CLIMAGRID

Greenspan Solution

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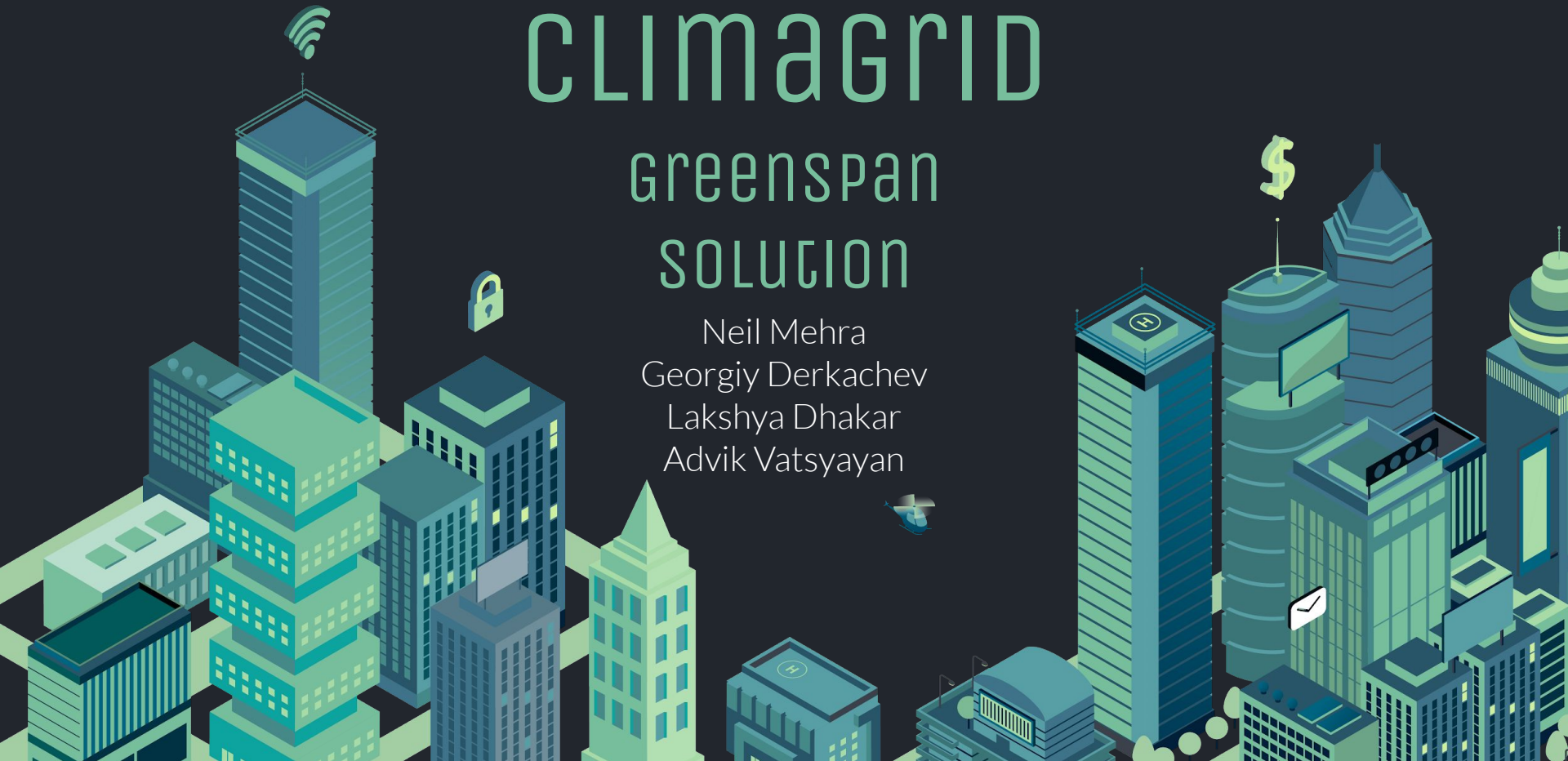


THE PROBLEM

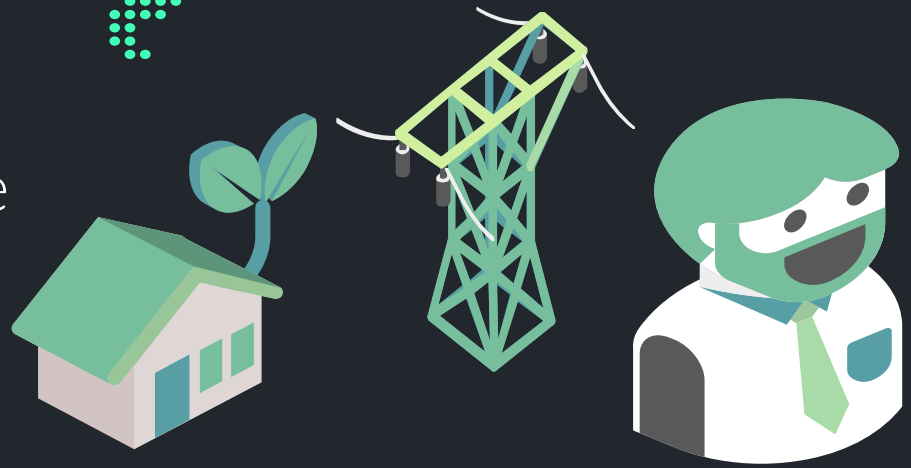
- Global warming is becoming an increasing concern in urban areas
- Scientific phenomenons like the urban heat island effect especially prevalent in cities
- Current city designs lead to inefficient management of resources

WHY DOES IT MATTER

- Cities are responsible for 70% of global emissions
- Reducing greenhouse gas emissions directly leads to cleaner air and better health for citizens
- Net-zero cities promote resource conservation by minimizing waste as well as maximizing water & energy

Target Audience

City planners, such as those working for GreenSpan along with actual city planners that can use this application to simulate their own cities, visualize the effects, and derive solutions from those projected results.

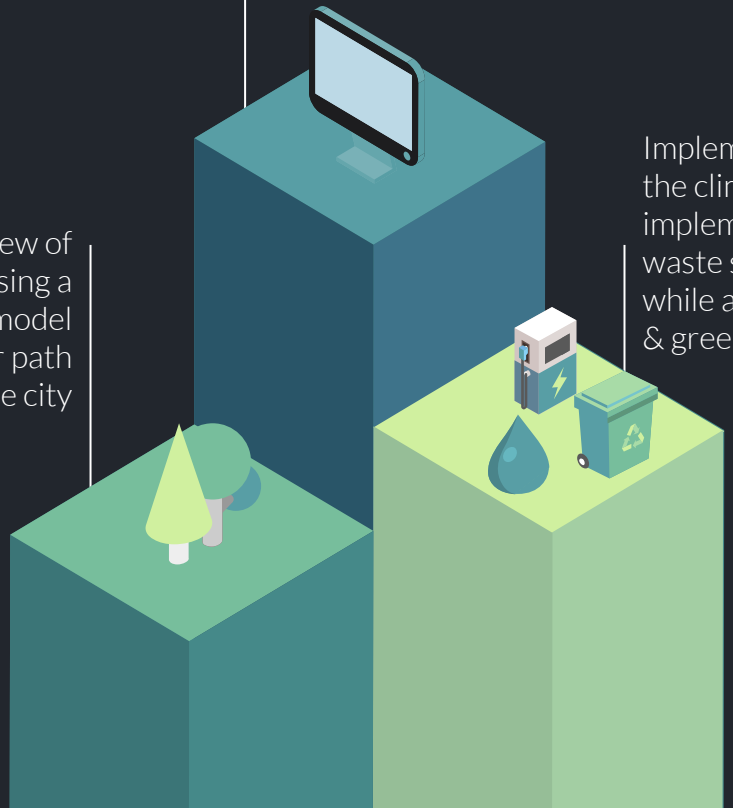


OBJECTIVES

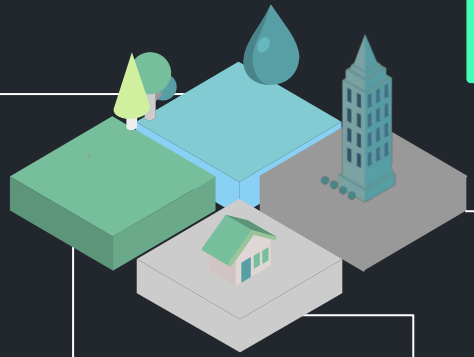
Create a net-zero city model using a cellular automata grid structure

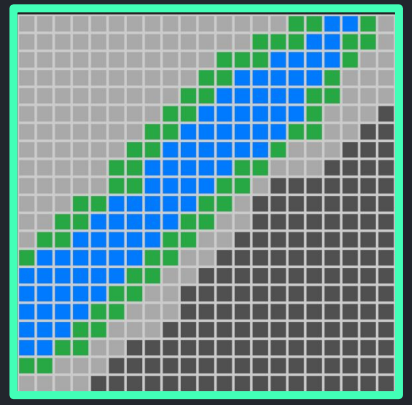
Implement a backend to read the climate model and implement heat, energy, and waste simulation models while accounting for density & green space

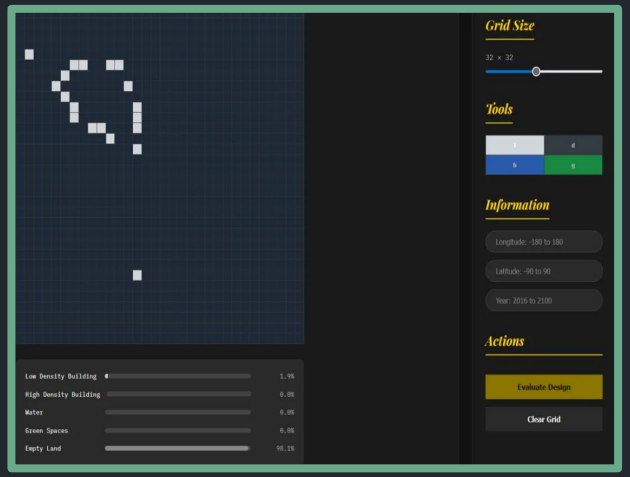
Generate a satellite view of the custom city using a custom diffusion model
Also generate a sewer path based on the city



City Grid







Water

Blue tiles on the grid represent water

Green Space

Green tiles on the grid represent green spaces

Low Density Housing

Light grey tiles on the grid represent low density housing

High Density Housing

Dark grey tiles on the grid represent high density housing

- Editable city with all four components
- The interface allows the user to make their own city with the grid.

API

We utilised an API that contained NASA Earth Exchange Daily Downscaled Projections.

The CMIP6 model we used projects ssp245, a moderate future that assumes small amounts of emissions reductions and general business as usual scenarios.

For this project, we used the ACCESS-CM2 Model.

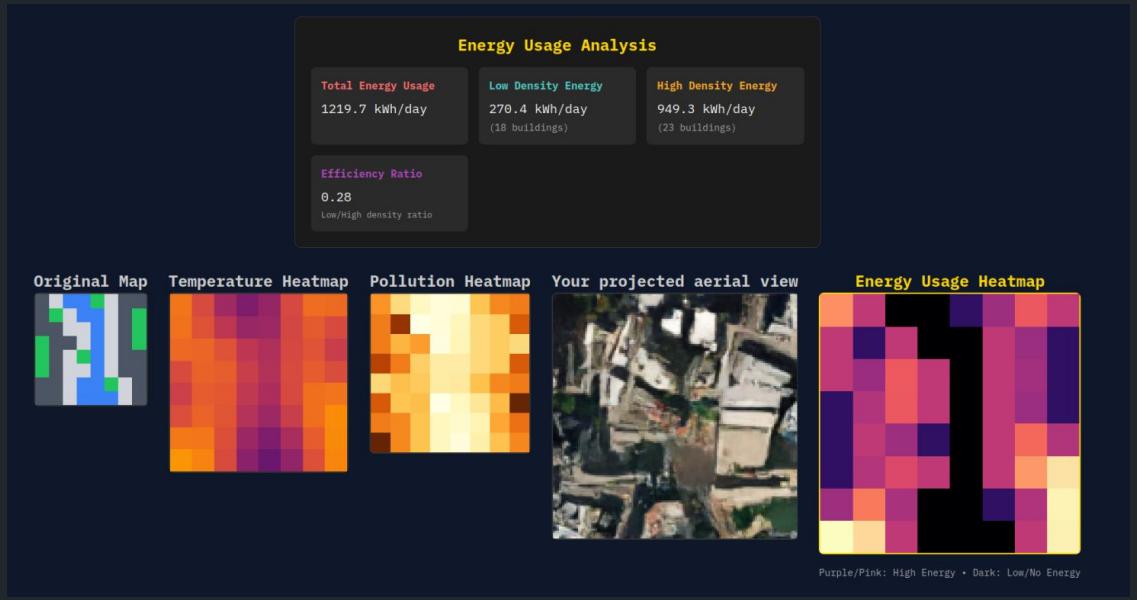
API

Grabbing temperature data!

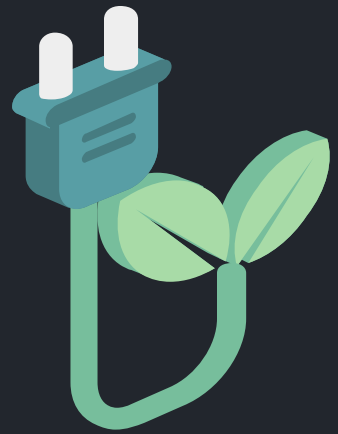
NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP-CMIP6) | NASA Center for Climate Simulation

THE HEATMAPS

- After designing the city, three heatmaps will appear for energy, waste, and temperature as well as a generated aerial view of the city.
- Selecting a heatmap will give an analysis showing the total usage, low density usage, high density usage, and the efficiency rate.



Energy



The electricity heatmap calculates and visualizes energy consumption across a grid-based city layout using a multi-step process. First, it assigns base energy values to different cell types: low-density buildings (60 kWh annually), high-density buildings (160 kWh annually), and zero consumption for green spaces, water bodies, and empty areas. The system then applies neighborhood effects within a 5x5 area around each cell.

Sources used for rules:

[20] Roth et al., Energy & Buildings, 2019 – "Urban morphology and electricity use in dense Asian CBDs" [21] Ng et al., Landscape and Urban Planning, 2020 – global park-cooling meta-analysis [22] Sun & Chen, Sustainable Cities and Society, 2021 – review of urban water-body cold-island intensity

Heat

The heat cellular automata step tries to visualize and simulate the urban heat island effect. It utilizes a diffusion model. In which each cell takes the sum of all surrounding direct cells and multiples it by a constant. These rules were taken from a research paper about urban island effect. There is also a decay value that symbolizes how heat naturally disperses into the environment.

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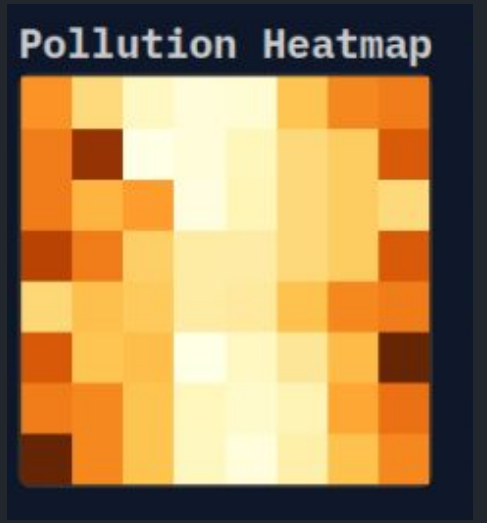
waste

- Waste, in the form of both organic and inorganic matter, rarely stays put.
- To simulate this, we created a cellular automaton with rules to “spread the waste”.
- We defined human generated waste as originating in human dwellings and spreading to other squares over time.

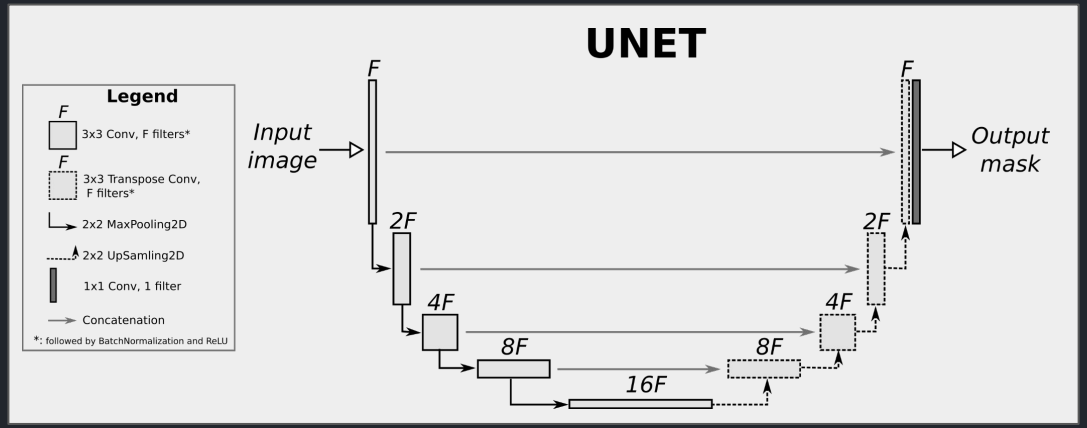


DIFFUSION

We developed a custom diffusion model for developing the satellite imaging. It takes the grid provided by user and provides it the model which generates a realistic looking image. The model is made based on the original unet design. There is a also a custom cosine scheduler which improves the training.

Before

After



conclusion

There are many factors that go into designing an effective net-zero city that is both suitable for nature and human life. ClimaGrid is a solution to GreenSpan's problem and it has real world applications as it can help us get closer to achieving the perfect net-zero city.