Final Project Write-Up

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I. DESCRIPTION OF APP FEATURES

The purpose of this application is to serve as a marketing tool for CSS Properties Management, a landscaping company that is currently working on developing and building biodigesters in Massachusetts and other areas. This application is meant to be something that can be presented to a municipality in order to highlight the benefits of using biodigesters, and the potential impact a biodigester can have on the community.

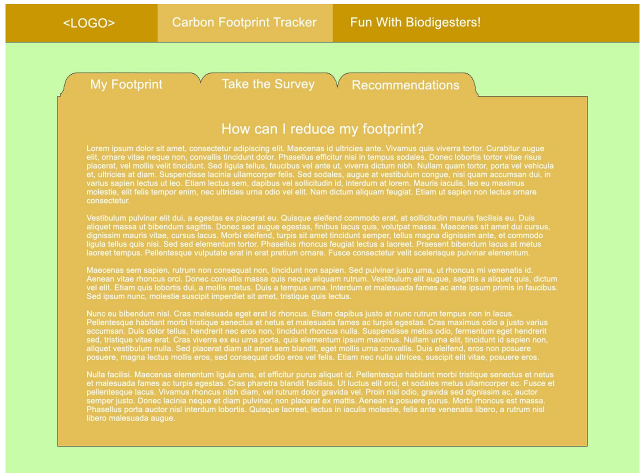
The application is divided into two sections. The first section is meant to be more of a consumer application, and is a tool where individuals can calculate and monitor their carbon footprint. This does not necessarily market biodigesters, but is meant to excite people about green initiatives. This entire interface is condense into a single, interactive page. At the top, there is a welcome message, and a link where users can update their account information. Below this is the user's most recent carbon footprint, followed by a list of goals that would allow the user to reduce their footprint. Finally, at the bottom, is the main interface. On the left is a graph that displays the user's carbon footprint over time. On the right side, the user has the ability to take a survey in order to calculate a new footprint. The survey relies on sliders for user input. From the user's perspective, it is easier to enter input using sliders than providing raw numerical input through a form. When the user finishes completing the survey, a new point appears on the graph on the left, and a new set of goals are generated.

The second section is targeted more towards community initiatives. The user is first prompted to enter a U.S. state and city. When the form is submitted, the user is directed to a new page. At the top, there is information about number of restaurants in the community, because restaurants are the major sources of food waste in the community. There is also information about the implications of using the waste in a biodigester. Below that is a virtual biodigester application. Users can enter an amount of food waste, and the application will indicate the amount of energy that is produced. Below this is information about how biodigesters work, and the perks of using them. This page serves as the primary marketing tool of the applications.

In order to use the application, users must create an account. A local account can be created by providing name information, an email address, and a password. Users can also sign up using Facebook.

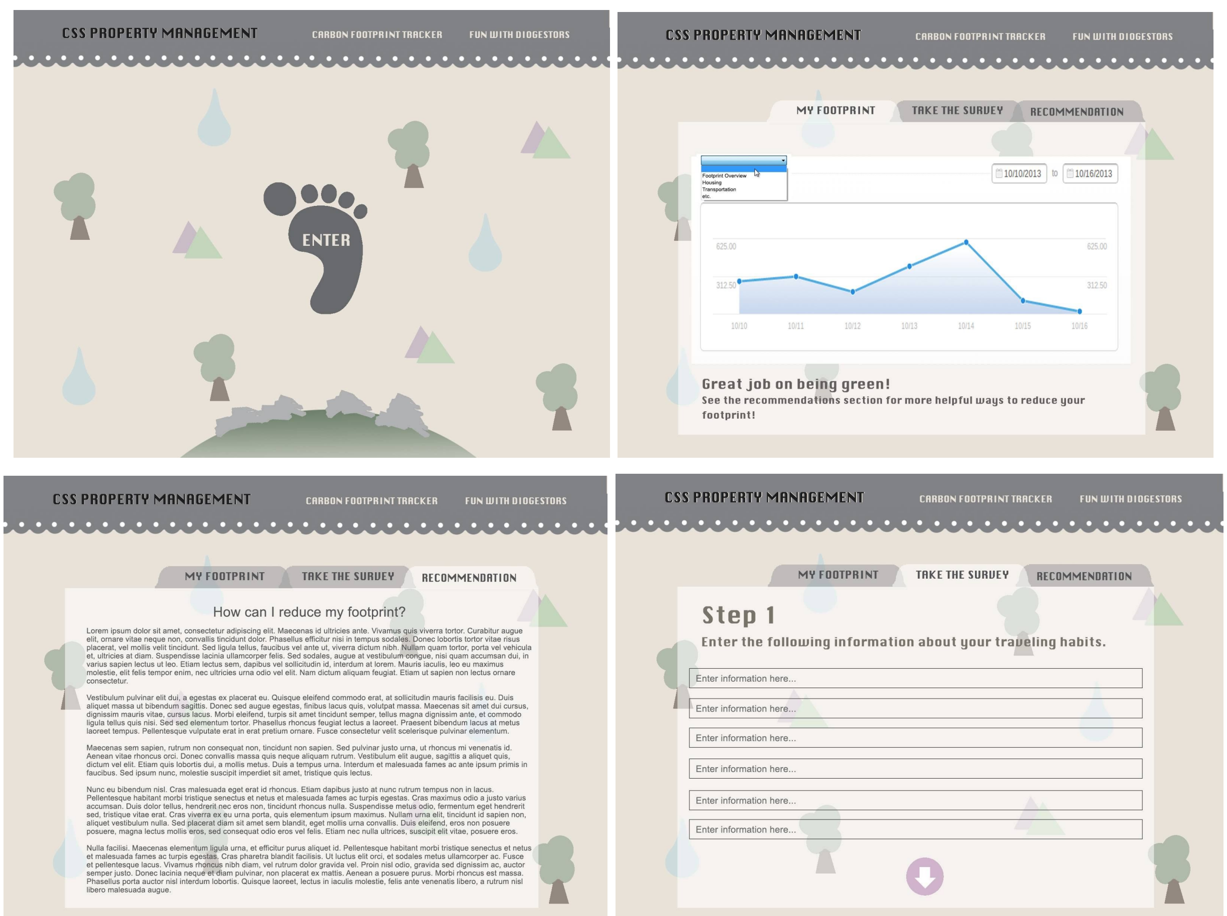
II. DESIGN PROGRESSION

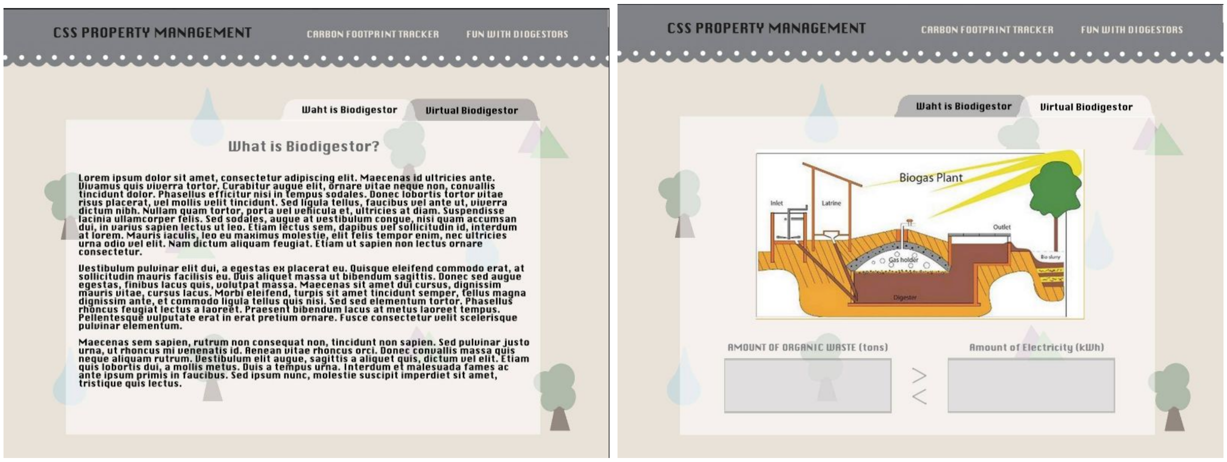
There were a series of design changes that were made from our initial design, which can be found below.



(a) The initial design of our web application

Our second iteration of the project design was similar to the above design in structure, but was different aesthetically. This design was a lot brighter, and more welcoming to individuals. Our mentor TA commented that he particularly liked the background image used in our second iteration of the design.





(b) The second design of our web application

Both of these initial designs resembled folders. The bar at the top allowed users to switch between the carbon footprint section, and the biodigester section. In each of the sections, there was a folder with tabs, that the user could click through to reach the different parts. Looking at the carbon footprint manager, for example, all parts are isolated into their own areas. The graph, recommendations, and survey are isolated. In the biodigester section, the virtual biodigester tool is isolated from the information about biodigesters.

The fact was, however, that while people knew how to interact with the interface, they did not get the type of interaction that we intended, which was an immersive experience that would allow individuals to be better attuned to changes in their carbon footprint usage as a result of doing simple, everyday things.

At the poster fair, Professor Reiss indicated that our survey was too static, and that the structure that we currently employed would bore the user. This led us to rethink our design for the carbon footprint section, so that the graph, survey, and recommendations all interacted on the same page. This type of structure can be seen in our final design. Screenshots of final design can be found at the end.

III. WEB TECHNOLOGIES

After learning about how a modern web app stack looks like, we decided to stick with MEAN. Our rationale for this is that we know how to use most of the technologies through CS1320, and because of this will find it easier to not only implement individual components of the project, but incorporate those components as well.

To start off the description of how we used each of the technologies in the MEAN stack, we have our database, which will be MongoDB. We set up various objects.

Mongo Scheme:

```
var userSchema = mongoose.Schema({

    local           : {
        firstName       : String,
        lastName        : String,
        email       : String,
        password     : String,
    },
    facebook        : {
        id          : String,
        token       : String,
        email       : String,
        name        : String
    },
    twitter         : {
        id          : String,
        token       : String,
        displayName  : String,
        username     : String
    },
    google          : {
        id          : String,
        token       : String,
        email       : String,
        name        : String
    },
    tasks           : [{
        name        : String,
        priority     : String
    }],
    cfp             : String
});

var sliderQuestionSchema = new Schema({
    title           : String,
    type            : String,
    category        : String,
    sliderData          : [{
                            name: String,
                            cfpVal: Number
                    }],
    suggestion      : String,
    answer          : Number,
    cfpImpact       : Number
});
```

```
// input question
var inputQuestionSchema = new Schema({
    title           : String,
    type            : String,
    category        : String,
    suggestion      : String,
    answer          : Number,
    cfpImpact       : Number,
    unit            : String,
    cfpFactor       : Number
});

// radio question
var radioQuestionSchema = new Schema({
    title           : String,
    type            : String,
    category        : String,
    radioData          : [{
                            name: String,
                            cfpVal: Number
                    }],
    suggestion      : String,
    answer          : Number,
    cfpImpact       : Number
});

var dpSchema = new Schema({
    userId          : Schema.Types.ObjectId,
    category        : String,
    date            : Date,
    cfp             : Number
});
```

Angular, Express and Node:

Node was used to build the server of our application. Node was used to handle requests from the client and return data to the client from the backend. In particular, node contacted the mongoose database in order to get the data for the user and survey questions. We used angular to structure the application. We had three services. A user service, a graph service, and a survey service. These services contacted the server using sockets in order to retrieve and update data to and from the server. The use of services, along with controllers, enabled us to organize our code. For example, this worked very well because there was a direct mapping between the services and the mongoose database objects. The user services contained the user database object. The graph service contained the graph object. And the survey service contained the survey questions object. The use of angular and sockets also enabled us to do all of the computation in the client side and only contact the server when updating user info. For example, computing the carbon footprint, display different data points, and processing the user's survey answers, are all done in the client side. The server is only contacted in order update the user's state in the database. Angular was also great for data binding. We are easily able to obtain and display all of the user's information in the front end and display live changes to the data when the user commits any actions.

Passport was used to organize the authentication features of the application. A user is authenticated by logging into the system with a username and password. The passport system checks if the user is valid by looking them up in a database. If they are valid, the passport system will generate a token representing the user's session. We decided not to store the user passwords on the database system. Instead, we opted to store hash values of the user's password. This is a good security practice because it prevents attackers from accessing the user's passwords if there is a data breach.

D3 was used to visualize the data that corresponded to the user's carbon footprint. D3 is a javascript tool that is great for dynamically presenting data. This came in handy with angular. In particular, we were able to use D3 to update graph whenever the user requests a different carbon footprint category, start or end date.

IV. TESTING

Standard testing was conducted as described in the testing lab. This includes accessibility, compatibility, security, usability, and print testing. Some sample tests include:

- We tried loading the application on different browsers to make sure that it loaded.
- We tried to carry out code injection attacks on all form fields, such as NoSQL injection and XSS.
- We tried passing junk input to form fields.

V. BUGS

When creating a new account and taking the survey for the first time, it is sometimes necessary to refresh the page for the graph to show up properly. This seems to be working now.

V. FEEDBACK FROM MENTOR TA

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Christopher Shum
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Chris gave us feedback regarding our project design. He liked the background image in one of our earlier designs, and this background was incorporated into the final design. Chris also recommended that we discuss our design with CSS. Since the main purpose of the application is marketing to municipalities, CSS recommended we use a more minimalistic design.

Chris recommended that we check out passport.js and d3.js for authentication and data visualization. Both of these web technologies were used in our project.

All in all, Chris seemed content with our progress on the project.

VI. FEEDBACK FROM CLIENT

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Sami Baghdady
Group Member
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Salyna Anza
CEO of CSS Property Management
salyna@csslandscape.com
774-249-1444
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The idea for the application was created by both Sami Baghdady (group member), and Salyna Anza, the CEO of CSS Property Management. Salyna was consulted for feedback throughout the process.

Salyna's initial vision of the application was that it would solely be a virtual biodigester than users could play around with, as well as information about biodigesters. In her mind, this application would be something that could be presented to a municipality for marketing, and could be used by grade schools in order to learn about biodigesters. Salyna was pleased when she found out that the application was expanded to include a second section, where users could track their carbon footprint. Although this section cannot directly be used for marketing biodigesters, it makes people more excited about green initiatives, which indirectly does help with marketing.

Because the primary user base of this application will be local governments that are not technologically savvy, Salyna recommended a clear design, and a user interface that would be easy and simple to interact with.

All in all, Salyna and CSS Property Management were happy with how the application ended up.

VII. CHANGES FROM INITIAL SPECIFICATION

Our project more or less followed the initial specification, and nearly all features outlined in the initial specification were implemented. However, we did not end up implementing a backend administrative panel for managing data. According to CSS, this application is meant to present information and be used for marketing. The only data that is being stored in our application is carbon footprint information. CSS indicated that this information was not useful to them, so we decided that it would not be worth implementing a panel to manage this data. The carbon footprint section is more of a gimmick used to engage people.

VIII. CHANGES FROM PROJECT DEMO

- The D3 graph was switched from a bar graph to a line graph. We felt like this would be more suitable, given the nature of the app. The time on the x-axis was expanded and now has finer units.
- Units were added to the carbon footprint measurements (lbs of CO2).
- Minor design modifications were made for increased aesthetic appeal.
- Facebook authentication was not working on Heroku server. Tweaked settings.

IX. BIGGEST CHALLENGES

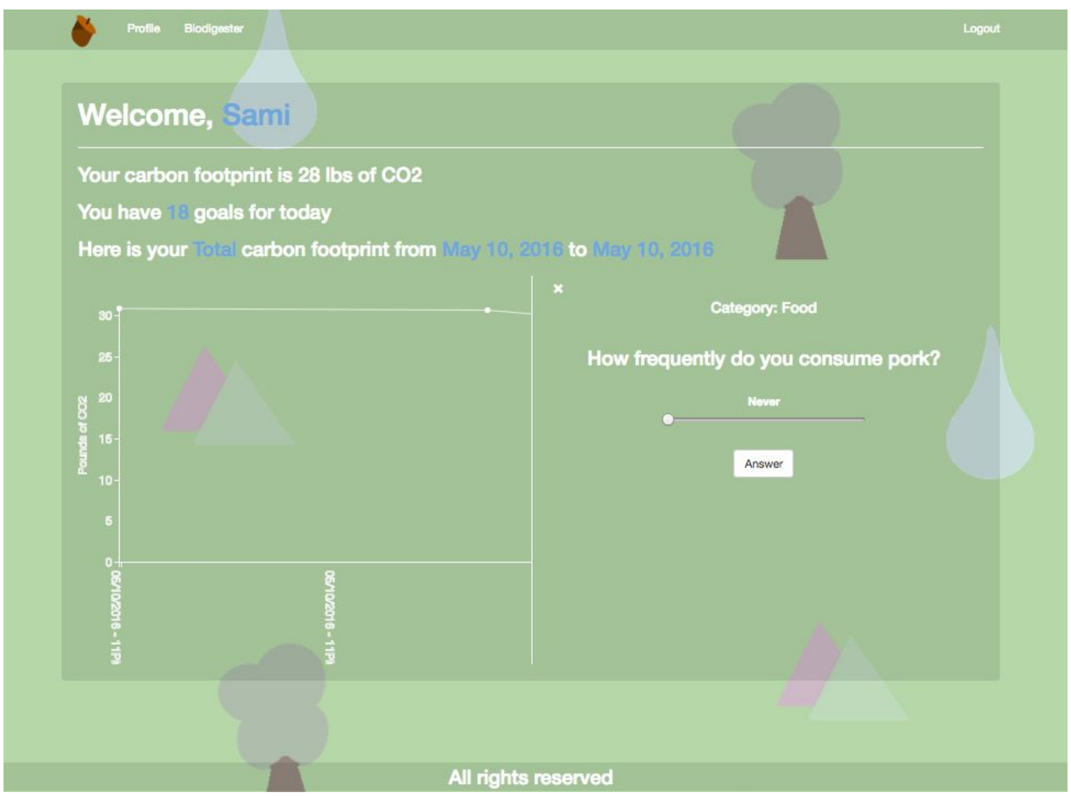
The biggest challenge for this project was collecting data. The data that was necessary to do calculations for the survey portion of the application was not available. Online, we found a few websites that had similar carbon footprint calculator. We gave the owners of these websites phone calls, and tried to discuss data with them. After about 3 weeks of no success, we decided to use dummy estimates for calculating data in the survey. However, the application was written so that the data needed for calculations could be updated fairly easily. Because this section is not that important in the eyes of CSS Property Management, this was not a very big deal.

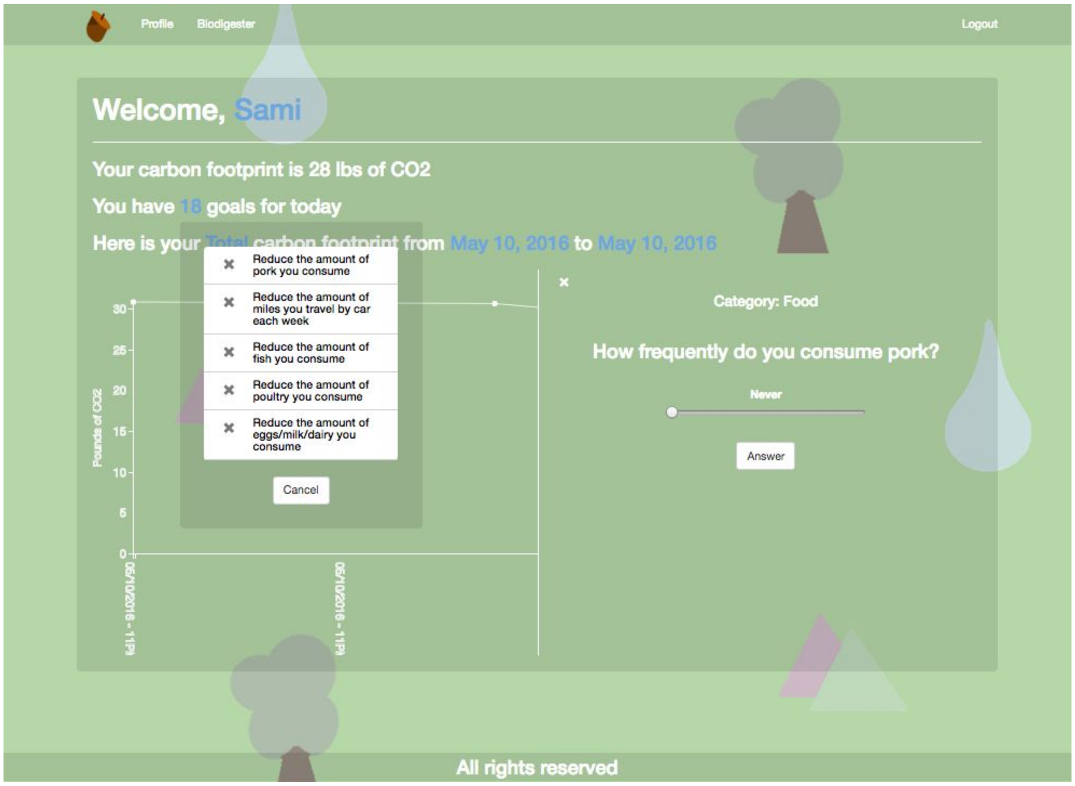
We were able to find all necessary data for the biodigester section of the application. We got in contact with Austep and AG Energy, both of which work with biodigesters. These companies provided us with data such as how much electricity is produced by a biodigester, given some amount of food waste. We were able to find the number of restaurants in a city using the CityGrid Places API. The amount of waste in a community was calculated using number of restaurants, the average amount of waste produced by a restaurant. This amount of food waste was converted to kilowatt-hours of electricity using the data from Austep and AG Energy.

On the technical side, we had the most difficulty getting the data visualization to work. D3 was confusing to use, especially with Angular.JS.

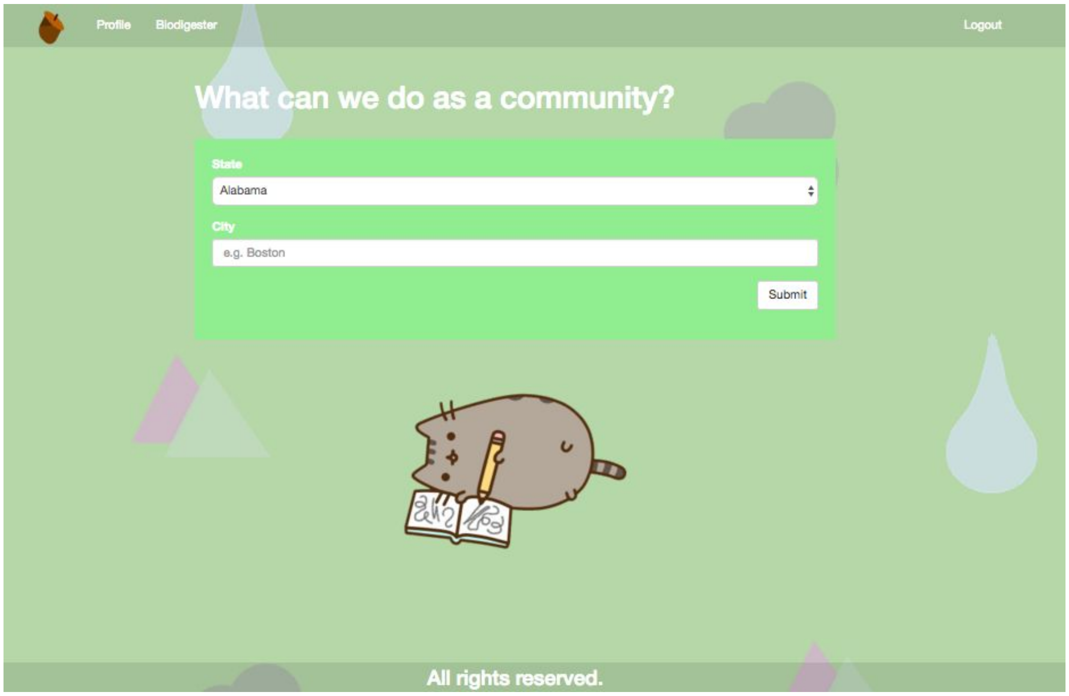
DESIGN SCREENSHOTS BELOW!


Profile
Biodigester
Logout
Welcome, Sami
Your carbon footprint is 28 lbs of CO2
You have 18 goals for today
Here is your Total carbon footprint from May 10, 2016 to May 10, 2016
Pounds of CO2
30
25
20
15
10
5
0
05/10/2016 - 11PM
05/10/2016 - 11PM
05/10/2016 - 11PM
05/10/2016 - 11PM
Let's update your carbon footprint.
All rights reserved

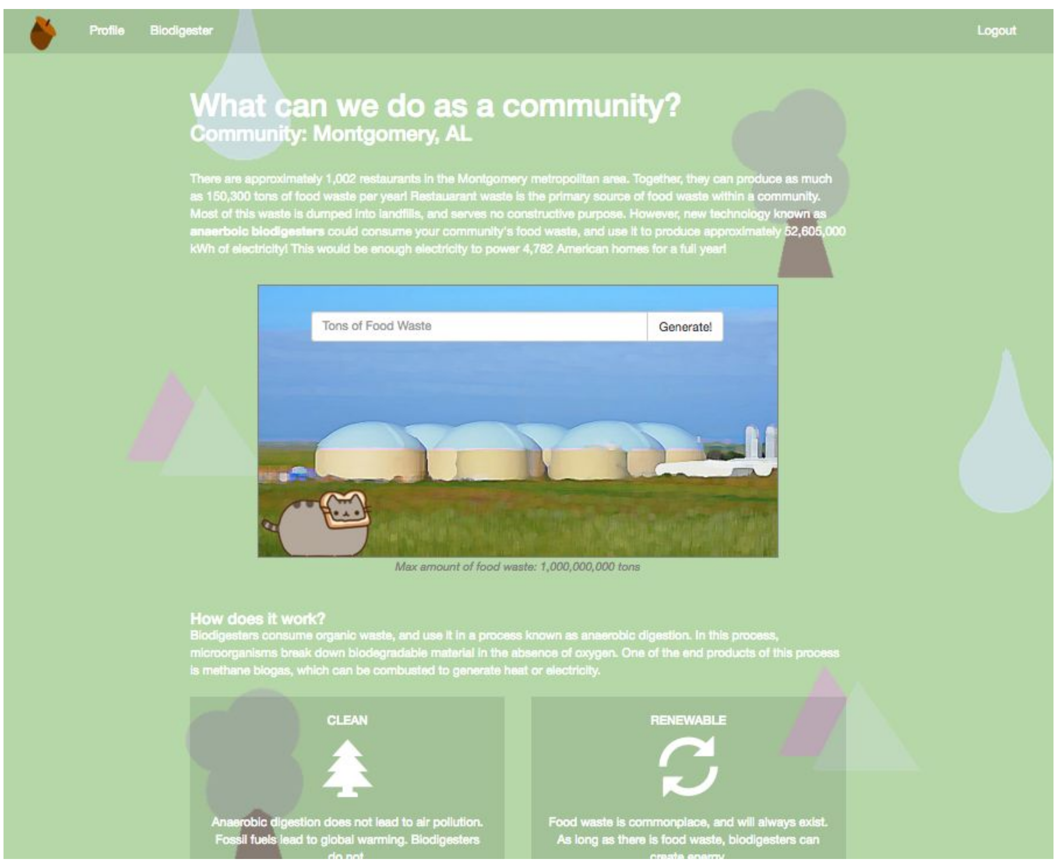

Profile
Biodigester
Logout
Welcome, Sami
Your carbon footprint is 28 lbs of CO2
You have 18 goals for today
Here is your Total carbon footprint from May 10, 2016 to May 10, 2016
Pounds of CO2
30
25
20
15
10
5
0
05/10/2016 - 11PM
05/10/2016 - 11PM
×
Category: Food
How frequently do you consume pork?
Never
Answer
All rights reserved


Profile
Biodigester
Logout
Welcome, Sami
Your carbon footprint is 28 lbs of CO2
You have 18 goals for today
Here is your Total carbon footprint from May 10, 2016 to May 10, 2016
Reduce the amount of pork you consume
Reduce the amount of miles you travel by car each week
Reduce the amount of fish you consume
Reduce the amount of poultry you consume
Reduce the amount of eggs/milk/dairy you consume
Cancel
Pounds of CO2
05/10/2016 - 11PM
Category: Food
How frequently do you consume pork?
Never
Answer
All rights reserved


Profile
Biodigester
Logout
Welcome, Sami
Your carbon footprint is 28 lbs of CO2
You have 18 goals for today
Here is your Total carbon footprint from May 10, 2016 to May 10, 2016
Food
Update
Cancel
Pounds of CO2
05/10/2016 - 11PM
Category: Food
How frequently do you consume pork?
Never
Answer
All rights reserved



Profile
Biodigester
Logout
What can we do as a community?
State
Alabama
City
e.g. Boston
Submit
All rights reserved.



Profile
Biodigester
Logout
What can we do as a community?
Community: Montgomery, AL
There are approximately 1,002 restaurants in the Montgomery metropolitan area. Together, they can produce as much as 150,300 tons of food waste per year! Restauarant waste is the primary source of food waste within a community. Most of this waste is dumped into landfills, and serves no constructive purpose. However, new technology known as anaerboic biodigesters could consume your community's food waste, and use it to produce approximately 52,605,000 kWh of electricity! This would be enough electricity to power 4,782 American homes for a full year!
Tons of Food Waste
Generate!
Max amount of food waste: 1,000,000,000 tons
How does it work?
Biodigesters consume organic waste, and use it in a process known as anaerobic digestion. In this process, microorganisms break down biodegradable material in the absence of oxygen. One of the end products of this process is methane biogas, which can be combusted to generate heat or electricity.
CLEAN
Anaerobic digestion does not lead to air pollution. Fossil fuels lead to global warming. Biodigesters
RENEWABLE
Food waste is commonplace, and will always exist. As long as there is food waste, biodigesters can

Biodigesters create an efficient amount of energy, given the amount of organic waste they consume.

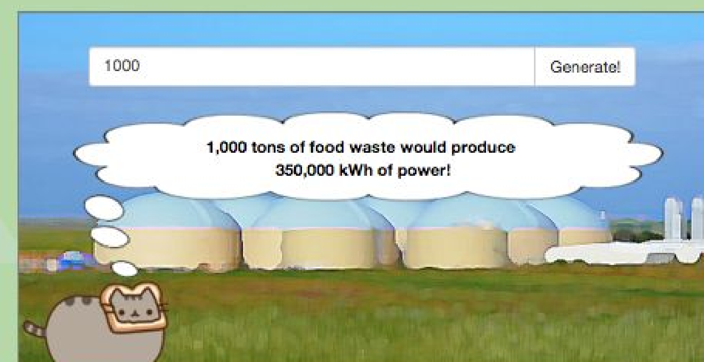
Once build, a biodigester has no operating cost. Food waste is a free byproduct of human consumption.

How do biodigesters compare to alternatives?

A majority of food waste ends up at a landfill or other waste management facility. As waste accumulates in landfills and is sealed off from oxygen, bacteria begins decomposing it anaerobically, in a process that is similar to what biodigesters do. Methane is produced and accumulates underground. Methane is highly flammable, which serves as a potential safety hazard, and is also a potent greenhouse gas with a global warming potential 25 times stronger than that of carbon dioxide. As this methane escapes to the atmosphere, there is significant air pollution.

In a biodigester, methane gas is captured and used for stoves or electricity. When methane is burned, some carbon dioxide is emitted, but this will impact global warming significantly less than if the waste was not used in a biodigester. In this sense, biodigesters actually mitigate the effects of global warming.

What about alternatives such as fossil fuels?
Fossils fuels do contribute to global warming. They are removed from underground, and then burned to produce energy. Similar to combusting methane, this process emits carbon dioxide. However, this carbon dioxide would not otherwise escape to the atmosphere and contribute to global warming, if the fossil fuels were not extracted and burned.



Max amount of food waste: 1,000,000,000 tons