**FINAL PRESENTATION**

**Tiril/Slide 1:**  
Welcome! Today, we’ll be presenting our project: the Cityplanner Tool application.

**Tiril/ Slide 2:**  
We are Team Alpha, and our team consists of

**Pål Egil Runde** from Norway. He has a bachelor's degree in frontend- and mobile development. He has project experience with making a voice application with Alexa and a personal project where he created a web application that displays different food recipes for users.

Then we have **Sini Vuorensyrjä** from Finland. She has a Bachelor’s degree in Business Information Technology and also a Master of Science degree in Molecular Biology. Her work experience consists of University research and laboratory work in Health Care field as a Production Services Team Leader.

We also have **Nazeli Selltröm Vera** from Sweden. She has a diploma in cross media production, where she studied analog and digital productions, and later used her knowledge as a production leader for making commercials and short films. She also has professional experience as an IT advisor consultant.

**Tiril Marie Pedersen Løken** (myself) from Norway. I have a bachelor’s degree in data engineering, specializing in the field of cybersecurity. I have project experience with making a multiplayer roleplaying game and my own personal portfolio website. I also have experience with pentesting and finding security flaws within web applications.

**Tiril/ Slide 3:**  
Throughout this presentation, we’ll cover the project’s scope, provide a demonstration, discuss the technologies we used, and explain how our team collaborated.

We’ll also share our methodology, highlight future improvements, and discuss the lessons we learned during the project.

**Tiril/ Slide 4:**  
The primary objective of this project was to demonstrate the knowledge and skills we’ve gained during the Brights Data Engineering training.

Our task was to create a hands-on project with sustainability at its core. Developing sustainable solutions is vital, as it fosters a culture of environmental responsibility at all levels—whether for individuals, organizations, or communities. This not only benefits the business model but also has a broader positive impact on the community and environment.

**Tiril/ Slide 5:**  
We’re excited to introduce the Cityplanner Tool – *Growing Greener Cities, One Tree at a Time* – an innovative app designed to transform urban planning by embedding sustainability into the very foundation of city development.

The Cityplanner Tool provides city planners with accurate emission data for their cities. Our tool analyzes this data and calculates the number and types of trees needed to neutralize emissions, forecast future emissions, and ensure a greener, cleaner urban environment.

**Tiril/ Slide 6:**

So how does it work?

Our app collects comprehensive emissions data, allowing city planners to understand the environmental impact through data-driven insights.

Based on this data, the tool recommends various tree species to effectively offset the carbon footprint. Whether it’s for a bustling city or a quiet town, our recommendations are tailored to meet each city's unique needs.

By incorporating these green solutions into urban planning, we can reduce pollution, improve air quality, and create healthier spaces for future generations.

**Sini/Slide 7:**

Now, let’s walk through a demo of our solution.

*\* Press play \**

The default view shows regional emission data for Finland or Sweden in 2022, as chosen from the dropdown. The stacked bar shows different regions in that country and various emission sources as different colors. The graph also allows users to drill down into specific emission sources.

Below the region's bar chart, on the right, is a donut chart showing total emissions by source for the selected country in the year 2022. To its right, a bar chart displays the average CO2 consumption of different tree species.

At the bottom, a comprehensible table offers detailed information on the tree species to help city planners in their decision-making.

User is able to select different cities from either Finland or Sweden, (let’s use Stockholm here.) When a city is selected, a line chart appears, showing the city’s emissions over time, along with predicted data for upcoming years, 2023 through 2025 in red.

The donut chart and bar chart are at the same time updated to reflect emissions by source, and the required number of trees to offset CO2 emissions, for that city in 2025.

With this information, city planners are able to make informed decisions regarding their cities landscaping and environmental development.

**Sini/ Slide 8:**

Let’s now look at the technologies we used for the project.

We primarily developed using Python, with a significant focus on the Pandas library for data manipulation and analysis.

We implemented a data pipeline to streamline workflows and maintain consistency across all code. We adopted modular coding practices and type annotations to ensure smooth collaboration.

For our database needs we utilized a local database with postgres.

For machine learning, we used a V-A-R (Vector Autoregressive) model to predict emissions for three years ahead.

We utilized Plotly for data visualization to create interactive, engaging charts and integrated these components into a cohesive, customizable data app using Dash.

**Sini/ Slide 9:**

Here is a look at our data pipeline, showing how we process data from raw emission files to final visualization in the web application.

We start by extracting raw emission data, primarily from Excel files for this project. Next, we transform the data—changing its layout, cleaning unused datasets, and creating customized datasets from multiple sources.

After the data is transformed into the desired format, we load it into a database, ensuring easy extraction and visualization within the app, while also improving scalability.

Finally, the processed data is extracted and visualized in the web application.

**Sini/ Slide 10:**

Data for this project was collected through multiple sources.

Emission data for different cities and regions in Finland was collected from the Finnish Environment Institute (SYKE) website.

Similar emission data was available for Swedish cities and regions through Swedish National Emission Database (SMHI).

Both Finnish and Swedish emission data was available for years starting from 1990 and up until 2022. However, there were differences between the two sources on which years between 1990 and 2022 had this data was available. So, for the final solution we kept only the years where both Finnish and Swedish emissions data was available.

Finally, the tree CO2 fixation data was obtained from the German National Forest Inventory (NFI).

**Pål/ Slide 11:**  
Initially, it was crucial to harmonize the finnish and swedish data and identify similarities to determine what could be used. Although all data underwent transformations, not all of it was utilized in the final product.

The main transformation tasks involved:

* Translation
* Replacing special characters
* Dropping redundant rows and columns
* Checking for duplicate or non-values
* Melting data frames – in simple terms, reformats the df by reducing the columns and increasing rows
* Pivoting data frames – basically the opposite of melting the dataframe.
* Creating necessary new columns
* And Packaging the final output into a neatly formatted CSV file ready for db loading

**Pål/ Slide 12:**  
As mentioned, we decided to use a VAR (Vector Autoregression) model because it could be trained on several time series simultaneously. Because, even though we didn't have many entries in each individual time series - which led to inaccurate predictions when trying to predict using an ARIMA-model - we did have time series data for many different cities. By training the VAR model on multiple cities at a time we got a more accurate prediction, due to it being able to pick up on interdependencies between these series. Training the VAR-model on multiple cities allowed it to pick up on possible national trends, like swings after policy changes, variations in data recording or major events like covid.

-The VAR model provided reasonable accuracy, particularly given the limitations of the data. The Mean Absolute Percentage Error, or MAPE was 9.8%, meaning that, on average, the predictions were off by 9.8% from the actual values when testing the accuracy of the model. From what we’ve gathered, an MAPE-score of below 10% can generally be considered good, although we would like to explore the nuances behind the score more.

Slide 13: (Pål)

For our database tables we had emission data by emission source for both Finnish and Swedish cities and regions. These are in turn used for the predictions and for graphs in the dash app.

Slide 14: (Pål)

We also had data tables with tree information that together with the emission data could calculate the amount needed to offset emissions.

Slide 15: (Pål)

When our data pipeline was completed and all data clean and available we brought it together in our Dash application.

The thought behind the layout for the landing page was to present current data for country level emissions and their sources in an easily accessible way.

When typing in and narrowing into a city, the line chart shows the different years evenly spaced even though the data points don’t have an even frequency. This was a conscious design choice, as the earlier periods with infrequent data points (from 1990 until 2015) would take up a disproportionate amount of space in the graph if not.

We tried to design the typography, color palettes and graphs with the Web Content Accessibility Guidelines (WCAG 2.0) in mind.

**(Nazeli) Slide 16:**

We adhered to an agile methodology throughout the project, dividing the workload while working iteratively and maintaining regular communication to provide support, and focus our efforts where needed.

The initial phase involved everyone collecting regional emission data, tree carbon fixation data and supplementary data that might be needed for machine learning purposes. In later stages we also divided some of the following tasks among ourselves but in broad strokes we divided the workload the following way:

* Nazeli and Tiril focused on transforming and harmonizing the countries emission data.
* Tiril later moved on to create the database, tables, and functions to load all data into the database, completing the pipeline.
* While Nazeli expanded data on Finnish cities and prepared the presentation for the pitch.
* Pål tried to identify, gather and process data that would help in making an accurate model predicting future emissions - later creating and testing the models - as well as contributing to the development of the Dash app.
* Sini processed the tree data and designed the Dash layout and the visualizations that goes with it and prepared the final presentation.

**(Nazeli) Slide 17:**

The team did not have any major roadblocks during the two week project but we learned a lot.

We learned how to search for data that would be valuable for the project, as well as interpretating it and identifying the neccesitys and the many different ways to transform and harmonize the data.

In a longer project, more database design and data table structure would be good to include, to make sure we build a truly scalable and flexible database. We would implement a datalake for the huge amount of future data that would be implemented to the database.

Overall the team learned how to work in an agile manner and how the individual elements of the project come together to form the final product.

**(Nazeli) Slide 18:**

Currently the tree recommendations represent how many trees for individual species would be needed to offset the total emissions amount for selected city based on 2025 emission predictions.

We aim to enhance the recommendations section by including shrubbery and diverse plant species to promote varied and sustainable landscape architecture. We believe that with the right data we could expand the prediction period so that we have a more sustainable amount of plants, reducing the cityplanning costs.

Therefore, the tool could incorporate additional data on the costs of the recommended trees, plants, and shrubbery, their maintenance requirements, life expectancy, and their impact on soil improvement. These enhancements would provide city planners with a more comprehensive and practical resource for making informed decisions.

**(Nazeli) Slide 19:**

In the future, our goal is to expand the City Planner Tool so that all Scandinavian countries can benefit from it, setting an exemplary standard for sustainable urban planning.

The potential for a 2.0 version largely depends on the availability and accuracy of data. We believe that by collaborating with each country's environmental protection agencies, we can access the precise and comprehensive data necessary for this expansion. Such partnerships would not only improve the tool's accuracy but also foster a collaborative approach to environmental sustainability across Scandinavia.

We envision a future where the potential of plants goes beyond aesthetics, embracing both decorative greens and edible species. Picture cities, large and small, equipped with hydroponic farms integrated into their urban landscapes. These farms would not only reduce carbon emissions but also strengthen local food systems, enhance community well-being, and bolster the country's self-sufficiency.

A 3.0 version in the long run could expand to include all of Europe, creating a unified platform for sustainable urban planning across the continent.

**(Nazeli) Slide 20:**

By integrating these green solutions into city planning, we can reduce pollution, improve air quality, and create healthier living spaces for future generations.

The City Planner Tool is more than just an app; it’s a commitment to sustainable development. It empowers city planners with the knowledge and resources needed to make environmentally responsible decisions, ensuring that every new project contributes positively to our planet.

Let’s take the first step towards a greener future. Let’s make our cities not only smarter but also more sustainable with the City Planner Tool.

Growing Greener Cities, One Tree at a Time.

**(Nazeli) Slide 21:**

Thank You!