

# Project Green Mammal



## About

Project Green is a project making use of optimization to solve a specific problem: To minimize the cost of a selection of project meeting its constraint. Specifically, the City of Greenvale has been mandated by the national government to drastically reduce its pollution footprint, identifying ten (10) specific pollutants to reduce. To achieve these reductions, Greenvale has access to a menu of 30 mitigation options. However, the valid solution only comes with specific combinations of projects. To visualize the problem, including its inputs and outputs, this program is created.

## Libraries and Dependencies

Python, Flask, FlaskSession, NumPy

## How to Run

1. Extract the project folder
2. Open the project folder in a terminal

```
cd path\to\CMSC150_PROJECT
```

3. The folder already includes a virtual environment and the required libraries. Activate that virtual environment using

```
Windows (Command Prompt): venv\Scripts\activate
```

```
Windows (Powershell): venv\Scripts\Activate.ps1
```

```
Linux: source venv/bin/activate
```

You should now see a (venv) at the beginning of the line of your command prompt

4. Just to be sure (hehe), install the dependencies using (venv must be activated):

```
pip install -r requirements.txt
```

5. Now, run the application using:

```
python app.py
```

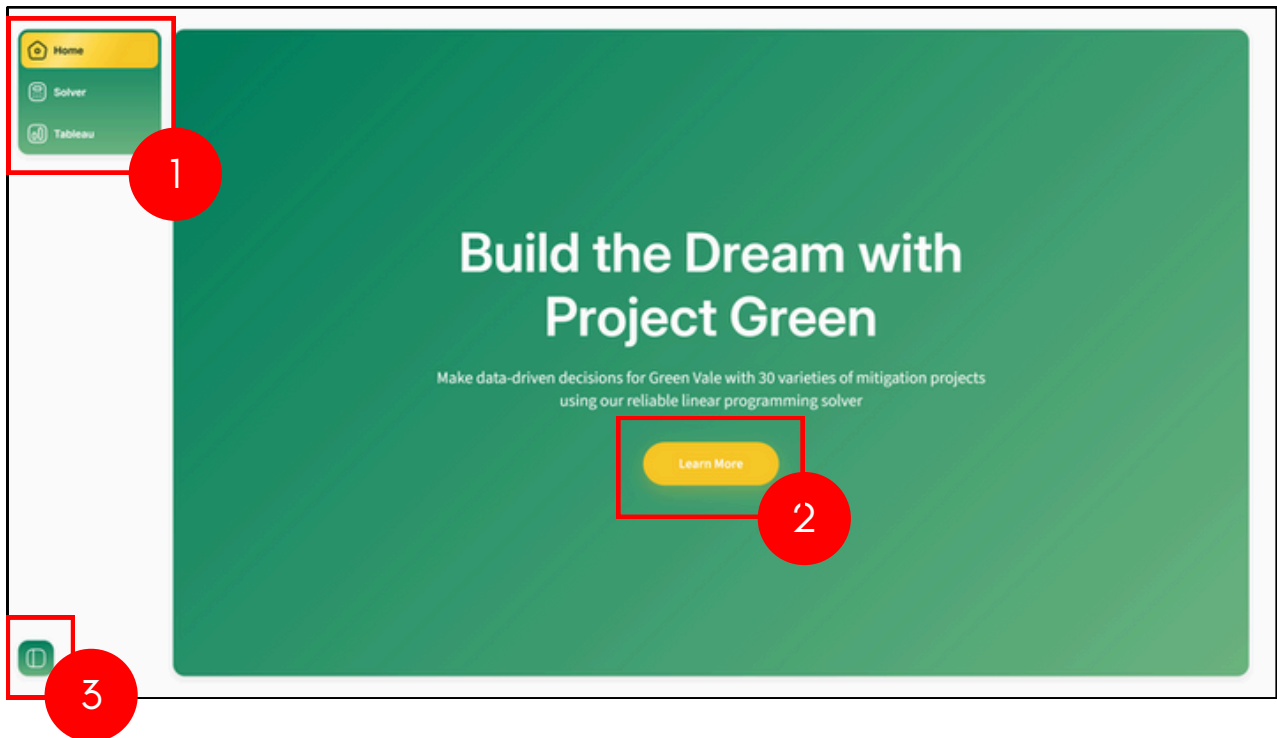
You should see the following in your command prompt

```
* Serving Flask app 'app'
* Debug mode: on
WARNING: This is a development server. Do not use it in a production deployment. Use a production WSGI server instead.
* Running on http://127.0.0.1:5000
Press CTRL+C to quit
* Restarting with stat
* Debugger is active!
* Debugger PIN: 504-183-845
```

6. Visit <http://127.0.0.1:5000>

# Navigation

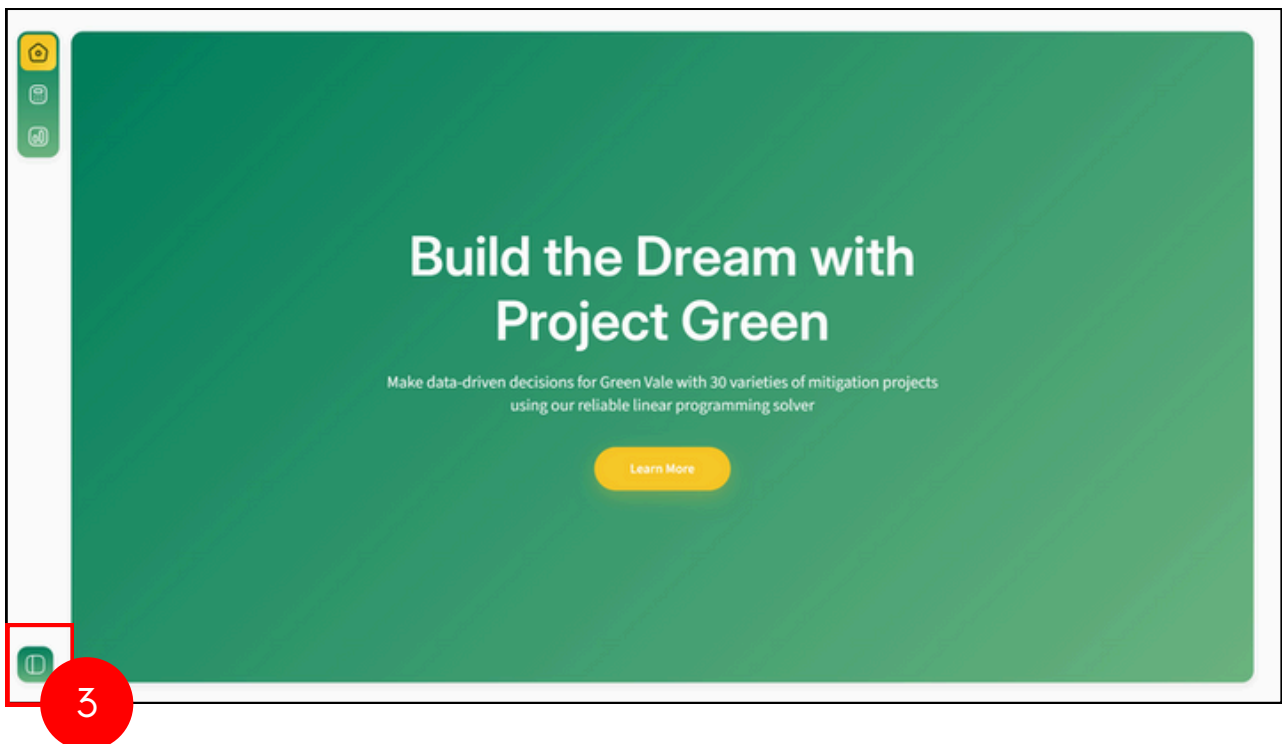
## 1. Home Page



1.1 Sidebar - Click each tab to navigate to it's respective page

1.2 Learn More - Click learn more to download the manual

1.3 Toggle Sidebar - Click toggle button to collapse or expand the sidebar



# Navigation

## 2. Solver Page

1

2

3

4

Project	CO <sub>2</sub>	NO	SO <sub>2</sub>	CH <sub>4</sub>	PM <sub>2.5</sub>	VOC	CO	NH <sub>3</sub>	BC	N <sub>2</sub> O	Cost
<input type="checkbox"/> Large Solar Park	60	0	0	0	0	0	0	0	0	0	4000
<input type="checkbox"/> Small Solar Installations	18	0	0	0	0	0	0	0	0	0	1200
<input type="checkbox"/> Wind Farm	55	0	0	0	0	0	0	0	0	0	3800
<input type="checkbox"/> Gas-to-renewables conversion	25	1	0.2	0.1	1.5	0.5	2	0.05	0.01	0.3	3200
<input type="checkbox"/> Boiler Retrofit	20	0.9	0.4	0.2	0.1	0.05	1.2	0.02	0.01	0.05	1400
<input type="checkbox"/> Catalytic Converters for Buses	30	2.8	0.6	0.8	0	0.5	5	0.01	0.05	0.02	2600
<input type="checkbox"/> Diesel Bus Replacement	48	3.2	0.9	1	0	0.7	6	0.02	0.08	0.03	5000
<input type="checkbox"/> Traffic Signal/Flow Upgrade	12	0.6	0.1	0.4	0.05	0.2	3	0.02	0.02	0.01	1000
<input type="checkbox"/> Low-Emission Stove Program	2	0.02	0.01	0.7	0	0.01	1.5	0.03	0.2	0	180
<input type="checkbox"/> Residential Insulation/Efficiency	15	0.1	0.05	0.05	0.02	0.02	0.5	0	0	0.01	900
<input type="checkbox"/> Industrial Scrubbers	6	0.4	6	0.4	0	0.1	0.6	0.01	0.01	0	4200
<input type="checkbox"/> Waste Methane Capture System	28	0.2	0.1	0.05	8	0.2	0.1	0	0	0.05	3600
<input type="checkbox"/> Landfill Gas-to-energy	24	0.15	0.05	0.03	6.5	0.1	0.05	0	0	0.03	3400
<input type="checkbox"/> Reforestation	3.5	0.04	0.02	0.01	0.8	0.03	0.1	0.01	0.005	0.005	220
<input type="checkbox"/> Urban Tree Canopy Program	4.2	0.06	0.01	0.03	0.6	0.02	0.15	0.005	0.02	0.002	300
<input type="checkbox"/> Industrial Energy Efficiency Retrofit	22	0.5	0.3	0.15	0.2	0.1	1	0.01	0.01	0.03	1600
<input type="checkbox"/> Natural Gas Leak Repair	10	0.05	0.01	0.01	4	0.02	0.02	0	0	0.01	1800
<input type="checkbox"/> Agricultural Methane Reduction	8	0.02	0.01	0.02	7.2	0.05	0.02	0.1	0	0.05	2800
<input type="checkbox"/> Clean Cookstove & Fuel Switching	1.7	0.04	0.02	0.4	0.1	0.02	2	0.06	0.34	0	450

5

6

5

6

Projects

Search projects

Solve

Project	CO <sub>2</sub>	NO	SO <sub>2</sub>	CH <sub>4</sub>	PM <sub>2.5</sub>	VOC	CO	NH <sub>3</sub>	BC	N <sub>2</sub> O	Cost
<input checked="" type="checkbox"/> Large Solar Park	60	0	0	0	0	0	0	0	0	0	4000
<input checked="" type="checkbox"/> Small Solar Installations	18	0	0	0	0	0	0	0	0	0	1200
<input checked="" type="checkbox"/> Wind Farm	55	0	0	0	0	0	0	0	0	0	3800
<input checked="" type="checkbox"/> Gas-to-renewables conversion	25	1	0.2	0.1	1.5	0.5	2	0.05	0.01	0.3	3200
<input checked="" type="checkbox"/> Boiler Retrofit	20	0.9	0.4	0.2	0.1	0.05	1.2	0.02	0.01	0.05	1400
<input checked="" type="checkbox"/> Catalytic Converters for Buses	30	2.8	0.6	0.8	0	0.5	5	0.01	0.05	0.02	2600
<input checked="" type="checkbox"/> Diesel Bus Replacement	48	3.2	0.9	1	0	0.7	6	0.02	0.08	0.03	5000
<input checked="" type="checkbox"/> Traffic Signal/Flow Upgrade	12	0.6	0.1	0.4	0.05	0.2	3	0.02	0.02	0.01	1000
<input checked="" type="checkbox"/> Low-Emission Stove Program	2	0.02	0.01	0.7	0	0.01	1.5	0.03	0.2	0	180
<input checked="" type="checkbox"/> Residential Insulation/Efficiency	15	0.1	0.05	0.05	0.02	0.02	0.5	0	0	0.01	900
<input checked="" type="checkbox"/> Industrial Scrubbers	6	0.4	6	0.4	0	0.1	0.6	0.01	0.01	0	4200
<input checked="" type="checkbox"/> Waste Methane Capture System	28	0.2	0.1	0.05	8	0.2	0.1	0	0	0.05	3600
<input checked="" type="checkbox"/> Landfill Gas-to-energy	24	0.15	0.05	0.03	6.5	0.1	0.05	0	0	0.03	3400
<input checked="" type="checkbox"/> Reforestation	3.5	0.04	0.02	0.01	0.8	0.03	0.1	0.01	0.005	0.005	220
<input checked="" type="checkbox"/> Urban Tree Canopy Program	4.2	0.06	0.01	0.03	0.6	0.02	0.15	0.005	0.02	0.002	300
<input checked="" type="checkbox"/> Industrial Energy Efficiency Retrofit	22	0.5	0.3	0.15	0.2	0.1	1	0.01	0.01	0.03	1600
<input checked="" type="checkbox"/> Natural Gas Leak Repair	10	0.05	0.01	0.01	4	0.02	0.02	0	0	0.01	1800
<input checked="" type="checkbox"/> Agricultural Methane Reduction	8	0.02	0.01	0.02	7.2	0.05	0.02	0.1	0	0.05	2800
<input checked="" type="checkbox"/> Clean Cookstove & Fuel Switching	1.7	0.04	0.02	0.4	0.1	0.02	2	0.06	0.34	0	450

Optimized Cost

\$ 233,966.99

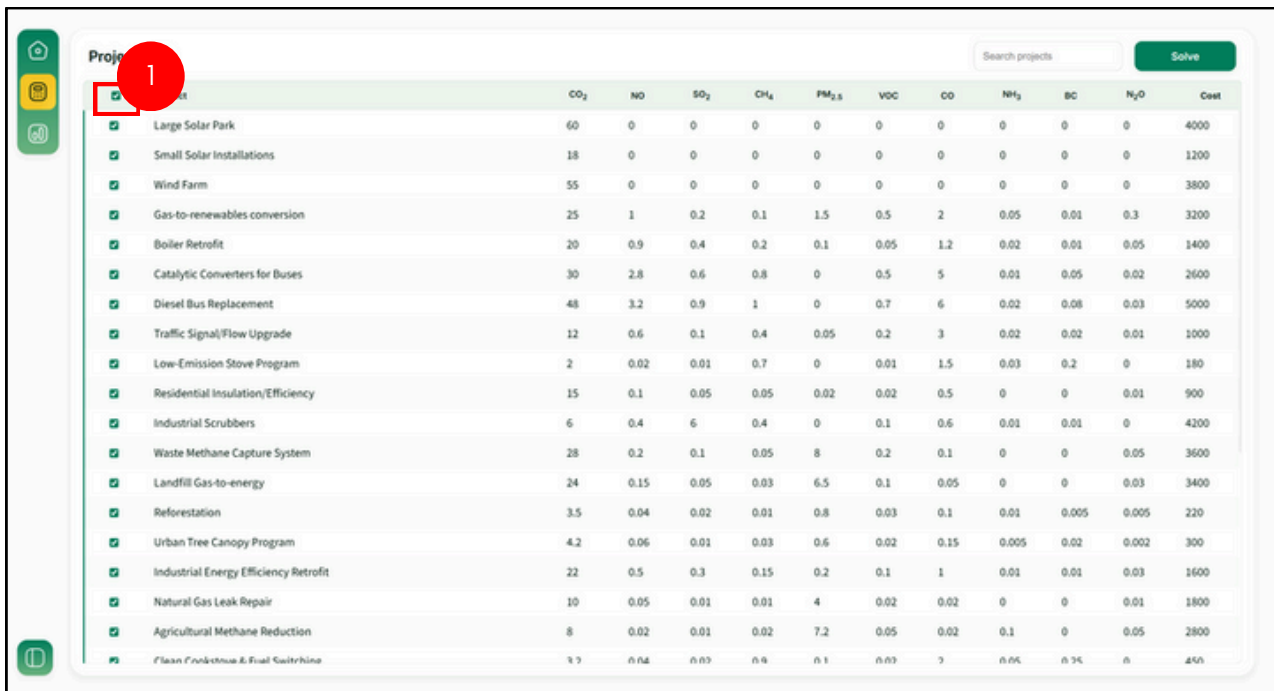
Cost

Pollutants

Mitigation Project	Units	Cost
Traffic Signal/Flow Upgrade	6.99	6,993.23
Low-Emission Stove Program	20.0	3,600.00
Industrial Scrubbers	2.25	9,431.45
Reforestation	20.0	4,400.00
Agricultural Methane Reduction	18.38	51,455.03
Clean Cookstove & Fuel Switching	20.0	9,000.00
Biochar for soils	20.0	28,000.00
Industrial VOC	5.15	13,383.18
Wetlands restoration	20.0	36,000.00
Household LPG conversion program	20.0	14,000.00
Industrial process change	4.34	21,704.09

# Navigation

2.1 Master Checkbox - Click the master checkbox to select/deselect all checkboxes. Clicking a selected master checkbox will deselect all checkboxes, while clicking a deselected master checkbox will select all checkboxes

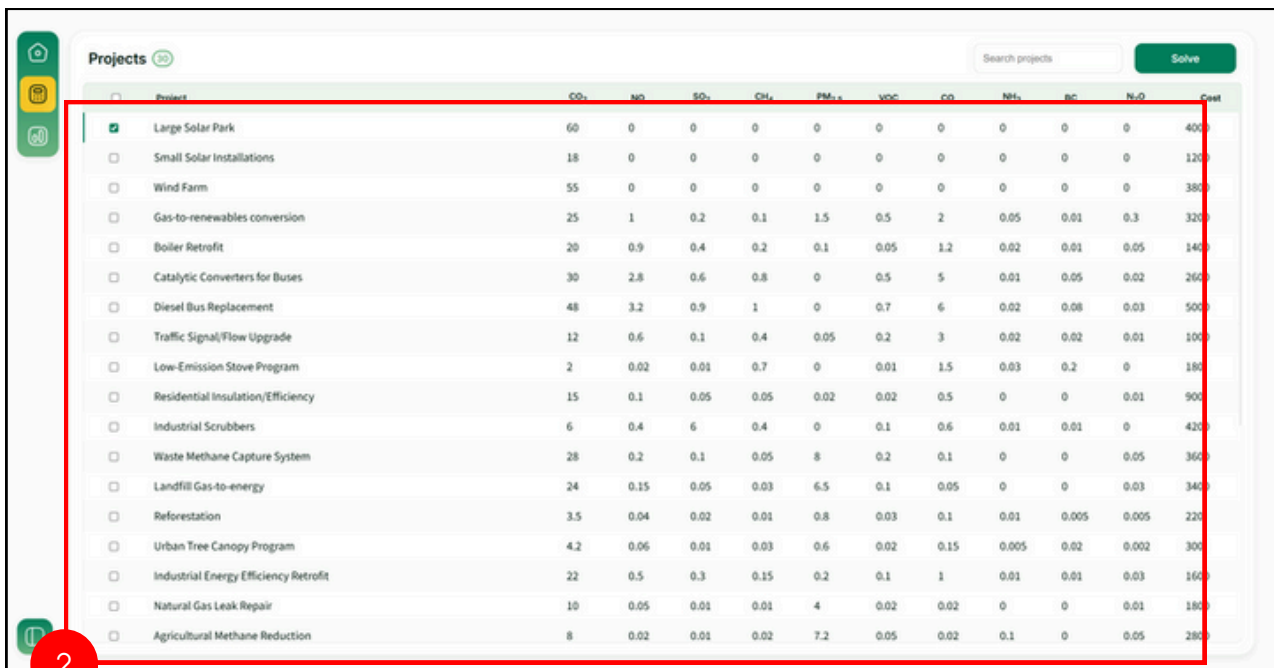


The screenshot shows a web application interface with a sidebar on the left containing three icons: a home icon, a list icon, and a magnifying glass icon. The main content area is titled 'Projects' and features a search bar and a 'Solve' button. Below the header is a table with 13 columns: Project, CO<sub>2</sub>, NO, SO<sub>2</sub>, CH<sub>4</sub>, PM<sub>2.5</sub>, VOC, CO, NH<sub>3</sub>, BC, N<sub>2</sub>O, and Cost. The table lists 20 projects, each with a checkbox in the 'Project' column. A red circle with the number '1' highlights the first checkbox, which is the master checkbox for the entire table.

Project	CO <sub>2</sub>	NO	SO <sub>2</sub>	CH <sub>4</sub>	PM <sub>2.5</sub>	VOC	CO	NH <sub>3</sub>	BC	N <sub>2</sub> O	Cost
<input checked="" type="checkbox"/> Large Solar Park	60	0	0	0	0	0	0	0	0	0	4000
<input checked="" type="checkbox"/> Small Solar Installations	18	0	0	0	0	0	0	0	0	0	1200
<input checked="" type="checkbox"/> Wind Farm	55	0	0	0	0	0	0	0	0	0	3800
<input checked="" type="checkbox"/> Gas-to-renewables conversion	25	1	0.2	0.1	1.5	0.5	2	0.05	0.01	0.3	3200
<input checked="" type="checkbox"/> Boiler Retrofit	20	0.9	0.4	0.2	0.1	0.05	1.2	0.02	0.01	0.05	1400
<input checked="" type="checkbox"/> Catalytic Converters for Buses	30	2.8	0.6	0.8	0	0.5	5	0.01	0.05	0.02	2600
<input checked="" type="checkbox"/> Diesel Bus Replacement	48	3.2	0.9	1	0	0.7	6	0.02	0.08	0.03	5000
<input checked="" type="checkbox"/> Traffic Signal/Flow Upgrade	12	0.6	0.1	0.4	0.05	0.2	3	0.02	0.02	0.01	1000
<input checked="" type="checkbox"/> Low-Emission Stove Program	2	0.02	0.01	0.7	0	0.01	1.5	0.03	0.2	0	180
<input checked="" type="checkbox"/> Residential Insulation/Efficiency	15	0.1	0.05	0.05	0.02	0.02	0.5	0	0	0.01	900
<input checked="" type="checkbox"/> Industrial Scrubbers	6	0.4	6	0.4	0	0.1	0.6	0.01	0.01	0	4200
<input checked="" type="checkbox"/> Waste Methane Capture System	28	0.2	0.1	0.05	8	0.2	0.1	0	0	0.05	3600
<input checked="" type="checkbox"/> Landfill Gas-to-energy	24	0.15	0.05	0.03	6.5	0.1	0.05	0	0	0.03	3400
<input checked="" type="checkbox"/> Reforestation	3.5	0.04	0.02	0.01	0.8	0.03	0.1	0.01	0.005	0.005	220
<input checked="" type="checkbox"/> Urban Tree Canopy Program	4.2	0.06	0.01	0.03	0.6	0.02	0.15	0.005	0.02	0.002	300
<input checked="" type="checkbox"/> Industrial Energy Efficiency Retrofit	22	0.5	0.3	0.15	0.2	0.1	1	0.01	0.01	0.03	1600
<input checked="" type="checkbox"/> Natural Gas Leak Repair	10	0.05	0.01	0.01	4	0.02	0.02	0	0	0.01	1800
<input checked="" type="checkbox"/> Agricultural Methane Reduction	8	0.02	0.01	0.02	7.2	0.05	0.02	0.1	0	0.05	2800
<input checked="" type="checkbox"/> Flare Combustion & Fuel Switching	1.7	0.04	0.03	0.6	0.1	0.03	0	0.05	0.34	0	400

2.2.1 Projects - Scroll down to view more projects

2.2.2 Checkbox - Click the checkbox to select the projects and add to the project selections



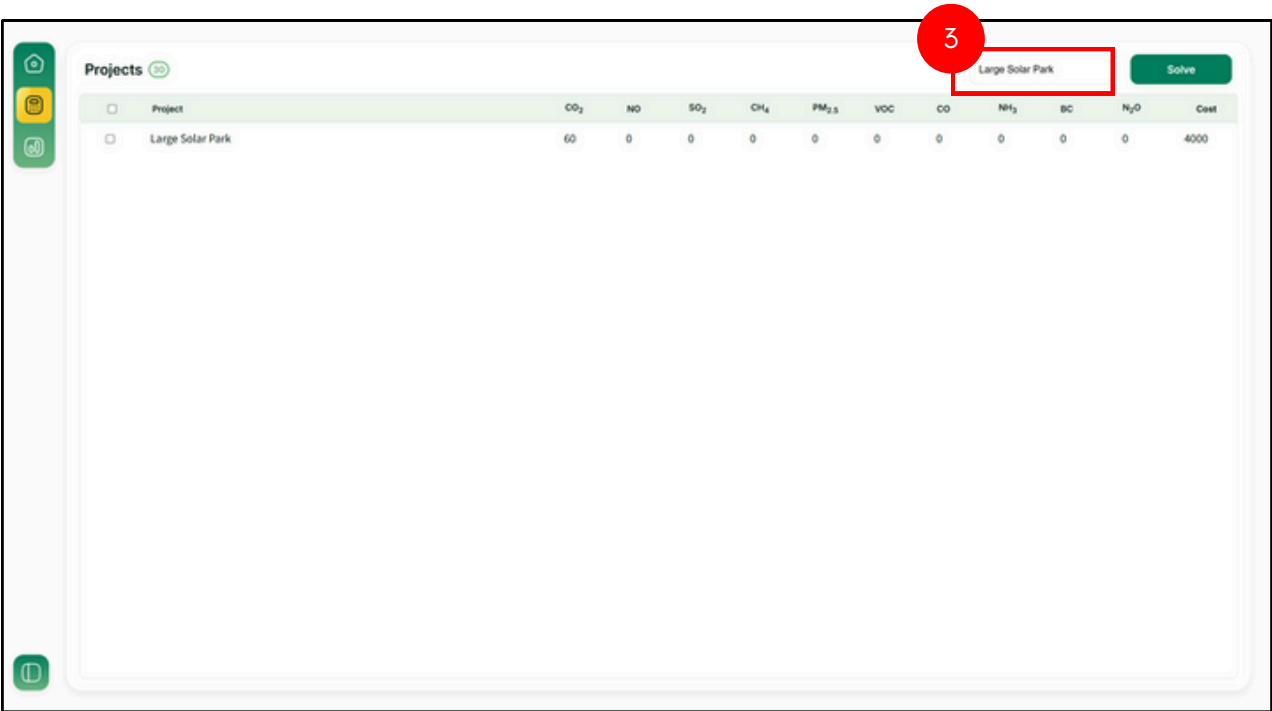
The screenshot shows the same 'Projects' table as above, but with a red box highlighting the checkboxes in the 'Project' column. A red circle with the number '2' is placed below the table, indicating the action to click the checkboxes.

Project	CO <sub>2</sub>	NO	SO <sub>2</sub>	CH <sub>4</sub>	PM <sub>2.5</sub>	VOC	CO	NH <sub>3</sub>	BC	N <sub>2</sub> O	Cost
<input checked="" type="checkbox"/> Large Solar Park	60	0	0	0	0	0	0	0	0	0	4000
<input type="checkbox"/> Small Solar Installations	18	0	0	0	0	0	0	0	0	0	1200
<input type="checkbox"/> Wind Farm	55	0	0	0	0	0	0	0	0	0	3800
<input type="checkbox"/> Gas-to-renewables conversion	25	1	0.2	0.1	1.5	0.5	2	0.05	0.01	0.3	3200
<input type="checkbox"/> Boiler Retrofit	20	0.9	0.4	0.2	0.1	0.05	1.2	0.02	0.01	0.05	1400
<input type="checkbox"/> Catalytic Converters for Buses	30	2.8	0.6	0.8	0	0.5	5	0.01	0.05	0.02	2600
<input type="checkbox"/> Diesel Bus Replacement	48	3.2	0.9	1	0	0.7	6	0.02	0.08	0.03	5000
<input type="checkbox"/> Traffic Signal/Flow Upgrade	12	0.6	0.1	0.4	0.05	0.2	3	0.02	0.02	0.01	1000
<input type="checkbox"/> Low-Emission Stove Program	2	0.02	0.01	0.7	0	0.01	1.5	0.03	0.2	0	180
<input type="checkbox"/> Residential Insulation/Efficiency	15	0.1	0.05	0.05	0.02	0.02	0.5	0	0	0.01	900
<input type="checkbox"/> Industrial Scrubbers	6	0.4	6	0.4	0	0.1	0.6	0.01	0.01	0	4200
<input type="checkbox"/> Waste Methane Capture System	28	0.2	0.1	0.05	8	0.2	0.1	0	0	0.05	3600
<input type="checkbox"/> Landfill Gas-to-energy	24	0.15	0.05	0.03	6.5	0.1	0.05	0	0	0.03	3400
<input type="checkbox"/> Reforestation	3.5	0.04	0.02	0.01	0.8	0.03	0.1	0.01	0.005	0.005	220
<input type="checkbox"/> Urban Tree Canopy Program	4.2	0.06	0.01	0.03	0.6	0.02	0.15	0.005	0.02	0.002	300
<input type="checkbox"/> Industrial Energy Efficiency Retrofit	22	0.5	0.3	0.15	0.2	0.1	1	0.01	0.01	0.03	1600
<input type="checkbox"/> Natural Gas Leak Repair	10	0.05	0.01	0.01	4	0.02	0.02	0	0	0.01	1800
<input type="checkbox"/> Agricultural Methane Reduction	8	0.02	0.01	0.02	7.2	0.05	0.02	0.1	0	0.05	2800

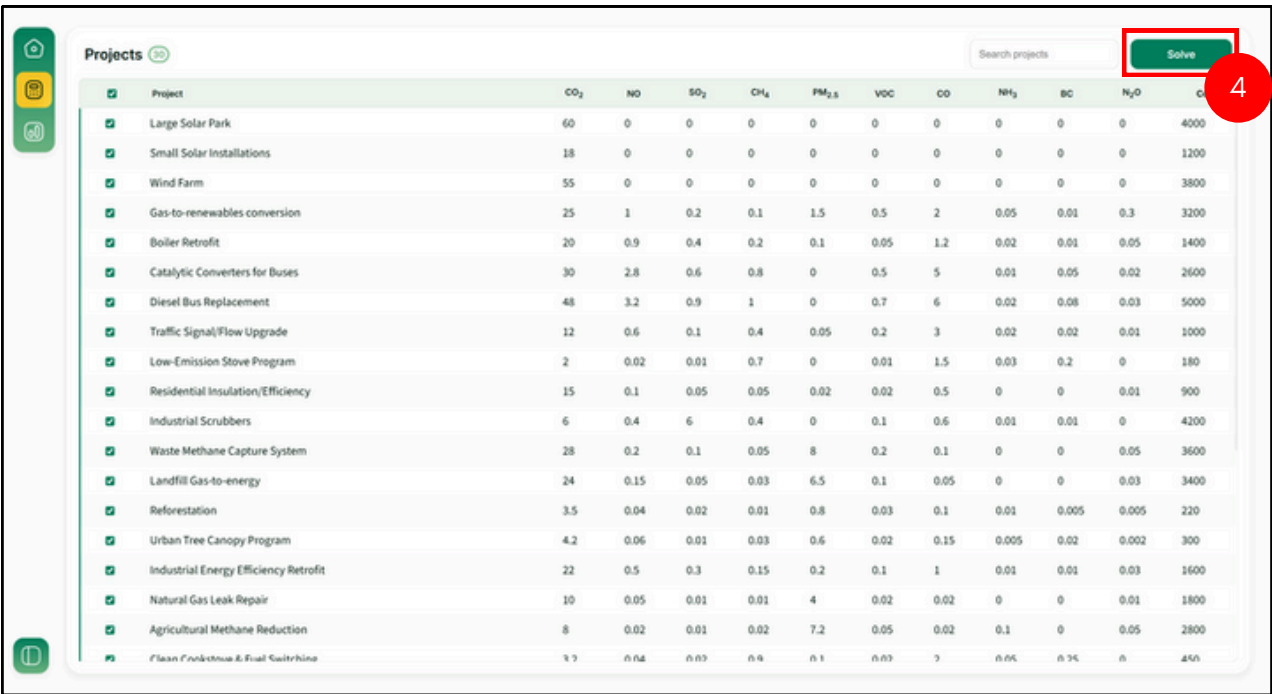


# Navigation

2.3 Search - Click the search bar and type an input to search for specific projects



2.4 Solve - Click the solve button to start optimizing based on the selection



## Navigation

2.4 A card and table will appear upon a successful optimization. The card will indicate the optimized cost and the table will display the cost per all units and pollutants breakdown.

Home

Projects

Help

Projects 20

Search projects

Solve

<input checked="" type="checkbox"/>	Project	CO <sub>2</sub>	NO	SO <sub>2</sub>	CH <sub>4</sub>	PM <sub>2.5</sub>	VOC	CO	NH <sub>3</sub>	BC	N <sub>2</sub> O	Cost
<input checked="" type="checkbox"/>	Large Solar Park	60	0	0	0	0	0	0	0	0	0	4000
<input checked="" type="checkbox"/>	Small Solar Installations	18	0	0	0	0	0	0	0	0	0	1200
<input checked="" type="checkbox"/>	Wind Farm	55	0	0	0	0	0	0	0	0	0	3800
<input checked="" type="checkbox"/>	Gas-to-renewables conversion	25	1	0.2	0.1	1.5	0.5	2	0.05	0.01	0.3	3200
<input checked="" type="checkbox"/>	Boiler Retrofit	20	0.9	0.4	0.2	0.1	0.05	1.2	0.02	0.01	0.05	1400
<input checked="" type="checkbox"/>	Catalytic Converters for Buses	30	2.8	0.6	0.8	0	0.5	5	0.01	0.05	0.02	2600
<input checked="" type="checkbox"/>	Diesel Bus Replacement	48	3.2	0.9	1	0	0.7	6	0.02	0.08	0.03	5000
<input checked="" type="checkbox"/>	Traffic Signal/Flow Upgrade	12	0.6	0.1	0.4	0.05	0.2	3	0.02	0.02	0.01	1000
<input checked="" type="checkbox"/>	Low-Emission Stove Program	2	0.02	0.01	0.7	0	0.01	1.5	0.03	0.2	0	180
<input checked="" type="checkbox"/>	Residential Insulation/Efficiency	15	0.1	0.05	0.05	0.02	0.02	0.5	0	0	0.01	900
<input checked="" type="checkbox"/>	Industrial Scrubbers	6	0.4	6	0.4	0	0.1	0.6	0.01	0.01	0	4200
<input checked="" type="checkbox"/>	Waste Methane Capture System	28	0.2	0.1	0.05	8	0.2	0.1	0	0	0.05	3600
<input checked="" type="checkbox"/>	Landfill Gas-to-energy	24	0.15	0.05	0.03	6.5	0.1	0.05	0	0	0.03	3400
<input checked="" type="checkbox"/>	Reforestation	3.5	0.04	0.02	0.01	0.8	0.03	0.1	0.01	0.005	0.005	220
<input checked="" type="checkbox"/>	Urban Tree Canopy Program	4.2	0.06	0.01	0.03	0.6	0.02	0.15	0.005	0.02	0.002	300
<input checked="" type="checkbox"/>	Industrial Energy Efficiency Retrofit	22	0.5	0.3	0.15	0.2	0.1	1	0.01	0.01	0.03	1600
<input checked="" type="checkbox"/>	Natural Gas Leak Repair	10	0.05	0.01	0.01	4	0.02	0.02	0	0	0.01	1800
<input checked="" type="checkbox"/>	Agricultural Methane Reduction	8	0.02	0.01	0.02	7.2	0.05	0.02	0.1	0	0.05	2800
<input checked="" type="checkbox"/>	Clean Cookstove & Fuel Switching	1.7	0.04	0.03	0.9	0.1	0.03	0.06	0.34	0	0.45	450

Optimized Cost

\$ 233,966.99

Cost

Pollutants

Mitigation Project	Units	Cost
Traffic Signal/Flow Upgrade	6.99	6,993.23
Low-Emission Stove Program	20.0	3,600.00
Industrial Scrubbers	2.25	9,431.45
Reforestation	20.0	4,400.00
Agricultural Methane Reduction	18.38	51,455.03
Clean Cookstove & Fuel Switching	20.0	9,000.00
Biochar for soils	20.0	28,000.00
Industrial VOC	5.15	13,383.18
Wetlands restoration	20.0	36,000.00
Household LPG conversion program	20.0	14,000.00
Industrial process change	4.34	21,704.09

2.4 Upon an infeasible selection, a card indicating *Infeasible* will be displayed along with a message.

Home

Projects

Help

Projects 20

Search projects

Solve

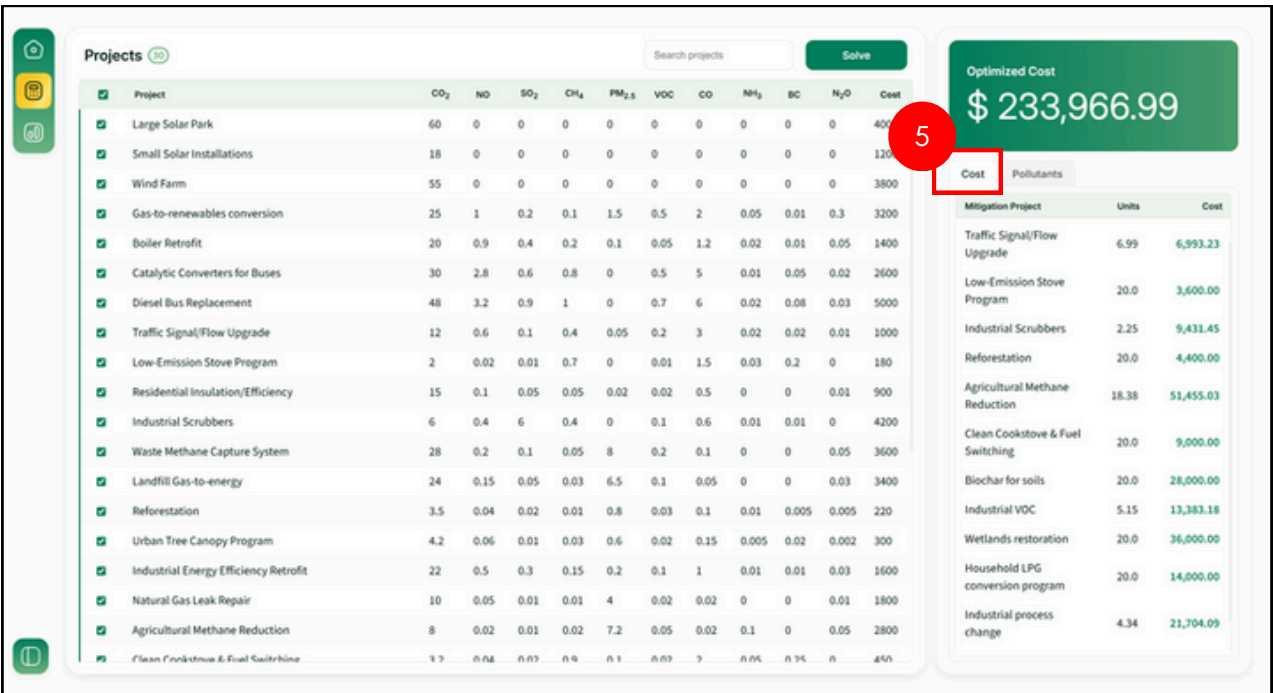
<input type="checkbox"/>	Project	CO <sub>2</sub>	NO	SO <sub>2</sub>	CH <sub>4</sub>	PM <sub>2.5</sub>	VOC	CO	NH <sub>3</sub>	BC	N <sub>2</sub> O	Cost
<input checked="" type="checkbox"/>	Large Solar Park	60	0	0	0	0	0	0	0	0	0	4000
<input type="checkbox"/>	Small Solar Installations	18	0	0	0	0	0	0	0	0	0	1200
<input type="checkbox"/>	Wind Farm	55	0	0	0	0	0	0	0	0	0	3800
<input type="checkbox"/>	Gas-to-renewables conversion	25	1	0.2	0.1	1.5	0.5	2	0.05	0.01	0.3	3200
<input type="checkbox"/>	Boiler Retrofit	20	0.9	0.4	0.2	0.1	0.05	1.2	0.02	0.01	0.05	1400
<input type="checkbox"/>	Catalytic Converters for Buses	30	2.8	0.6	0.8	0	0.5	5	0.01	0.05	0.02	2600
<input type="checkbox"/>	Diesel Bus Replacement	48	3.2	0.9	1	0	0.7	6	0.02	0.08	0.03	5000
<input type="checkbox"/>	Traffic Signal/Flow Upgrade	12	0.6	0.1	0.4	0.05	0.2	3	0.02	0.02	0.01	1000
<input type="checkbox"/>	Low-Emission Stove Program	2	0.02	0.01	0.7	0	0.01	1.5	0.03	0.2	0	180
<input type="checkbox"/>	Residential Insulation/Efficiency	15	0.1	0.05	0.05	0.02	0.02	0.5	0	0	0.01	900
<input type="checkbox"/>	Industrial Scrubbers	6	0.4	6	0.4	0	0.1	0.6	0.01	0.01	0	4200
<input type="checkbox"/>	Waste Methane Capture System	28	0.2	0.1	0.05	8	0.2	0.1	0	0	0.05	3600
<input type="checkbox"/>	Landfill Gas-to-energy	24	0.15	0.05	0.03	6.5	0.1	0.05	0	0	0.03	3400
<input type="checkbox"/>	Reforestation	3.5	0.04	0.02	0.01	0.8	0.03	0.1	0.01	0.005	0.005	220
<input type="checkbox"/>	Urban Tree Canopy Program	4.2	0.06	0.01	0.03	0.6	0.02	0.15	0.005	0.02	0.002	300
<input type="checkbox"/>	Industrial Energy Efficiency Retrofit	22	0.5	0.3	0.15	0.2	0.1	1	0.01	0.01	0.03	1600
<input type="checkbox"/>	Natural Gas Leak Repair	10	0.05	0.01	0.01	4	0.02	0.02	0	0	0.01	1800
<input type="checkbox"/>	Agricultural Methane Reduction	8	0.02	0.01	0.02	7.2	0.05	0.02	0.1	0	0.05	2800
<input type="checkbox"/>	Clean Cookstove & Fuel Switching	1.7	0.04	0.03	0.9	0.1	0.03	0.06	0.34	0	0.45	450

Infeasible

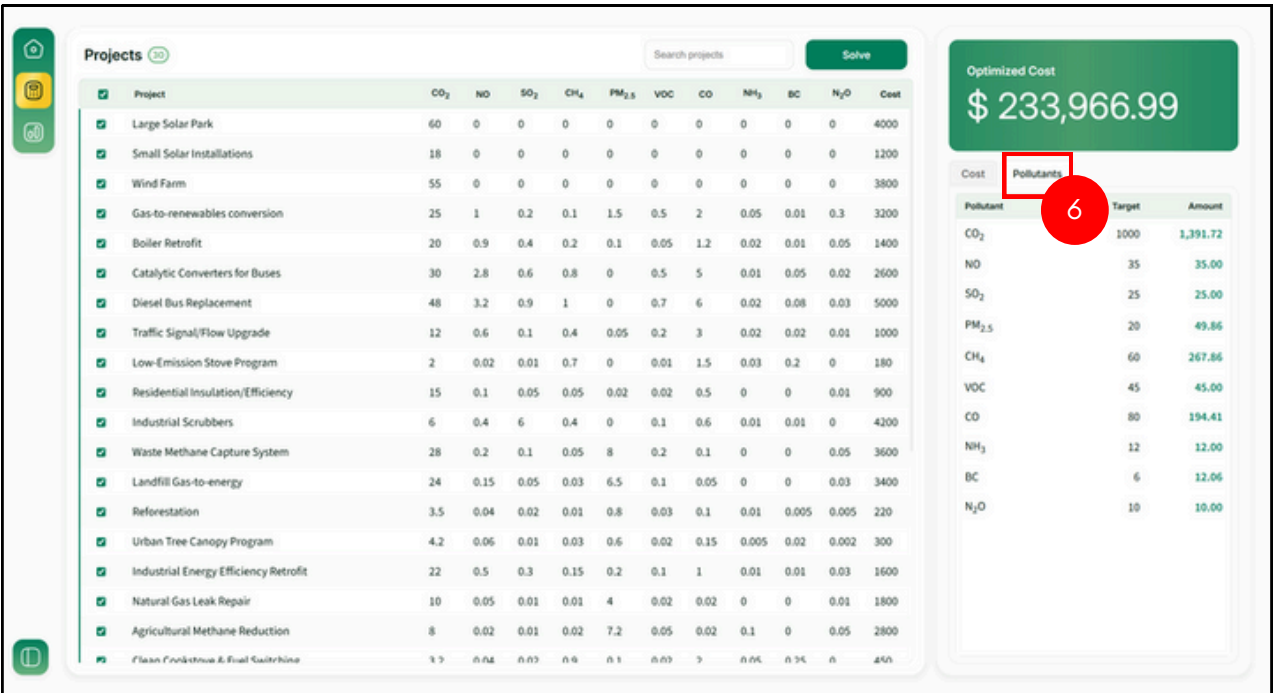
These project selections aren't compatible.  
Please pick another selection.

# Navigation

2.5 Cost Breakdown - Clicking the cost tab will display a table indicating the total units to be implemented and the total cost of the specific project



2.6 Pollutants Breakdown - Clicking the pollutants tab will display a table indicating the target pollutants and the amount of pollutants produced by the optimized solution

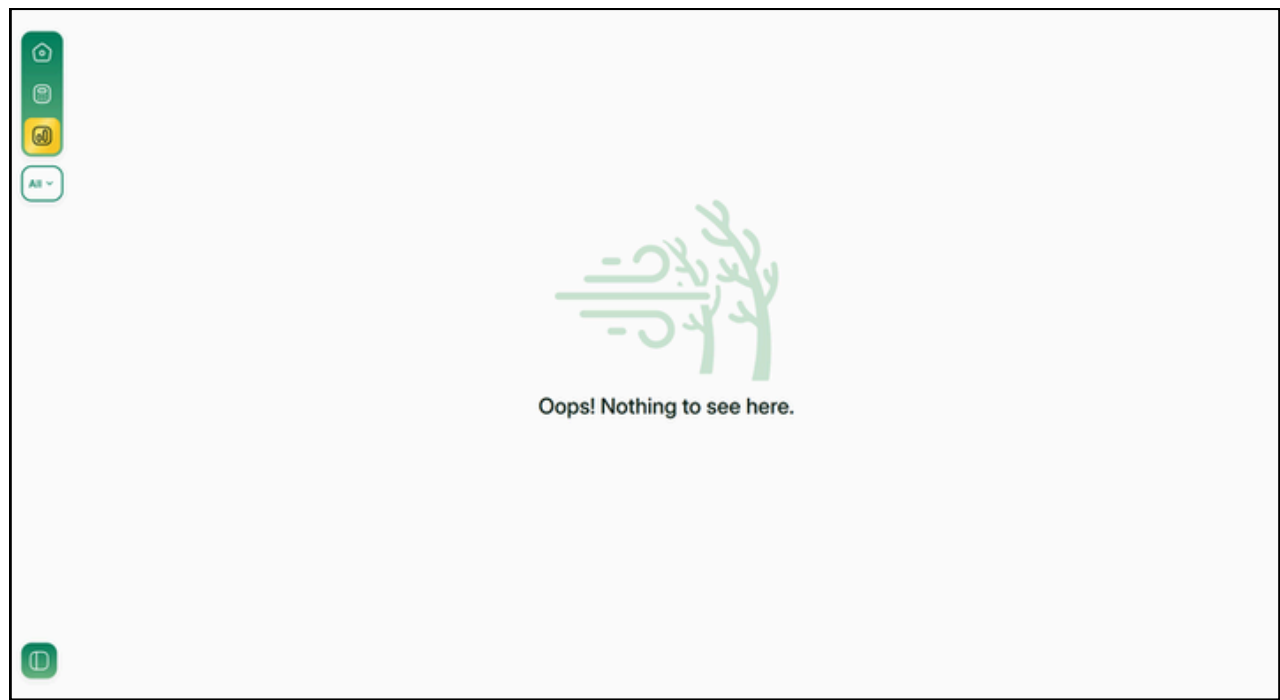




# Navigation

## 3. Tableau Page

3.0 Blank Page - Upon visiting with an empty tableau iterations, a blank page is displayed



## Navigation

3.1. Iteration Display – Users will be able to view a specific iteration of the solution, displaying the iteration number, the tableau, and its basic solution. Labels at the top of each tables include the slack variables, the unknown project variables, the (Z) solution variable, and the solution value.

3.2. Iteration Selection Dropdown – Whether infeasible or not, users will be able to see each iteration of the solution (stops at the final tableau for infeasible solution). Users can choose to view all iterations, or a specific iteration depending on their preference.

## Navigation

3.2. Iteration 0 displays the initial tableau of the system of linear equations of the problem. The final iteration displays either the solution of the problem or the final tableau before concluding the problem's infeasibility.

3.3. Download - Click the Download button to download the table content as a .csv file

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