 aimed to target a political audience and activists who could catalyze change, but reaching this level of political support requires the social commitment of many citizens, civic organizations, and local committees, as well as the political actors in the local municipalities and parliament. Due to a 180-day limit imposed on citizens' initiatives, this project sought to create the support and materials for a citizens' initiative campaign that can be run at Miljøpunkt's pace.

Presentations at local committee meetings in Indre By and in Christianshavn provided us with the opportunity to inform these civic leaders about the extent to which the tour boats and seaplanes are polluting their canals. Here we were able to recommend a set of steps that could be taken by the city that could assist in encouraging the implementation of a zero-emission zone and hold discussion on important topics of concern.

Figure 7: Presentation to Indre By Local Committee, June 12, 2025

Electric boat charging

At our local committee meetings, we received many questions about the technicalities of a large-scale boat conversion, including the responsibility of funding and building charging stations. To find an answer to this question, we conducted an interview with a co-owner of Clean eMarine, a Danish-based company with experience in transitioning commercial and recreational boats to electric power. One of the essential takeaways of this interview was the responsibility of the companies to initiate the transition to electric power, of the city to create a grid capable of supporting the chargers needed to sustain electric tourism in the canals, and of both parties to acquire the charging stations to allow electric boats to run in a zero-emission zone.

Recommendations

We believe that the best way to move forward is equal action on the part of the city, companies, and citizens to hold each other accountable through the actions below.

For Miljøpunkt and the Local Committees in Indre By and Christianshavn:

- **Expand the email list** to increase outreach to groups passionate about pollution within the canals so they will already have a significant number of supporters for a citizens' initiative once they start it.
- **Hold public outreach events to build social support for a citizens' initiative**: This serves to inform the public and gain support for the citizens' initiative.

- **Create a Citizens' Initiative:** Consider options to work with stakeholders to create a citizens' initiative to propose a zero-emission zone for commercial passenger vehicles in the canals.

For the Municipality and Related Agencies in Copenhagen

- **Support a Citizens' Initiative:** Support initiatives to revise the tour boat contracts and create a transition period for a zero-emission zone commercial passenger boats on seaplanes in the harbor.
- **Improve Boat Charging Infrastructure**: In Amsterdam, the majority of new electric charging stations were provided by private enterprises rather than the municipality. Private firms may be permitted or incentivized to build electric charging stations that they build, operate, and maintain. The capacity of the power grid should be evaluated to facilitate the more widespread transition to electric engines.
- **Advertising Electric Alternatives**: Promotions targeting tourists and corporate customers hosting events on tour boats will increase demand for these services, provide an incentive for transition to electric engines, and create healthy competition encouraging companies to offer zero-emission options.
- **Host public events**: Uniting communities allows a collective method to keep the public informed of changes being made and provides the supporters for a citizens' initiative.

For the Citizens of Copenhagen

- **Continue to advocate for the environment** by supporting Copenhagen's green initiatives.
- **Sharing knowledge** on the situation in the canals to maintain support for our cause.
- **Join our mailing list** to stay updated on information about this issue.

For Higher Levels of Government in Denmark

- **Guidelines for Ultrafine Particle Pollution:** Currently, no restrictions or guidelines exist for ultrafine particle pollution. Despite the growing data indicating their risks.
- **Move the seaplane dock farther out of the harbor:** By moving the seaplane dock farther out of the harbor, the noise levels produced by this company will not reach dangerous levels onshore.

Conclusions

Working towards creating a greener city is no simple task, and Copenhagen deserves all the praise it receives for the distance it has come over the past decades. Creating a zero-emission zone in the canals presents numerous challenges, but thanks to the collaboration among Miljøpunkt, local committees, the municipality, and Copenhagen residents, steady progress has been made towards this goal. Between citizens, government representatives, and even the owners of the tourism companies, the cooperation between every party we have interacted with—directly or indirectly—has been amazing. For this goal to be achieved, this mutual support must be continued by all roles to ensure progress does not stagnate. With such a strong community, we believe that Denmark should be a worldwide model for how we can all do a little more to help our planet thrive.

Table of Contents

Acknowledgements

This project could not have been completed without the individuals and colleagues who helped us throughout our time here:

We are grateful for the guidance we received from Peter Hansen, our advisor from Worcester Polytechnic Institute. The input he provided ensured that we conveyed our messages in a way that is true to our process and efforts.

We would like to thank Marianne Spang Bech of Miljøpunkt Indre By & Christianshavn. Her knowledge and passion guided the direction of our project, and her efforts gave us the opportunity to accomplish a great amount in our short time here.

We would like to thank all of those at the Miljøpunkt Indre By & Christianshavn work group who made the time to meet with us. Listening to our findings, giving us feedback, and giving us the suggestions and recommendations we needed laid the foundation for our methodology and how we approached our goal.

We thank Mads Aarup for his recommendations, his Clean eMarine connection, and for taking us on a tour through the canals to obtain on-site data and showing us the best parts of Copenhagen through a personal lens.

We extend our gratitude to Julie Nørløv, Suzie O'Hair, and the co-owner of Clean eMarine for creating time in their schedules to meet and provide us with valuable information to guide the scope of our end materials.

We appreciate Cindie Ørnstrup for the work she has done in helping us in the ideation of our materials, translations, and other tangible works needed to achieve our goals.

Authorship

Each member of our project group contributed to every part of our project, from measuring and interpolating data to presenting our findings to local committees. Each section of this report was worked on equally by everyone, and after being drafted, every section was reviewed and edited by each member, one after the other. Our goal with this method was to ensure that we conveyed a consistent train of thought and tone throughout our report. This report was made without the use of any artificial intelligence or chatbot tools.

Meet the Authors

Hello! I am **Dante Nguyen**, a mechanical engineering major from Quincy, MA. Living in Copenhagen has shown me the change that can be achieved when a city dedicated to sustainability works together with its citizens and companies towards a communal goal.

Hej! My name is **Thomas Gray** and I am a Mechanical Engineering student from Cape Elizabeth, Maine. This project has shown me how when multiple communities work together to complete a goal, amazing things can happen! This summer has been amazing and I learned so much about living in Northern Europe.

Hi! My name is **Anna Beaver**, and I am an Environmental Engineering major with a minor in Fire Protection Engineering from Santa Barbara, California. I love to paddle board and travel. I have loved working on this project, and have learned so much about the process behind legislation and making a difference through community action.

Hi! My name is **Zachary Chan**. I am a mechanical engineering student from Los Angeles, California. I love to run, hike, and ski. I am incredibly grateful for this experience. The time I have spent in Copenhagen has taught me so much about sustainability and how to empower communities.

Table of Figures and Tables

1. Introduction

Copenhagen, Denmark, is considered one of the most sustainable capitals in the world. With a goal of being carbon positive by 2035, the city has created regulations for emissions from cars, motorcycles, public transportation, and private businesses. Despite these restrictions on city streets, the iconic canal tour boats are still powered by emissions-producing diesel engines. Due to a contract signed in 2019, these tour boats are allowed to operate diesel engines until 2037. In addition, Nordic Seaplanes offers sightseeing tours and flights to Aarhus from a dock in Langelinie where seaplanes fly at low elevations above the harbor and city center. The sightseeing tours in particular fly in low elevations near residential areas in the inner city, and both flights create emissions and excess levels of noise in the canals where they depart and land.

Marianne Spang Bech is the center manager of Miljøpunkt Indre By & Christianshavn, an independent environmental organization working to make Copenhagen a healthier and more environmentally friendly city. The tour boats and seaplanes in the harbor produce ultrafine particles (UFPs) and excessive sound levels. These emissions pose health risks to the surrounding neighborhoods and are a point of concern for Miljøpunkt as well as the local committees in Indre By and in Christianshavn. The Copenhagen City Council expressed its concern with the emissions from harbor boats in March 2025. Despite the issue persisting for years and being a shared point of concern for multiple stakeholders in Copenhagen, the issue has stagnated due to the restrictive nature of the contract and the slow nature of political progress.

Therefore, the goal of this project was to examine air and noise pollution levels and develop material to support the efforts of Miljøpunkt Indre By & Christianshavn to promote a zero-emission zone for tour boats and planes in the harbor.

To accomplish this goal, our group identified three objectives:

1. **Collect and interpret data** on the extent of the tour vehicles' air and noise pollution to build a concrete argument for change

2. **Identify and connect with target communities** to build social support for our cause
3. **Create resources to encourage social and political change** and empower community stakeholders

By pursuing these objectives, our project provided recommendations for Miljøpunkt and other stakeholders to develop the social and political support for a citizens' initiative to establish a zero-emission zone.

Figure 8: Windmills seen from the North Harbor. Photo credits: Anna Beaver

2. Background

Danes take pride in their country's environmental initiatives and do their part to improve their cities. Copenhagen has set ambitious goals to address climate change and backed their ambitions with actions. Restrictions and guidelines on vehicle emissions on the city street have been placed to encourage greener alternatives, such as biking, personal electric vehicles, or the completely electric public transportation system. In 2012, Copenhagen set the goal to become carbon neutral by 2025 but has revised the goal with a new climate plan to become carbon positive by 2035 (Climate Plan 2035, 2025), with the companies running on diesel engines being a major factor preventing this goal from being achieved.

This chapter will cover the adverse health effects that occur from the emissions and sound levels produced by these tour companies, the major obstacles that have prevented change despite Copenhagen's focus on sustainability, and the process we derived from Amsterdam to create our methodology.

The dangers of diesel engines in canal tourism

Tourism is vital to Copenhagen, bringing in around 4 million visitors annually (Road Genius). Within the city, Nyhavn and the canals are must-see attractions, and the canal tour boats are an amazing way to view the city from the water. There are two industry leaders for canal boat tours, Stromma and Netto-Bådene, which both run large, diesel engine boats. A third tourism company of interest, Nordic Seaplanes, provides a tour of the city through aerial tours above the city. These vehicles run on different types of fuel, but all operate on diesel combustion engines, which produce emissions and high levels of noise that are linked to adverse health effects.

Diesel engines emit a variety of harmful pollutants, including ultrafine particles (UFPs) and high levels of noise. High levels of ultrafine particles have been linked to negative health outcomes, including cardiovascular disease and respiratory issues (Health Effects of Ultrafine Particles). In Amsterdam, studies have found that air pollution leads to a decrease of eleven months in average lifespan (City of Amsterdam, 2023). Noise

pollution is also correlated to increased stress levels, as well as cardiovascular disease (Noise and Health).

For air pollution, the primary component we measured was ultrafine particles. Currently, the World Health Organization does not have a set guideline on a safe level for UFPs; however, the WHO has stated, “Exposure to UFP can increase the likelihood of pulmonary, cardiovascular and ischemic heart diseases” (Air Pollution is Responsible). In addition, UFP exposure has been linked to long- and short-term respiratory disease as well as childhood asthma, “UFP constitute… a health risk, due to their specific properties such as high number concentration and surface area, high deposition efficiency in the pulmonary region where they can cause inflammation, and a high propensity to penetrate the epithelium and translocate to the blood system, causing a variety of diseases.” (Ambient Ultrafine Particles)

While there is no formal implementation of a zero-emission zone or enforcement of quiet hours, the guidelines of the Danish Environmental Protection Agency provide a standard for what can be considered “acceptable” within a given area, often influenced by what would be a safe level (Recommended Noise Limits).

On the noise side of pollution, noise levels above 85db are well known to cause hearing damage, but perhaps a lesser-known effect of noise pollution is the various other health issues it has been linked to (Noise-Induced Hearing Loss). A research paper from the Journal of Exposure Science and Environmental Epidemiology suggests that consistent exposure to noise pollution can lead to loss of sleep, stress, cardiovascular disease, and many other noise-associated non-communicative diseases (NCDs). In fact, most major organ systems in our bodies, as well as our mental health, can be significantly affected by noise pollution (Hadad, et al. 2024).

Current state of Copenhagen's zero-emission zone

In 2019, a contract between the canal tour boat companies and the city was renewed by By & Havn, a city-owned company that acts as a landlord for Copenhagen's ports, allowing diesel engine canal tour boats to operate until 2037. Prior to 2019, Stromma had already converted 2 of their 17 boats to electric. One of these was a "retrofit" in 2009, and the other was an original electric build in 2013. It is possible that at the time this contract was signed the city believed this conversion process would continue even with a contract allowing Stromma to continue using diesel engines.

However, there have been no further boat conversions by Stromma or Netto-Bådene in Copenhagen since 2013 even though the technology needed to convert a boat is more readily available and cheaper than it has been for years (Clean eMarine, personal communications, June 19, 2025). This has made it difficult for the city to decrease emissions within the canals, leading local municipalities to set their eyes on making land transportation emission free in the meantime. Recently, however, the city has begun to take real action against the fossil-fuel boats and planes in the canals.

On March 6, 2025, it was proposed that the "Citizens' Representation [to] instruct the Lord Mayor, the Mayor of Culture and Leisure and the Mayor of Technology and Environment to enter into a dialogue with CPH City & Port Development and the State about creating a fossil-free port in Copenhagen's inner harbor and the canals connected to the inner harbor." (Medlemsforslag om fossilfri havn, 2025). In addition, the proposal endorsed by the city instructed technical and financial sectors of the city government to investigate the financial requirements that would be needed for a fossil-free port. A major concern raised at this meeting was that implementation should consider the owners of small boats might bear large financial costs if privately-owned boats were required to convert to electric engines on the same schedule. For this reason, the first implementation of a zero-emission zone should only affect commercial passenger vehicles to remove the largest criticism. This allows time for the infrastructure to be developed before forcing every boat to be converted.

Additionally, continuing from Mads Aarup's proposal that "municipality should enter into a dialogue with CPH City & Port Development" (B-sag: Fossilfri havn). Further discussion was made on May 8th to begin written correspondence, and acknowledgements were made regarding the electrification and removal of canal tour boats, removal of loudspeakers from tour boats, and communication with Stromma and Netto-Bådene condemning the use of fossil fuels regarding both their health effects, as well as the contradicting message they send with respect to the goals Copenhagen has set.

Figure 9: An infographic created to explain what is preventing Copenhagen from transitioning to electric boats

A role model: Amsterdam's zero-emission transition

Looking closely at Amsterdam's progression towards a zero-emission zone gives an outline and actions that Copenhagen could take inspiration from with a more local lens. An agenda for a meeting in 2023 provides a record for Amsterdam's plan for implementation of a zero-emission zone for both road traffic and canal transportation in the city center (Zero Emission Mobility in Amsterdam).

Amsterdam adopted a zero-emission zone for commercial and recreational boat owners in 2019, and they were given five years to convert their boats to electric. One difference between Amsterdam and Copenhagen is that Amsterdam's contracts with tourism

companies are significantly shorter, usually only lasting up to five years. Because of this, Amsterdam was able to implement a zero-emission zone and force these tour companies to convert without a long contract to prevent them. Copenhagen's standing contract with Stromma was signed for an 18-year period (2019–2037), and they hope to be carbon positive by 2035, which is before the contract expires. While working towards reaching parliamentary action to overrule this city-level contract through a citizens' initiative, we followed Amsterdam's example to prepare for any obstacles that may come up.

In Amsterdam, one of the biggest changes that had to be made to facilitate the implementation of a zero-emission zone was the addition of charging stations along the canals. With only 20 charging stations in 2019, Amsterdam added about 200 stations in five years, with plans to increase this number to 2500 by 2030. This increase in charging stations required collaboration between businesses and the city, with infrastructure upgrades to the electric grid necessary to connect these new charging stations. The city also has set up 12 city-run charging stations, as well as collaborated with private companies to offer public charging opportunities (Zero Emission Implementation Agenda).

Through **three main forms of action**—Political Support, Social Support, and Infrastructure—Amsterdam successfully created a zero-emission zone and removed gas-powered engines from their canals in a period of about five years.

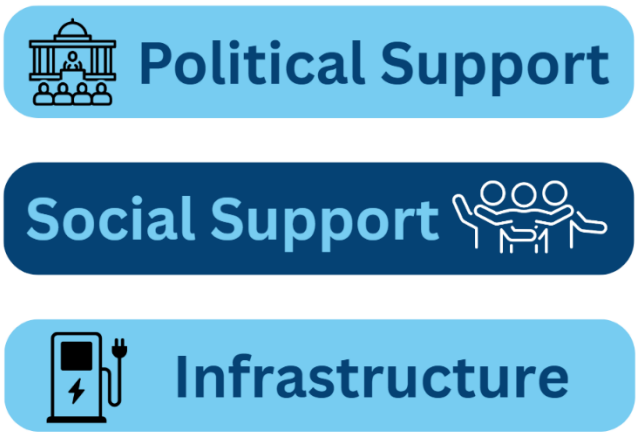


Figure 10: An infographic created to explain Amsterdam's transiton process

The combination of government regulation, support and cooperation from private citizens, and the strengthening of the electric grid around the canals led to this successful conversion, with the zero-emission zone being put into place on April 1, 2025 (Zero Emission Implementation Agenda).

Following this framework, Copenhagen could achieve a similar zero emission zone well before the 2037 contract expiration date.

Figure 11: Netto-Bådene boat docked near Refshaleøen (Thomas gray, June 3, 2025)

3. Approach

Our project aimed to encourage the implementation of a zero-emission zone through three main objectives:

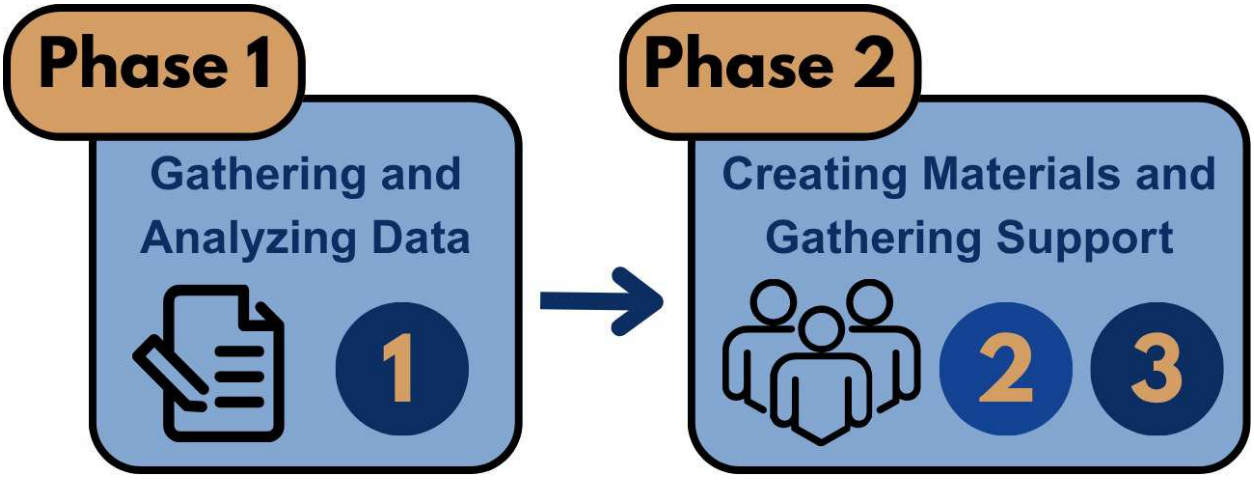
Due to the contract signed between the tour boat companies and the City of Copenhagen, tour boats cannot be compelled to change until this contract expires in 2037. Social support can provide pressure for change, but neither conversion to electric boats nor removal of seaplanes from the harbor are likely from social pressure alone.

Therefore, action by the Danish parliament is required to overrule this contract. Our overall approach was to collect convincing data to inform the public of the health risks and develop materials to help convince the public to support a citizen's initiative to bring the issue before Parliament.

In Denmark, a citizens' initiative is a type of petition that requires signatures from 50,000 Danish citizens to bring an issue directly to Parliament for review and a vote (*The*

Parliament). A parliamentary vote to create a zero-emission zone will override the existing contract with the tour boat operators. Citizens' initiatives have a 180-day limit and can only be created and supported by Danish citizens.

As a result, we created resources to enable Miljøpunkt Indre By & Christianshavn to start this campaign when this best fits their goals and schedule. The objectives used in this approach can be categorized into two phases.



Phase One aims to gather and consolidate data on the emissions and sound from the tour vehicles, covering the scope of objective 1.

Phase Two encompasses objectives 2 and 3, where we begin to use the data as a catalyst for interaction with both the local community to build social support and then with activists and politicians to empower political action.

Through building support and empowering people with the ability to initiate action, we were able to put the tools and knowledge into the hands of the people who are able to implement this zero-emission zone and bring Miljøpunkt one step closer to achieving their goal.

4. Phase One: Collecting and Updating Data to Build Persuasive Stances

Data collected by the previous WPI group in 2024 found that passengers on one of these tour boats were exposed to very high ultrafine particle (UFP) concentrations and dangerous noise levels (Carroll, et al., 2024). With this evidence of the health risks to passengers on Stromma and Netto-Bådene tour boats, our methodology aimed to gather data about levels of air particles and noise in surrounding areas to gather support for the next phases through a persuasive lens.

Methodology

We took measurements in areas of high traffic to highlight the health risks posed by these vehicles to citizens and tourists who frequently visit these areas. Both noise and air pollution measurements were taken at multiple locations, including the harbor bus stop in Nyhavn, the dock near the famous “The Little Mermaid” statue, the playground directly adjacent to the Nordic seaplanes dock, and in Refshaleøen along the edge of a canal near Reffen, a popular food court frequented by tourists and locals alike. We also recorded noise and air pollution from a private electric boat within the canals and from a Stromma dock at the north side of Langelinie Park. Unfortunately, our findings at these last two locations were inconclusive.

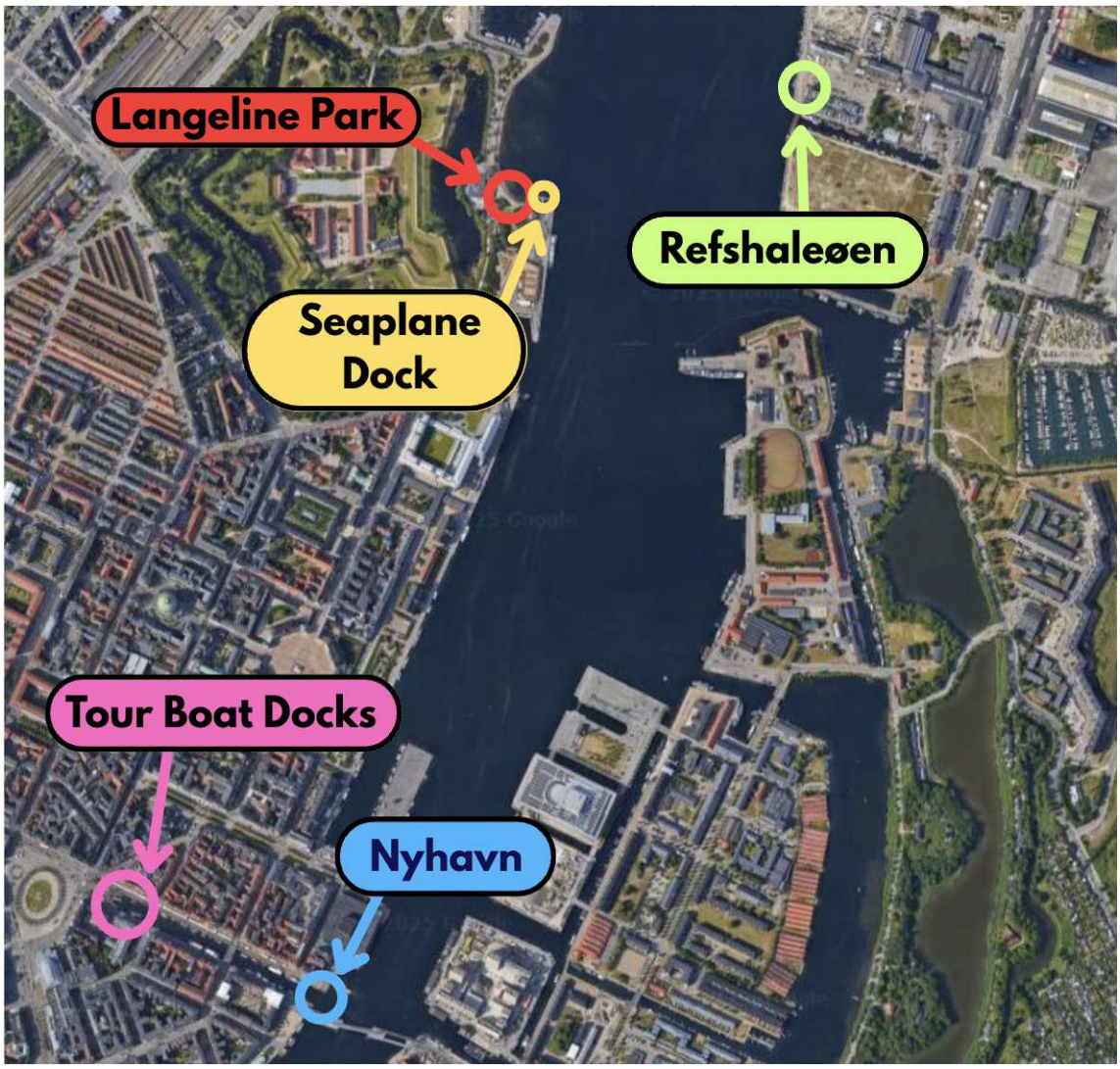


Figure 12: A map of our measurement sites as well as key docking locations for tour boats and seaplanes (Google maps, 2025)

These measurements were taken in May and June, the beginning of the tourist high season in Copenhagen. This is the season when tourists and citizens are most likely to frequent these areas and attractions to take advantage of the warm weather and festivals that occur during this time of year, making these sites high-risk areas for pollution. We took data on several different days with varying weather conditions to maximize the chances of successful data collection without background contamination. Air pollution was measured in ultrafine particle levels using a P-Trak 8525 Ultrafine Particle Counter, and noise pollution was recorded in decibels using the Brüel & Kjær 2250 Sound Level Meter.

Figure 13: P-Trak 8525 Ultrafine Particle Counter (left) and the Brüel & Kjær 2250 Sound Level Meter (right) being used near Langelinie Park. Photo Credits: Dante Nguyen

Results, Standards, and Analysis

Seaplane Ultrafine Particle Measurements at Refshaleøen

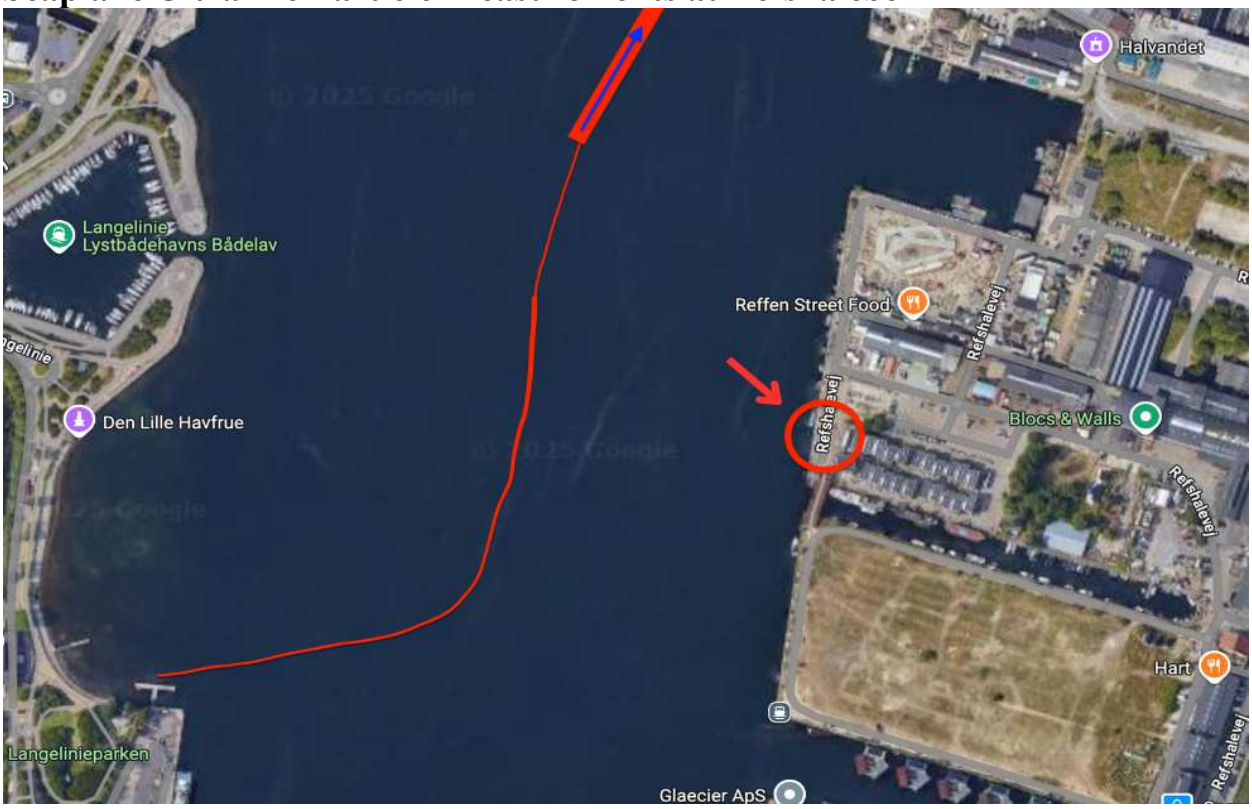


Figure 14: Map of the Northern harbor with our measurement site circled and a line marking the path taken by a Nordic Seaplane taxiing to its takeoff/landing zone (Adapted from Google Maps, 2025)

We recorded the seaplane's noise levels from Refshaleøen during a takeoff and landing on 17th. We decided to record in this because of Copenhagen's consistent winds directed Eastward, making Refshaleøen directly downwind of the Nordic seaplanes when they taxi to their takeoff area. Figure 14 is map of the northern harbor, showing where we recorded and the path the seaplanes take.

Measurement site in Refshaleøen allowed for the best UFP measurements of the Nordic Seaplanes due to the downwind location from where the seaplanes taxi and take off. As the plane passed by approximately 100 meters away, ultrafine particle levels surpassed 80,000 parts per cubic centimeter, and despite being in 6m/s winds (14mph), spikes lasted for up to 90 seconds with local UFP levels remaining above the average for up to five minutes. These spikes were 20 times the average ambient level of 4,000 pt/cc. A graph of this data can be found in Figure 15.

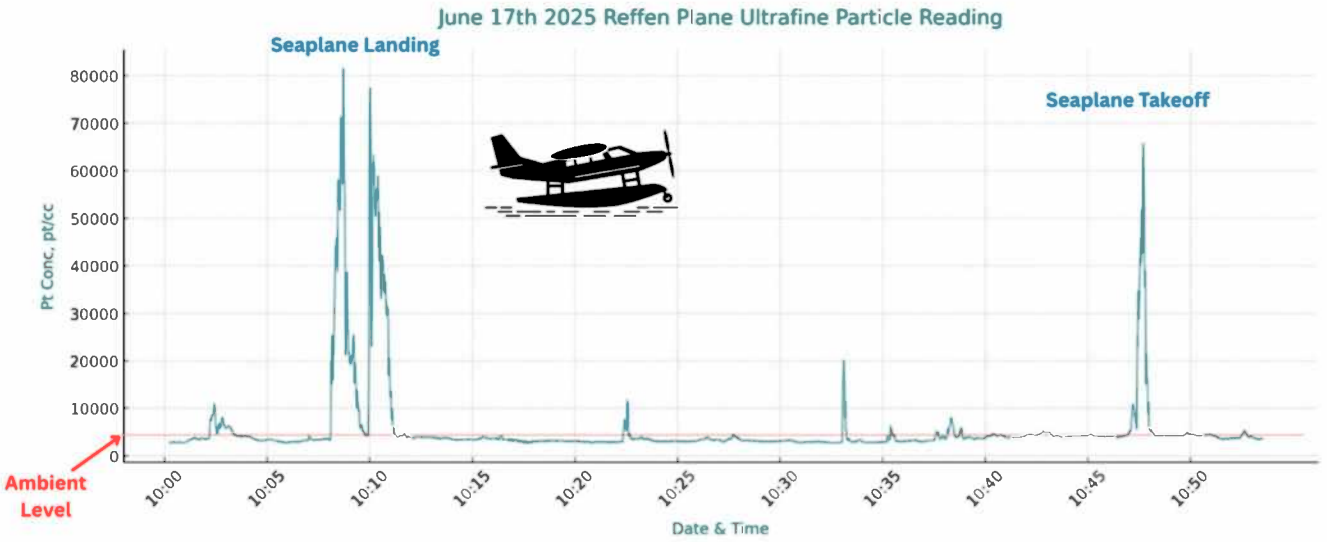


Figure 15: Seaplane Emissions spread throughout the Northern Harbor. Recorded at Refshaleøen on June 17, 2025.

The measurement location along the edge of the canals is also a site where lawn chairs are often placed for the tourists and residents enjoying the Reffen food stands and events, making it a high-traffic area. Notably, this location is located near Urban Riggers, a collection of apartments and residences in Refshaleøen. Exposure to these UFP spikes strongly suggests the potential for various health risks that residents and visitors alike may experience when these planes enter and exit the harbor.

Although research into ultrafine particles is relatively new and no exact standards exist yet, many recent studies have linked high levels of UFP exposure to different health issues such as cardiovascular disease, respiratory disease, and childhood asthma. The seaplanes take off and land either six or twelve times a day, six from the usual three daily flights to Aarhus and back, and another six depending on if they offer tours that day, which are usually every hour from 11:00 to 13:00 (Nordic Seaplanes). With the amount of consistent traffic Refshaleøen receives, the frequent pollution exposure is an extreme health hazard to anyone who either lives in Refshaleøen, visits frequently or works nearby.

Nyhavn Canal Tour Boat Air Pollution Measurements

Additional UFP measurements were taken on May 24, 26, and June 2 at the Nyhavn Canal by the harbor bus dock, a location where Stromma and Netto-Bådene tour boats accelerate to turn out of the mouth of the Nyhavn Canal to enter and exit the harbor. The emissions measured at this highly populated area are equally significant to the seaplane's pollution levels.

On June 2nd, we recorded UFP levels for about an hour. The recording from the P-Trak 8525 can be found in Figure 16 with each passing boat labeled. Despite being downwind in 6–8 m/s winds (13.4–17.9 mph), our readings spiked each time a tour boat went by. The UFP levels detected by the UFP Counter were remarkably high, peaking over 70,000 parts per cubic centimeter, which is 15 times the average ambient level in. It is worth noting that throughout our recording, harbor buses came by often and transported large crowds of regular commuters. These harbor buses produced no ultrafine particles due to their electric motors, and the noise pollution produced was minimal and blended in with ambient levels.

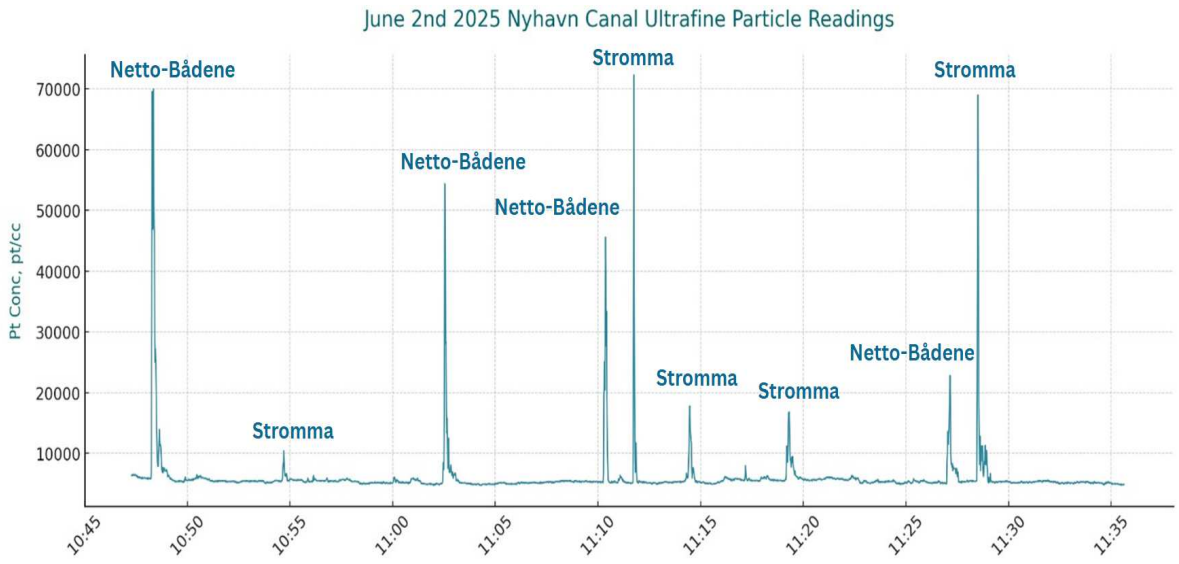


Figure 16: P-Trak 8525 recording on June 2nd from the Nyhavn Harbor Bus Stop. Each labeled spike represents a Stromma or Netto-Bådene boat passing by.

This data shows the great extent and frequency to which these tourism boats pollute the air. Once again, due to limited research on UFPs, it is safe to say that prolonged or

frequent exposure to the tour boats in Nyhavn can be very dangerous to anyone, especially those with any preexisting respiratory or heart issues.

The variance in UFP emissions between boats may be due to a variety of factors, including sudden changes in wind speeds, directions, and gusts, and the different rates that certain drivers accelerate in and out of Nyhavn. We also observed that the UFP levels of boats entering the port tend to be lower than when they leave, which is also correlated to their accelerations. However, after finishing our recording on May 26th a tour boat entered the canal and the P-Trak 8525 spiked beyond 80,000 pt/cc, showing that in either direction the tour boats still pollute a very significant amount.

It is worth noting that throughout our recording, harbor buses came by often and transported large crowds of regular commuters, increasing the amount of people in the area; however, these harbor buses have no spikes on the graph because as an electric vehicle they produce no ultrafine particles, and the noise pollution produced was minimal and blended in with ambient levels, showing how compared to electric boats these diesel engines are terrible for the local area.

Figure 17: Yellow electric harbor bus passing by Refshaleøen (Dante Nguyen, June 17, 2025)

A final note is that although Stromma uses hydrotreated vegetable oil instead of diesel, a supposedly healthier fuel, there was no indication that their boats produced lower UFP levels than Netto-Bådene's boats, which we suspect to be running on diesel due to the

different odor they give off.

Figure 18: Taking measurements at Nyhavn (Dante Nguyen, June 2, 2025)

Seaplane Noise Recordings at Langelinie Park

Figure 19: Seaplane dock at Langelinie next to a playground (white structures on the right), (Dante Nguyen, May 21, 2025)

Along with UFP measurements, we used the Brüel & Kjær 2250 to record sound levels produced by Copenhagen's canal vehicles. Our first location for this was in Langelinie Park, directly adjacent to the Nordic Seaplane dock and in front of a playground, which can be seen in Figure 19. At this site we recorded multiple landing and takeoff sequences.

These sequences were incredibly loud, and every time the planes started their engines or reached the dock it became difficult to hear conversations from each other without raising our voices. We even received comments from locals and tourists who would gather to spectate the planes running, stating that the planes were obnoxiously loud and that they were glad someone was doing something about it.

Although any part of the seaplane's landings and takeoffs were loud, the seaplane's docking sequence was the most notable. Figure 20 shows a graph of a landing sequence recorded by the sound meter over a period of 90 seconds on May 21 from 16:00 to 16:01, revealing sound levels significantly in excess of both local standards and general safe levels.

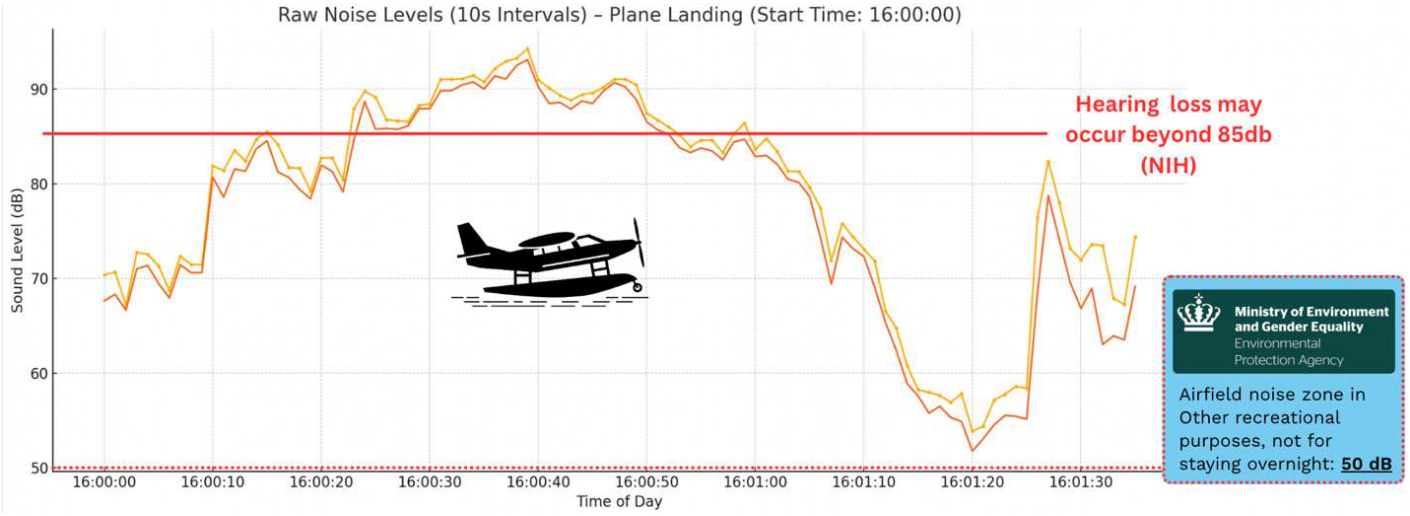


Figure 20: Recording of Seaplane Noise Pollution at Langelinie Park exceeds recommended levels during landing on May 21, 2025

Along with the curve displaying the seaplane's raw noise output, we decided to include two relevant noise level standards. The first is the dotted line along the bottom of the graph. This indicates the 50 dB standard recommended by the Danish Ministry of Environment's EPA for airfield noise in in recreational areas that do not have overnight staying (Danish Environmental Protection Agency, 2025).

Throughout its docking sequence from over 30 meters away there no instance where the noise levels went below this point, even when the engines were turned down most of the way when the plane reached the dock before turning them back on to correct its positioning. The second standard is shown by the solid red line. This represents the National Institute of Health's (NIH) 85 dB threshold for when one experiencing this sound is at risk of permanent hearing damage (Noise-Induced Hearing Loss (NIHL) | NIDCD, 2025). Although it usually takes repeated or sustained exposure to 85 dB noises before experiencing significant hearing damage, higher noise levels require less exposure time before experiencing the same or even more hearing damage.

During this sequence, the plane's engines peaked at 94 dB. Over time, such levels produced by the 6-12 daily takeoff/docking sequences could cause significant hearing damage to frequent park visitors or locals who work in the various local shops and snack bars.

It should also be noted that young children were present at the playground within 30 meters of the seaplane dock. Children are often more susceptible to the effects of excessive sound levels due to being in a growing and developmental phase of their lives (Balk, 2023).

Additionally, at the Nordic Seaplane dock, we observed seaplanes refueling while the planes were docked. During the fueling process, fuel could be seen dripping from the nozzle of the fuel pump into the harbor as it was being removed from the seaplane. There have been no further observations of fueling at the Nordic Seaplanes dock, but the presence of the fuel pump suggests the risk for fuel to regularly leak into the water by the Little Mermaid if all refuels occur at this dock, which over time could harm any life in the nearby water.

Figure 21: Nordic Seaplane docked at Langelinie, fueling over the water with no visible drip-prevention system. Photo Credits: Thomas Gray, May 2025

Seaplane Noise Levels Recorded at Refshaleøen

Figure 22: Seaplane and Stromma tour boat passing by Refshaleøen (background), Urban Rigger housing measurement site (overlayed). Photos by Thomas Gray and Dante Nguyen, June 17, 2025.

While recording ultrafine particle levels at Refshaleøen, we also recorded the noise levels of the seaplanes taxiing to their takeoff zone and back to the dock. As the plane was somewhere in the ballpark of 100 meters away from us and the taxiing process is relatively quiet compared to the docking and takeoff our data from this process was inconclusive.

However, we followed the seaplane to the northern edge of the Reffen Street Food Court in hopes of recording its takeoff noise levels. Unfortunately, because the plane's takeoff zone and our recording area were separated by a building, a lot of the direct noise was blocked. In addition, strong winds facing directly into the sound meter muddled the noise and made the data on the graph inconclusive without strong spikes.

The echoes from the plane, however, could be heard reverberating throughout the northern harbor, holding a steady level in the low 70s and peaking at 77 dB. Because this sound is from an echo, it is safe to assume that areas all around the harbor experienced similar noise levels, including waterfront residences, parks, and other recreational areas along the Northern Harbor.

These levels recorded at Refshaleøen from echoes alone surpass the Ministry of Environment's recommended levels for recreational areas and parks of 50 dB and the limit set for recreational areas with overnight stays of 45 dB (Danish Environmental Protection Agency, 2025), which would be the limit around the "Urban Rigger" housing near the Reffen Food Court and campsites set up in the area for music festivals like COPENHELL, which happened from June 18th to the 21st this year.

Inconclusive Noise and Air Pollution Measurements

Other recordings taken at many different locations throughout the canals of both the seaplanes and tour boats were deemed inconclusive. This decision was made either due to the recordings being too noisy, background interference, or insignificant data. Despite this, we thought some these samples were worth noting. The various locations where we recorded inconclusive measurements include the mouth of Nyhavn, by the Stromma dock adjacent to the statue of "The Little Mermaid", and on a private electric boat inside of the canals.

The first set of inconclusive data was taken adjacent to the Little Mermaid statue from May 19 to May 21. At this time, we were using the P-Trak 8525 to record UFPs and an older model of the Brüel & Kjær sound level meter. The older sound meter's data reviewing software only displayed an instantaneous peak that was recorded at an unlabeled time during the recording and an average noise level over the whole recording, which did not provide us with much useful information.

Because of this, we soon asked Miljøpunkt to use their newer meter, the Brüel & Kjær 2250. The P-Trak still revealed some fluctuations in ultrafine particle readings, with the greatest one on May 20 coming from a Stromma tour boat that raised the ambient level of 3,000 ultrafine particles per cubic centimeter (pt/cc) up to 8,000 pt/cc, which is almost three times the ambient level, but is not large enough for us to deem it significant. Also, the takeoff and landing of the Nordic Seaplane were not detected by the P-Trak at all.

The lack of strong supporting data and conclusive findings from the seaplane and tour boats can mainly be attributed to strong winds, at around 6 m/s and pointing East each

day of our measurements. These winds pushed the emissions away from the data collection site, which led us to take future measurements from the other side of the harbor in Refshaleøen, which were documented in the first section of our Phase one Results and Analysis. These poor results, along with interference from nearby diesel-powered buses and cigarettes, are what led us to deem our measurements by “The Little Mermaid” inconclusive. Figure 23 contains our measurements at this location on May 20th with peaks labeled based on what created it.

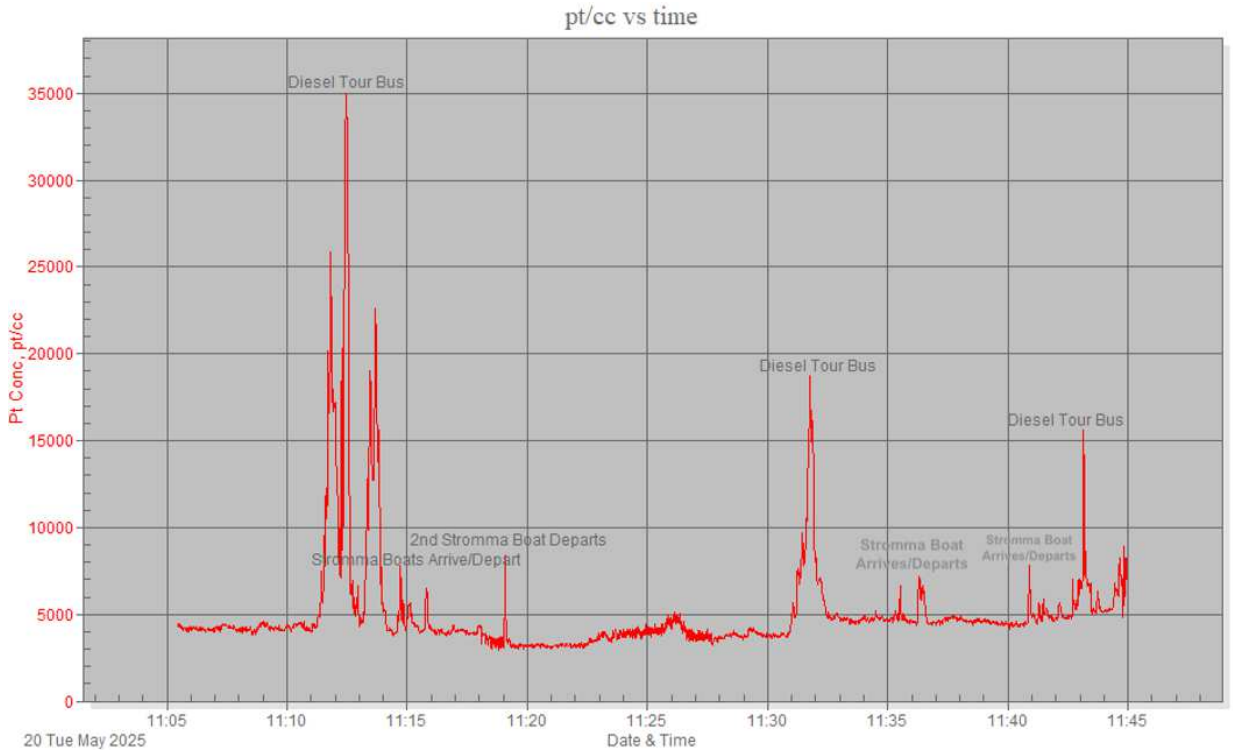


Figure 23: Ultrafine particle recordings from "The Little Mermaid" on May 20, 2025. The three largest spikes are from diesel tour buses upwind of us, and the smaller spikes are from tour boats passing by the statue.

Our next inconclusive site was by the mouth of Nyhavn, at the same location as we recorded UFP emissions from tour boats entering and exiting the canal. Although our UFP data from this site was very significant, our noise level recordings from June 2nd were not so conclusive. Due to background noise pollution contaminating the data set, quantitative noise pollution observations from the boats at Nyhavn were inconsistent; however, the noise was loud enough to interrupt conversations in Nyhavn and cause nearby groups of people to have to speak up. Although an annoyance, the noise emitted from the boats here did not appear to surpass any local standards by a significant margin, leading us to deem it inconclusive.

Our third and final inconclusive data set was from an electric boat we rode throughout the canals on May 26th. Mads Aarup, a member of our Miljøpunkt work group and the Indre By local committee, offered to take us out on his personal boat which uses an electric engine and a homemade battery system. Mads proposed it as an opportunity to record the noise and air pollution of the tour boats by driving close to them while getting a zero-emission guided tour of the canals. Measurements on the water would provide a strong argument for how pollution affects other boaters and kayakers, so we were very excited to try this out.

Unfortunately, due to the time we went out in the evening, most of the tour boats had finished for the day with only a few boats still running. We had a hard time finding them, let alone getting close to them due to the speeds they go through the canals. Combined with contamination of UFP's detected from restaurants' grills that we drove by, our data was not significant enough to create the argument we had hoped for.

Figure 24: Preparing to go on Mads Aarup's boat (Thomas Gray, May 26, 2025).

Moving into Phase Two

Our findings were shared with the Miljøpunkt work group to gauge their perspectives on our work. Based on the feedback they gave us we selected the graphs that would

resonate with our audience using evidence that suggests the strongest correlation between the presence of the diesel engine-powered vehicles and the effects that they have.

Additional graphs of air and noise pollution recordings, including graphs deemed inconclusive due to data interference or lack of statistical significance, can be found in Appendix B. Examples of this includes the UFP readings at Langelinie Park that ended up not supporting our message because of the wind trajectory bringing particles away from the reading device rather than the lack of emission impact.

5. Phase Two: Building Social and Political Support for Change

Building Social Support

For objectives 2 and 3, we focused on building social and political support for change through generating interest, informing our audience, and creating the steps for potential action.

Soliciting Feedback

To ensure our progress was heading in the right direction, we shared our findings at various meetings with Miljøpunkt's work group. This work group was comprised of community members with different aspects of involvement in the city and environmental initiatives, which allowed us feedback from various perspectives. We not only received feedback regarding which graphs and data sets were persuasive and statistically significant, but we were also able to gather further connections from the work group members to further explore each angle.

One of these connections was Julie Nørløv, a city hall worker with experience in communications for the Indre By & Christianshavn districts. Interviews were held with Julie as well as with Suzie O'Hair, a marketing expert and personal connection in California, US. The interviews focused on how to present our data in a way that would resonate most with our target audiences and maintain this engagement to utilize for future actions. Our interview questions can be found in Appendix A.

Flyers and Website

Based on these meetings and interviews, we identified the most influential data and began working on different social initiatives. Taking the advice from these experts, we aimed to first gather attention through a short, simple message. Our group opted for flyers with simple, recognizable graphics for our target demographic alongside a simple question and call to action to "hook" our audience. We chose different images of Nyhavn for flyers aimed at the general public and one with kayakers for posting at

Kayak Bar, a popular hangout location for Kayak groups in Copenhagen.

Figure 25: Flyers targeting different demographics

Physical forms of these flyers were placed by restaurants and busy roads in the Indre By and Christianshavn, popular bike parking stations, and at various buildings within the Danish School of Education (DPU). We created an effective system to gather as many

initial interested groups as possible, give them access to information and finally, a way to connect them with Miljøpunkt for future updates on a citizens' initiative.

Figure 26: The front page of our informational website

Using the data we collected and the feedback from our work group meetings, we constructed an engaging informational website that highlights the negative health effects of high ultrafine particle exposure and noise pollution as well as the environmental issues caused by diesel engines in the canals. Attached links outline the data we collected from the seaplanes and tour boats and the associated health and environmental risks that come with it. Focus groups with fellow WPI students provided feedback on how to improve the site visually and where to cut out or emphasize important information. We used this feedback to continually iterate and improve the website throughout this phase. Our flyers and website can be found in Appendix A, and our website can be reached through the QR codes on the flyers.

Articles in Christianshavneren and Kosmopol

Another recommendation from the city hall member was to use the press as a medium to spread our message to a greater audience. We wrote an article covering canal pollution from the tourism vehicles and how the zero-emission zone would benefit the city for submission formatted as a Miljøpunkt news briefing. This news briefing was submitted to Christianshavneren, an activism-oriented community newspaper in

Christianshavn. This article, formatted as a Miljøpunkt news briefing, can be found in Appendix A.

The article submission, while unable to make the June issue due to translation times, is scheduled for the July issue. Readers turn to Christianshavneren to get involved in local activism, making this paper an invaluable medium for reaching our intended audience. Christianshavn's residents are key stakeholders and a primary demographic in the creation of a zero-emission zone.

Kosmopol, an online new source of TV2, and a leading source for local news in Copenhagen, also released an article in early June a few days after we sent our article to Christianshavneren. This article was initiated by a complaint about the tour boats from a Nyhavn resident and contained an interview from Stromma's president, Mads Vestergaard Oleson. Following this, we sent our article to Kosmopol in hopes of reaching gaining their attention towards our project. A couple of days later, Kosmopol interviewed Marianne and inquired about the tour boats and seaplanes, resulting in an article called "Environmental Organization Fights for Electric Canal Cruises", or "Miljøorganisation kæmper for eldrevne kanalrundfarteran" in Danish (Juul Bruun, 2025). Through this interview, Marianne was able to not only share information regarding the diesel engines in the canals, but also our recommendations for a citizen's initiative to bring the issue up to Parliament. The same week, Kosmopol published another article about local residents complaining about the noise and pollution from seaplanes and tour boats (Boye, 2025). Both articles conveyed a widespread distaste for the existence of commercial diesel engines in the inner harbor, spreading more awareness and interest in the situation. Kosmopol's articles showcasing the issue and Miljøpunkt's current actions towards a solution gather positive attention towards this project's goal, and gives a cause that citizens' can focus their attention into supporting.

Through the social backing gained through these initiatives, we hope to give Miljøpunkt the members needed to begin a citizens' initiative campaign to propose the implementation of a zero-emission zone after we leave Copenhagen.

Building Political Support

We made progress in building political support by sharing our findings with the local committees in Indre By and Christianshavn and outlining a set of recommended steps in order to bring attention a potential citizens' initiative.

Presentations to Local Committees

Miljøpunkt Indre By & Christianshavn works alongside local committees to address current issues, with many of the organization's work group members serving as members at these meetings. To build support for our final objective, Miljøpunkt put us on the agenda for two local committee meetings, one for Indre By and the other in Christianshavn, the two most affected areas surrounding the Copenhagen harbor. Each local committee (Lokaludvalg) is a formal government council that considers all local issues on a wide variety of topics, including those brought to the local committee by individual citizens.

Figure 27: Presentation to Indre By Local Committee, June 12, 2025. Photo Credit: Peter Hansen

The presentations to the Indre By Local Committee at Trinitatis Kirke Songnehus on June 12, 2025, and to Christianshavn Local Committee at Hal-C, Arsenalvej, on June 18, 2025, were both well received and led to productive discussions. At these meetings, we presented our most impactful graphs emphasizing the frequency and severity at which the tour vehicles emitted UFPs, as well as the harmful sound levels produced by the seaplane's landing sequence near the playground where the original dock is located. Various members were surprised at the guidelines and safe levels that were surpassed according to the values depicted by our graphs.

Figure 28: Presentation to Christianshavn Local Committee, June 18, 2025. Photo Credit: Peter Hansen

When we pointed out that a portion of the landing sequence exceeded the NIH's set threshold for hearing damage, one local committee member remarked that he laughed at the ridiculousness.

Following our presentations was the opportunity for discussion and questions. We received feedback on how we could emphasize control measurements to highlight the

disruption that the emissions and noise levels have on typical daily life to create to persuade and gain the support of those outside of the canals as well.

A concern was brought up at our first local committee meeting at Indre By regarding who the financial burden of the electric charging facilities would fall upon. One of our group members stated that most boat charging facilities in Amsterdam were privately owned or had been installed by private companies, with the city funding only a small fraction of the total. The cost of electrical distribution was not borne by the municipality alone. These details were noted by members of the committee and prompted us to look more into this popular topic of discussion.

Electric charging facilities for boats

Following the local committee meeting, our group underwent further investigation into the details of electric conversion and infrastructure. Several questions were asked about the logistics of the increased charging stations, primarily around funding. Hoping to gain a better understanding of what is needed from every party for the technical and financial aspects of electric conversion, we held an interview with one of the co-owners of Clean eMarine, a Copenhagen based producer of electric propulsion systems for leisure boats and professional vessels. In the past, Stromma has mentioned that one of the challenges preventing them from converting sooner is “the current infrastructure where [they] do not have enough charging opportunities” (Carroll, et al., 2024).

The co-owner of Clean eMarine mentioned that there has been endless talk with Stromma regarding the types of batteries that would be installed in future boats, such as optimizing for overnight or en route charging, fast or normal charging, lower or higher capacity batteries, and more—decisions that are difficult to make with little knowledge of what charging infrastructure will be available in the future. Additionally, if overnight charging were to be considered, the city of Copenhagen would have to increase the capacity of the cabling. They must have the available amps coming into that plot of land.

That being said, our connection at Clean eMarine believes that it is still realistic to convert on Stromma’s behalf. Costs of batteries and other parts needed for a

conversion are more affordable and available than they've been since the COVID-19 pandemic. Paired with a 3- to 4-month conversion time for each boat and the potential for a conversion company to work on multiple at once, there is plenty of time for Stromma to finish the conversion process and test their boats within Copenhagen's 2035 carbon positivity goal. While concerns may be raised for Stromma and Netto-Bådene on the loss of boats during high season while conversion is happening, the well-being of tourists and citizens alike must take precedence (Personal communication, Clean eMarine).

Primary Takeaways

The overall findings of our initial phase, serving initially to validate the issue and inform the public, resulted in uncovering the severity of the issue and the extent to which it impacts Indre By & Christianshavn. While we are unable to create the degree of social backing needed during our time here, we were able to put the issue on a higher priority for the community and local committees. By drawing greater urgency to the topic and bringing more attention to the issue, we involved more people that are passionate about resolving the issue and have the tools to accelerate progress.

The acquired social support also serves to pressure the companies that rely on the city's support, as well as the Danish government, to initiate change. Stromma has made the most progress in putting the community first, with greener fuel choices and investments in high-quality docks along the canals designed not only to park boats but also to provide places for the locals to gather and relax. With their passion for supporting the canal community, it is not unlikely that they will begin to invest in converting their fleet to electric due to public pressure, in turn pressuring Netto-Bådene to convert their fleet as well.

We hope Miljøpunkt will be able to utilize the resources we have developed during our time here to efficiently gain traction for a citizens' initiative and create the proposal once sufficient support and pressure are gathered. Taking into account the situation and the suggestions from the parties and individuals we have communicated with, we believe

that the best way to move forward is equal action on the part of the city, companies, and citizens to hold each other accountable through this process.

6. Recommendations

These recommendations are split into sections based on which level of government or which social group would be required for this action. We believe that both political and social support will be necessary to solve this health and social issue and overturn this contract preventing change.

Miljøpunkt and Local Committees in Indre By and Christianshavn

Create a Citizens' Initiative

We recommend that the Miljøpunkt Indre By & Christianshavn board should start a citizens' initiative that proposes a zero-emission zone for commercial passenger vehicles in the canals. A commercial passenger vehicle is defined as a motorized vehicle, land, or water, that carries a large quantity of passengers for profit. The driver of a commercial passenger vehicle can be either the consumer or one issued by the service provider. This would overturn the 2019 contract that allows the boats to run using diesel engines until 2037 and force a conversion of the tour boats to electric, as well as provide grounds for the city to move the Nordic Seaplanes out of the harbor.

Additionally, emphasizing a zero-emission zone for commercial passenger vehicles is important for maintaining the support of the local community. Otherwise, support for the citizens' initiative may be hindered if citizens are concerned about converting their personal pleasure boats to comply with a zero-emission zone. Running a citizens' initiative would be an effective way to turn social support into national-level political support and would also help Miljøpunkt gain even more social support for their future projects.

Continue Social Initiatives

We recommend that Miljøpunkt work on growing the email list to increase outreach to local residents, stakeholders, and groups passionate about pollution within the canals. An expanded email list keeps people informed about upcoming events, consolidates community support, and builds an engaged group of citizens. In addition, an improved email list allows Miljøpunkt to easily coordinate collective action, such as a citizens'

initiative to influence sustainable policy changes. We also recommend that Miljøpunkt hold events, such as an educational workshop for kayakers to teach them about the negative health impacts of the diesel engines. Public events will help raise awareness, spark local dialogue, and bring in more supporters. Furthermore, we recommend that Miljøpunkt continue with regular press releases and news articles to keep the issue of canal pollution at the forefront to help influence local residents and lawmakers. Lastly, Miljøpunkt should continue to post flyers in high-traffic locations to reach new audiences who care about the environment.

Public Outreach Events

We recommend that the local committee organize their own public events that highlight canal pollution and promote sustainable alternatives to tour boats. The local committee could host town hall meetings to inform local residents about the negative environmental and health impacts from the diesel boats and seaplanes. These public events will not only raise public awareness but also show political commitment to addressing this issue.

Copenhagen Municipality and Related Agencies in Denmark

Electric Boat Charging Infrastructure

The Municipality or By & Havn should develop plans to increase the number of electric boat charging stations along the canals and port of Copenhagen. In Amsterdam, the vast majority of new electric charging stations were provided by private enterprises rather than the municipality. Private firms may be permitted or incentivized to build electric charging stations that they build, operate, and maintain. The capacity of the power grid to charge multiple boats should be evaluated. Increasing the capacity to charge electric boats will facilitate the more widespread transition to electric engines.

Additionally, ensuring that the grid strength is capable of supporting chargers is imperative for a zero-emission zone, as any infrastructure and charging stations are dependent on the grid's ability to supply sufficient amperage. Without both the infrastructure and charging stations, the difficulty for sustaining canal tourism in a zero-emission zone would increase. In the future, a stronger grid and more plentiful access to

electric charging facilities for boats will ease the electric transition beyond commercial tour boats.

In Amsterdam, the majority of these electric charging facilities for boats are operated by private companies, with only 12 of the over 200 locations being city-run and funded. A plan like this could take place in Copenhagen, with private companies paying for their own charging stations and individual marinas being responsible for their respective upgrades.

Offer Advertising for Electric Alternatives

We recommend that the city offer advertising for electric alternatives for the tour boats. These advertisements could target both tourists and corporate customers who want to host events using tour boats. An example is how VisitCopenhagen promotes the harbor buses and highlights their electric capabilities and role in reducing CO_2 emissions: (The Harbor Bus). Offering extra advertising would incentivize tourism companies to transition to electric engines before the 2037 deadline and will also create competition for electric canal tourism through alternatives like Go Boats and FriendShips.

Move the seaplane dock farther out of the harbor

By moving the seaplane dock farther out of the harbor, the noise levels produced by this company will not reach dangerous levels onshore. Minimizing the disruption felt by locals living under the landing route and people sitting near the planes' docking location, this solution would also remove the main social opposition to the seaplanes, allowing them to finish out their contract without the complaints and resistance seen in local news sources (Gierl, 2024).

Nordic Seaplanes has worked with a company developing an electric seaplane, which, if used, would remove the harmful pollution recorded during the landing and takeoff sequences (Ros, 2024). These short trips would be a perfect use for this technology and would reduce emissions, helping Copenhagen reach their carbon-neutral goal. This technology is not developed enough to go into use now but should be monitored closely as a future option.

Scope of Recommendations

Guidelines for Ultrafine Particle Pollution

Currently, no restrictions or guidelines exist for ultrafine particle pollution. Despite limited research on the risks associated with UFPs, there has been more and more data coming out recently supporting that UFPs from emissions can be very unhealthy. Without these rules, industries can pollute without consequences and with no oversight or guidelines for what is considered safe. By working with researchers to create standards for ultrafine particle pollution, the government can regulate these harmful emissions, creating a safer and healthier environment for its citizens.

Only Commercial Boats

In Amsterdam, the majority of opposition faced for the zero-emission zone was from private pleasure boat owners, who did not have the funds to convert their vessels (Amsterdam to Ban, 2025). By focusing on commercial vessels, the citizens' initiative can remove the worst polluters from the canal with minimal infrastructure upgrades needed, allowing for a future zero-emission zone to include personal vessels.

Only Canal Vehicles

Questions were raised during presentations with the local committees about including the double-decker tour buses in this zero-emission zone, but this was outside the scope of this project. There already is a zero-emission zone for cars in the central areas, so this, as a separate project, could be expanded to include all the tourist attractions visited by the hop-on-hop-off buses.

7. Conclusions

Working towards creating a greener city is no simple task, and Copenhagen deserves all the praise it receives for the distance it has come over the past decades. Creating a zero-emission zone in the canals presents numerous challenges, but thanks to the collaboration among Miljøpunkt, local committees, the municipality, and Copenhagen residents, steady progress has been made towards this goal. Between citizens, government representatives, and even the owners of the tourism companies, the cooperation between every party we have interacted with—directly or indirectly—has been amazing. In order for this goal to be achieved, this mutual support must be continued by all roles to ensure progress does not stagnate. With such a strong community, we believe that Denmark should be a worldwide model for how we can all do a little more to help our planet thrive.

Figure 29: A Stromma canal boat passing by the Nordic Seaplane dock (Thomas Gray, May 19, 2025)

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Appendices

Appendix A: Campaign Materials

Website

Flyers


HYTTEFADET
MILJØPUNKT
INDRE BY & CHRISTIANSHAVN
AGENDA 21 · FOR ET BÆREDYGTIGT KBH
ARE YOU BREATHING CLEAN AIR?
SCAN TO LEARN HOW YOU CAN HELP STOP POLLUTION IN OUR CANALS!


MILJØPUNKT
INDRE BY & CHRISTIANSHAVN
AGENDA 21 · FOR ET BÆREDYGTIGT KBH
ARE YOU BREATHING CLEAN AIR?
SCAN TO LEARN HOW YOU CAN HELP STOP POLLUTION IN OUR CANALS!


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INDRE BY & CHRISTIANSHAVN
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ARE YOU BREATHING IN CLEAN AIR?
SCAN TO LEARN HOW YOU CAN HELP STOP POLLUTION IN OUR CANALS!

Additional campaign material

Miljøpunkt Press Release

Submitted to Christianshavneren and Kosmopol in June of 2025

Presseorientering

Vi taler for grønne kanaler og en plan for alternativer til dieselmotorer NU

Det er ikke nyt, at Miljøpunkt Indre By & Christianshavn sætter fokus på forureningen i vores bydele, om det er fra busser, biler eller knallerter på cykelstien. Det er heller ikke nyt, at vi ser på forureningen fra kanalrundfartsbådene. Vi sætter igen fokus på forureningen i Københavns Havn og kanaler, og hvad der er sket det sidste år, det gør vi sammen med fire amerikanske universitetsstuderende fra Worcester Polytechnic Institute (WPI)

De studerende har målt forurening og indsamlet data om mængder og kendte virkninger af den og nye muligheder for at få en hurtigere grøn omstilling og nul-emission i havnen. Denne gang ser vi også på de vandflyvere, som flyver over Københavns Havn og kanaler og hvad det kan betyde for dem som bor, arbejder og færdes her. Nemlig virkninger af de store mængder ultrafine partikler, der udledes samt og støjen fra vandflyvere og kanalrundfartsbåde.

Der er målt på luftforurening fra kanalrundfartsbådene fra firmaerne Stromma og Netto-bådene når de sejler inden for 50 meters afstand til land eller kaj. Der er målt niveauer af ultrafine partikler, som er 1000 gange større end baggrundsniveauet uden både.

Tidligere undersøgelser foretaget af andre studerende hos Miljøpunkt Indre By & Christianshavn har vist, at 65 % af de adspurgte, der bor i nærheden af kanalerne, oplever en negativ effekt af forurening fra kanalbåde i deres liv, og over 96 % af borgerne mener, at driften skal ophøre for at være i overensstemmelse med Københavns bæredygtighedsmål, og ville være villige til at stemme for at konvertere nuværende kanalbåde til el.

For høje koncentrationer af ultrafine partikler kan forårsage en lang række sygdomme så som astma, luftvejslidelser og hjerte-kar-sygdomme. Især børn er udsatte. Målinger af støjen fra Nordic Seaplanes' turflyvninger over havnen ved Langelinie viser, at de støjer mere end 95 decibel, hvilket udgør en sundhedsrisiko for børn og familier, selv når de er i nærliggende parker og legepladser.

I dag har firmaerne en kontrakt, der giver dem mulighed for at fortsætte med at bruge dieselmotorer indtil 2037.

Københavns Kommunes Borgerrepræsentation har besluttet at arbejde for en nul-emissionszone i havnen. Handlinger til implementering af en nul-emissionszone i kanalerne og havnen kan iværksættes ved en lovændring i folketinget hvis der skal ske ændringer inden 2037.

Men borgerne i byen har også en stemme – og mange stemmer kan skabe forandringer.

Vil du høre de studerendes anbefalinger til mulige handlinger for en hurtigere grøn omstilling så vær med på møde i Indre By Lokaludvalg den 12. juni i Trinitatis Sognegård, Pilestræde 61, eller på møde i Christianshavns Lokaludvalg den 18. juni i Hal C, Arsenalvej 6.

Du kan også læse mere om de studerendes arbejde på Miljøpunktets hjemmeside www.a21.dk.

Link til tidligere miljøundersøgelse om forurening, manglende vilkår til at begrænse forurening fra kanalrundfarten i Københavns Havn og kanaler, sammen med studerende i 2024.

Kontakt vedrørende opfølgende projekt om virkemidler til grøn omstilling af Kanalrundfart og vandflyvere maj-juli 2025 samt projekt 2024 til Miljøpunkt Indre By & Christianshavn,
centerleder Marianne Spang Bech på telefon 3393 2121.

Kontakt vedrørende studier og resultater 2025 fra WPI-studerende på e-mail på gr-e25-boats@wpi.edu.

Foto af WPI-studerende 2025

Om Miljøpunkt Indre By & Christianshavn

Miljøpunkt Indre By & Christianshavn arbejder for at skabe grundlag for bedre livskvalitet og for mere bæredygtige bydele, bl.a. gennem indsatser og projekter, som skaber en grønnere by, med grønne gader, facader og baggårde, mere biodiversitet og vildere natur, mere ro, bedre udnyttelse af ressourcerne, mindre affald, mere bytte og genbrug, grøn mobilitet, bedre klima og forbrugsbaseret CO2-reduktion mv. Vi laver projekter i byen, vejleder om at skabe grønt, bytte, genbrug og grøn mobilitet, nyhedsbreve, vejledninger og rapporter. Vi debatterer, vejleder og viser muligheder for bæredygtig omstilling gennem konferencer, temamøder, arrangementer i byen, byvandringer mm. Alt sammen med byens borgere, skoler, institutioner, lokaludvalg, foreninger, NGO'er, erhverv og studerende.

Miljøpunkt Press Release

English translation (Google translate version)

It is not new that Miljøpunkt Indre By & Christianshavn focuses on the pollution in our districts, whether it is from buses, cars or mopeds on the cycle path. It is also not new that we look at the pollution from the canal tour boats. We are once again focusing on the pollution in the Port of Copenhagen and canals, and what has happened in the last year, we are doing this together with four American university students from Worcester Polytechnic Institute (WPI).

The students have measured pollution and collected data on the amounts and known effects of it and new opportunities for a faster green transition and zero emissions in the port. This time we are also looking at the seaplanes that fly over the Port of Copenhagen and canals and what this can mean for those who live, work and travel here. Namely the effects of the large amounts of ultrafine particles that are emitted as well as the noise from seaplanes and canal tour boats.

Air pollution from canal tour boats from the companies Stromma and Netto have been measured when they sail within 50 meters of land or quay. Levels of ultrafine particles have been measured that are 1000 times greater than the background level without boats.

Previous studies conducted by other students at Miljøpunkt Indre By & Christianshavn have shown that 65% of respondents who live near the canals experience a negative effect of pollution from canal boats in their lives, and over 96% of citizens believe that

the operation should cease in order to be in line with Copenhagen's sustainability goals, and would be willing to vote to convert current canal boats to electricity.

Excessive concentrations of ultrafine particles can cause a wide range of diseases such as asthma, respiratory diseases and cardiovascular diseases. Children are particularly vulnerable. Noise measurements from Nordic Seaplanes' sightseeing flights over the harbor at Langelinie show that they are more than 95 decibels, which poses a health risk to children and families, even when they are in nearby parks and playgrounds.

Today, the companies have a contract that allows them to continue using diesel engines until 2037.

The City Council of Copenhagen has decided to work towards a zero-emission zone in the harbor. Actions to implement a zero-emission zone in the canals and harbor can be initiated by a legislative amendment in the Folketing if changes are to be made before 2037.

But the citizens of the city also have a voice – and many voices can create change.

If you would like to hear the students' recommendations for possible actions for a faster green transition, please join the meeting of the Inner City Local Committee on June 12th at Trinitatis Sognegård, Pilestræde 61, or the meeting of the Christianshavn Local Committee on June 18th at Hall C, Arsenalvej 6.

You can also read more about the students' work on Miljøpunktet's website www.a21.dk.

Link to previous environmental study on pollution, lack of conditions to limit pollution from the canal cruise in the Port of Copenhagen and canals, together with students in 2024.

Contact regarding follow-up project on instruments for green conversion of the Canal Cruise and seaplanes May-July 2025 and project 2024 to Miljøpunkt Indre By & Christianshavn, center manager Marianne Spang Bech on phone 3393 2121.

Contact regarding studies and results 2025 from WPI students on e-mail at gr-e25-boats@wpi.edu.

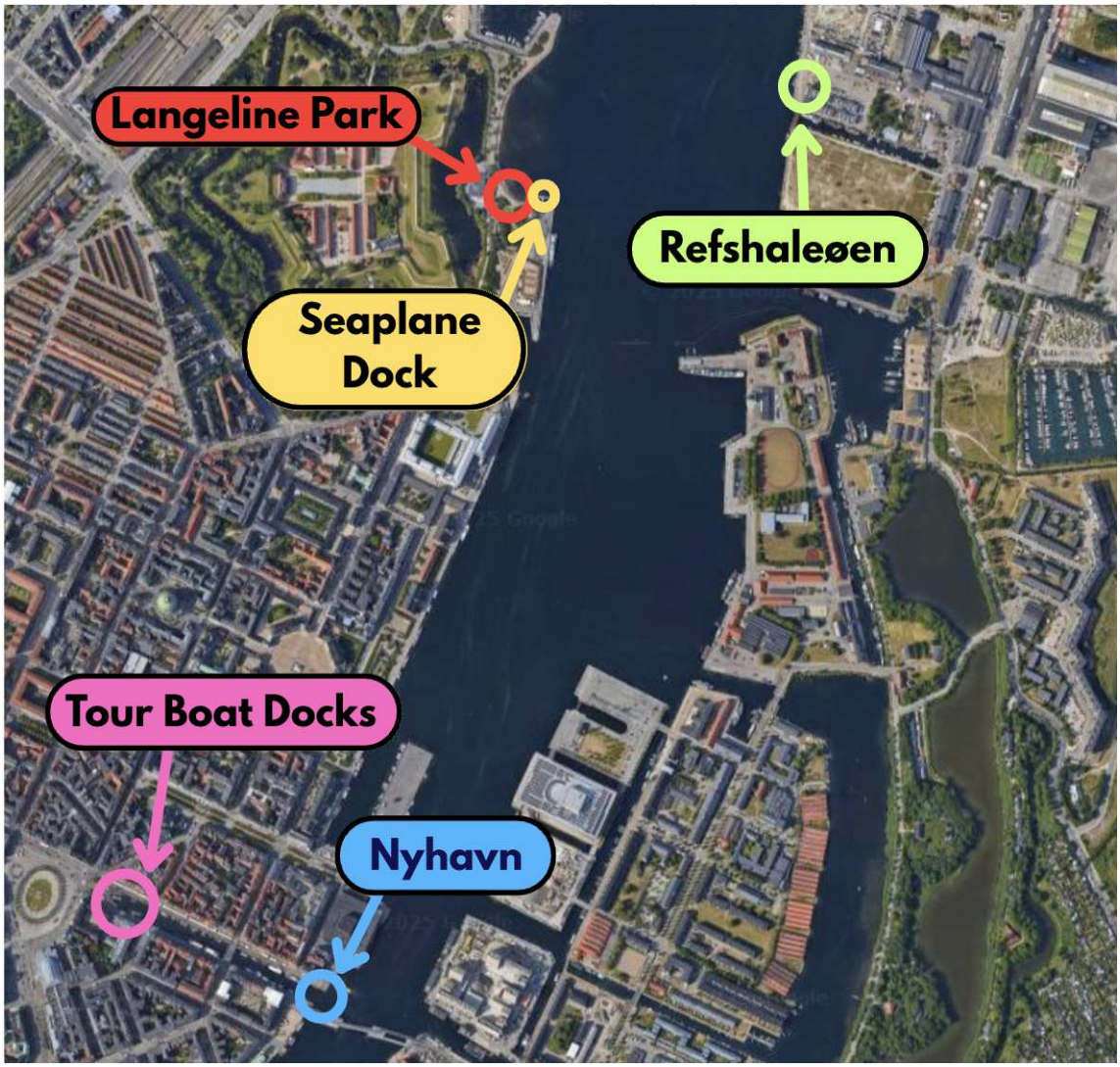
Interview Questions for Campaign and Communications Experts

Asked to both Suzie O'Haire and Julie Nørløv

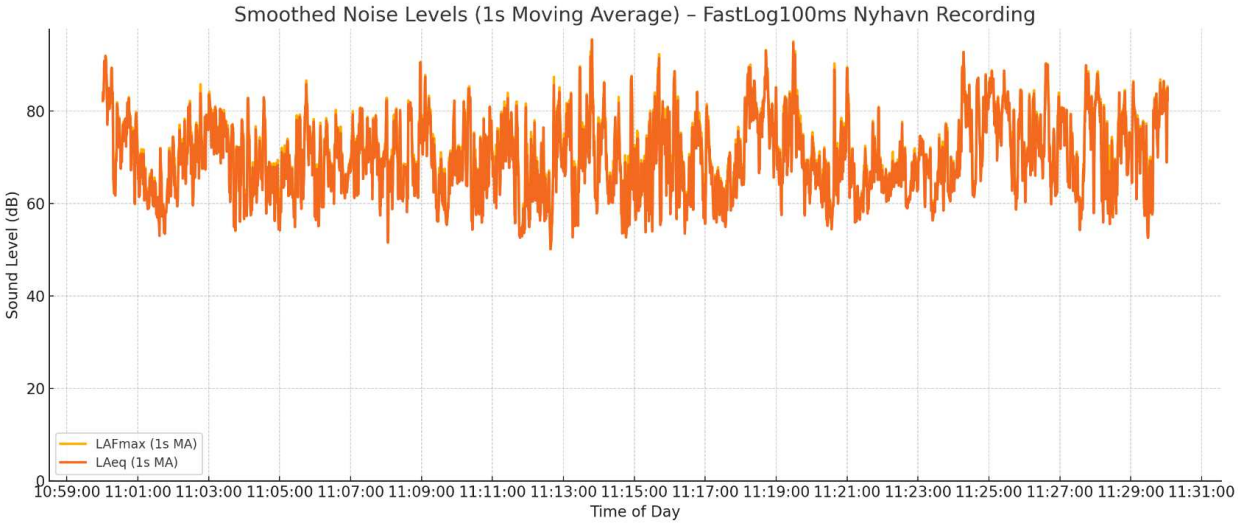
- What have you found to be the best strategies for both obtaining and maintaining public engagement?
- What media platforms have proven most effective for environmental campaigns, and why?
- How do you track the effectiveness of marketing campaigns?
- What has been useful in your previous campaigns? What hasn't been?
- What difficulties and challenges do you typically encounter when trying to market or campaign an idea?
- How do you handle conflicting feedback from different groups when refining campaign messaging?
- How do you gauge public sentiment towards a cause before launch to avoid backlash or disengagement?
- What are the key points that we should understand as students before we begin designing and testing campaign materials for our citizens' initiative?
- Given our objectives, what would be your recommended strategies to maximize visibility and engagement?
- How do we turn raw data (noise dB readings, air pollution readings) into something that people care about?
- What messaging strategies work best in getting citizens to care about issues that do not directly affect them?

Appendix B: Measurements

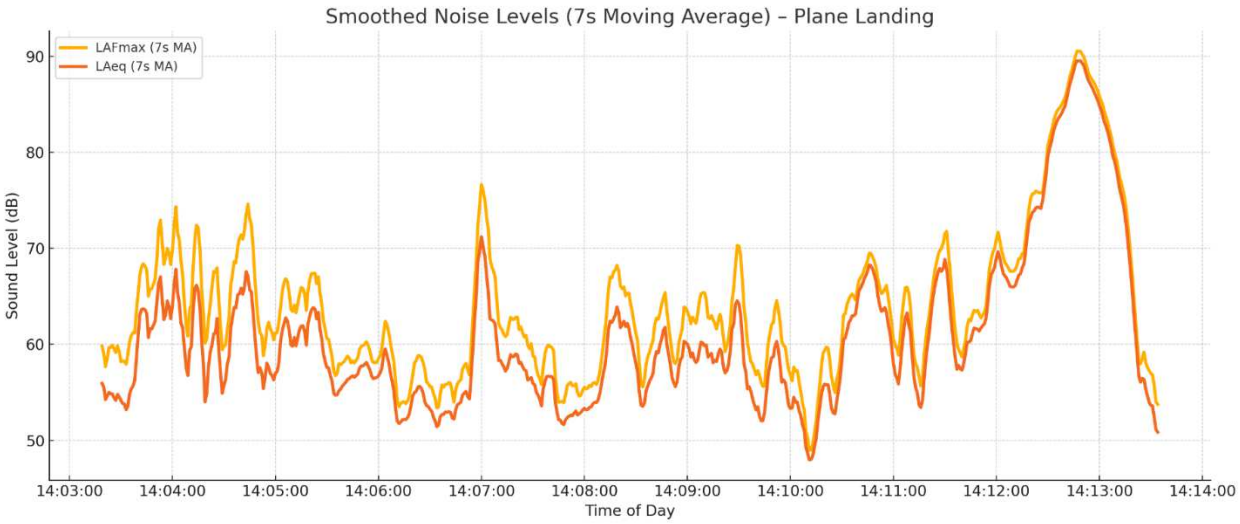
Map of Measurement Locations



Nyhavn: Tour Boat Noise Pollution Measurements (June 2nd)



Langelinie Park: Seaplane Noise Data (longer recording, May 21)



Refshaleøen: Sea Plane Noise Data (June 17)