Sustainability Through Open Data

An Interactive Qualifying Project submitted to the Faculty of WORCESTER POLYTECHNIC INSTITUTE in partial fulfilment of the requirements for the degree of Bachelor of Science

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Abstract

Open data is becoming widely available in the United States, but it can be challenging to effectively communicate this data to the public. The purpose of this project was to identify usable sources of open data to display on public facing digital signage that will educate communities on the local production of solar and wind energy, both actual and potential. The team aggregated open data sources following criteria we designed for this project's use case and conducted interviews and surveys to design the most comprehensive display of this data for use in urban communities. We made recommendations to our sponsor, Roadify, including potential organizations to contact when seeking applicable data sources as well as strategies to display the data effectively. Although our team was unable to find data sources and elements that directly follow our criteria, we were able to develop educational designs to serve as a demonstration of our concept. Through our research we also concluded that displaying data on this topic would be beneficial to communities in the United States as it would spread awareness about the underutilization of renewable energy.

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Executive Summary

As technology advances, there have been massive improvements made in the way we collect, store, and distribute data. The United States government has catalyzed the movement of open data by making this the standard for government information to create transparency. As open data is free to access, download, or redistribute by any third party, this data can be of educational benefit to the public. Currently, there lacks a medium to effectively communicate influential open data to the masses.

Digital signage is a useful way to communicate valuable information to the public that relates to the community around them. The use of digital signage complements the notion of smart cities using information communication technologies to improve quality of life within a community. Digital signage also complements our project's use case, the stumble-upon use case, as it can reach a large audience who may have not sought out the information prior to interacting with the sign. This use case requires a display that is easily understood, impactful, and remains relevant over time.

Currently, companies like Roadify aggregate hundreds of public transit open data sources to be made available for public facing digital signage. These signs influence the end user by delivering relevant and influential transit and mobility information. As open data exists in many other content categories, creating this interaction by displaying environmental data can potentially impact the wellbeing of the environment and general population.

Today, the United States (U.S) demonstrates a large reliance on non-renewables to meet its energy needs. In 2018, 80% of all energy consumed in the U.S came from fossil fuels (DeSilver, 2018). Producing energy from fossil fuels like coal releases toxic chemicals known as greenhouse gasses (GHG) into the atmosphere. These GHG have lasting effects on environmental and human health such as extreme weather, disruption in food supply, and respiratory disease from air pollution (EPA, n.d.). Using renewable energies such as solar and wind power will reduce the emissions of GHG, creating benefits to society.

Although solar and wind power are being used increasingly, they still are underutilized in the U.S, as they were responsible for just 4% of the nation's energy consumption in 2018 (DeSilver, 2018). By displaying open data that shows the potential and actual local production of solar and wind energy, alongside the consumption and production of nonrenewable energy, our project will help educate people on how they influence environmental sustainability.

This project followed a methodology to further the efforts of environmental sustainability using digital signage. We developed criteria to evaluate open data sources to find geospatial data throughout the United States, scaled locally. It was also essential these data were updated frequently to remain relevant to the end user. Furthermore, these data needed to be structured and formatted in a way easily readable by a machine. Through a funneling process using this criterion, we identified open data sources with information on renewable and nonrenewable sources of energy production and consumption throughout the United States.

We created mock displays using sources we identified to test the clarity, relevance, and understanding of the data. We conducted interviews with subject matter experts to see if we could better display our data, evaluate the accuracy of the data, and understand the potential impact that could be created through these displays. This impact was further tested in the WPI community with surveys that contained these mock displays. This survey mimicked the use case of our project, allowing us to adjust these mock signs to best display our data and show that this is a viable concept.

The last step was to create an organized spreadsheet of all our data sources sorted by certain categories. We used the spreadsheet-hybrid software Airtable (Airtable, n.d.) to organize these data sets in categories like its format, location, and update frequency. This will allow Roadify to easily further the efforts of this project, as this methodology showed that this concept of environmental sustainability through digital signage has the potential to be meaningful and is a feasible goal.

Using our criteria, the team was able to identify a plethora of data sources, eventually narrowing our selection down to eight solar and wind energy datasets. We learned very quickly that open data directly following our criteria is difficult to find. Despite this setback the team was able to identify four high quality datasets to use in our mentioned displays. These sources were

the Global Solar Atlas (Global Solar Atlas [computer software], n.d.), Global Wind Atlas (Global Wind Atlas [computer software],n.d), EIA Real Time Electricity Data Browser (EIA Database Beta, n.d.) and EIA Electric Systems Operating Data (Hourly Electric Grid Monitor [computer software], n.d.). These data sets provided information pertaining to the generation of electricity by power source on a state level and allowed us to create the mock displays used in our surveys.

Our expert interviews allowed us to gain perspectives into digital signage, sustainability, and the display of individual data points. Specifically, our interview with Micah Chase, a WPI professor in the Foisie Business Program, gave us insight into drawing the attention of end users to our signage. He led us away from the use of text and moved our focus towards graphs, which made understanding our data easier. He also gave us tips on making our sign more interactive and measuring the success of our sign. We learned that quantifying the impact of the digital sign would be particularly challenging, but that it would spread awareness if the information were displayed effectively.

Another interview with Paul Mathisen, the director of sustainability at WPI, emphasized the need for visualization in our displays, as the first thing he mentioned was to focus on displaying graphs so more people would understand our display within our use case. Professor Mathisen also warned us that the units our numerical data was being displayed in were confusing and required a definition. Finally, when asked if he thought that displaying this data would be beneficial to the community, he expressed interest in this concept saying it had the potential to make an impact in communities.

Our survey results also yielded qualitative patterns that allowed us to make meaningful edits to our display. These results indicated that a portion of the titles and text on our signage was unclear. In addition to the issue of clarity, some survey respondents had difficulty understanding the units our data was displayed in. We rectified these issues by making the titles simpler and more descriptive, increasing font sizes, changing colors so that different data points stand out, and adding definitions of our units. Respondents also found that it was hard to connect the data points. We assumed this was due to the unclear titles and text. Although there were critical comments, we also got positive responses as well. Our respondents showed an overall interest in

the data we presented. This indicated that despite the cluttered, confusing elements within the display, the story we were attempting to convey was clear.

The team learned from our research that although open data is widely available, the ideal solar and wind sources that fit our criteria proved challenging to find. The data we needed to complete this project, at the level both the team and our sponsor were aiming for, needed to fit our strict criteria to be effectively used within the stumble-upon use case. The specific elements and figures we needed were often reported on a different scale or not updated frequently. Due to this, the data displayed on our signage would begin to lose its relevance and accuracy as time went on making it unsuitable for this project's use. The team attributes this to several factors, including the lack of efforts to make real time energy production and consumption data elements available for small geospatial locations around the U.S.

As the market for open data develops, open data will begin to improve at a rapid rate. Despite our setbacks, the most important conclusion the team came to was that there is a lot of genuine interest in the display of energy open data to promote sustainability. Our project demonstrates the ability for digital signage to become more prevalent when combined with data sources in our category. Our model can be used to make an impact in communities and potentially lead to sustainable changes across the U.S.

In order to ensure the future success of digital signage projects related to ours, sources which match all three major criteria must be identified. Increasing the quality of the data sources help the sign convey the desired story clearly and help develop an effective display for the stumble-upon use case. Within the data sources, the four data elements needed are localized data for solar and wind electricity production, localized data for non-renewable electricity production, localized data for the consumption of electricity by power source, and a more functional data source with comprehensive elements of solar and wind energy potential. These four points will deliver an easy to understand and impactful story for end users. While these sources may or may not exist in the public setting, reaching out to other private companies may elevate the quality of data significantly.

We found several companies that aggregate solar and wind data in a variety of formats. One company was SolarEdge. SolarEdge has connections to a network of solar installers and private

energy companies, and they offer several smart home features and products that track electricity production and consumption in real time across the United States. SolarEdge provides these services to its customers, installers, and other qualified partners and may be able to provide localized data for a county, town, or even exact address.

Another company the team recommends reaching out to is the EIA, as they provided two of the data sources used in our mock signage. This independent statistics and analysis company aggregates electricity data for the United States government. The EIA has a large beta testing program for data sources that are more dynamic and useful. These programs can be useful in finding new sources of energy information.

Next, a company known as MapDwell provides information on solar energy potential to solar panel installers. This local source of data can make an impact on the public by providing accurate local solar potential data. This source is not currently accessible, but a partnership would provide high quality data.

Finally, the team recommends reaching out to SunNumber. This organization provides a "solar score" or overall score for the potential of solar energy based on your address. This data is not only local but is updated frequently. The company's mission is similar to the goal of our project, which may make them forthcoming with data sets and pertinent information.

Following our interview and survey results the team wants to reiterate the importance of displaying the data in an engaging and understandable manner. Currently, RoadifyTV is unable to create graphs and customizable graphics. We suggest that Roadify works to upgrade its system so that graphics can be processed easily. Once this is addressed the success of the project will come significantly easier than if the information was presented in plain text format. In addition to the graphical upgrades the team also feels that there are ways to make signage of this variety more interactive. Specifically, by creating a competitive aspect, engagement with the signage can increase. One way to accomplish this is to compare data from one county or city to another. In our signage our team included a QR code to lead users to further educational information about solar and wind energy. This QR code or a more robust code can be included in the final design to allow the signage end users to engage with educational tools and get connected with corporate

partners or solar installers. Any way to get end users involved with the de-carbonization of their electricity grid is a positive impact created from our signage.

Our project was unable to identify or display data sources of a quality that the team desired to find in our research. We have, however, shown that this is a feasible concept within the stumble upon use case. Furthermore, this research can spark public interest and has the potential for impact. Our team feels that by continuing research related to this project, efforts to switch to renewable energy sources can be furthered across the United States.

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1.0 Introduction

The 21st Century has been a technological explosion, with massive strides in the ways digital data is collected, stored, and distributed to the public. With this renaissance of technology comes a flood of new data sources, as more industries and services turn to interconnected technology. This has often been referred to as, "the data revolution," where there is now so much open data freely flowing around it has become, "... a wide, deep, torrent of timely, varied, resolute and relational data" (Kitchin, 2014).

Though open data is free to access, the ability to distribute this information in an effective manner is a challenge for today's society. Companies such as Roadify aggregate relevant structured open data sources which they make available for display to end users. Previously, Roadify focused heavily on the transit and mobility content category; however, Roadify is now aggregating content from other available open data sources to provide end users with local information that can have a potential impact on their communities.

One area where open data has made a large impact is in monitoring of energy production and consumption needs, especially from renewable energy. Environmental awareness is truly relevant in society today, as the quality of the environment affects the health of individuals as well as their local community. Currently in the United States (U.S.), "Our production and use of energy (most of which comes from fossil fuels) contributes to climate change, accounting for more than 84% of U.S. greenhouse gas emissions" (EPA, 2017). These toxic chemicals can have negative health and environmental effects such as extreme weather and air pollution.

The goal of this project was to identify usable open data sources produced from wind and solar power production, and to display these data concisely on public facing digital signage in an effective way. We identified data sources such as Solar Atlas (Global Solar Atlas [computer software], n.d.) and Wind Atlas (Global Wind Atlas [computer software], n.d.) to support the development of a digital sign for communicating with the public. We strived to produce a display that was easily understood, informative, relevant, and beneficial to the end user.

We used WPI (Worcester Polytechnic Institute) as a model to mimic a small urban community that this sign would theoretically be utilized and gave a survey to community

members of WPI to analyze the effectiveness and impact of our display for our use case. This step ensured our goal of providing communities with information via signage from open data sets that can potentially be of benefit to society.

2.0 Background

2.1 Introduction

In this section, we will discuss aspects of the project that are relevant to the research we conducted. We introduce open data and discuss how these data can be utilized to inform and create change within a community as it relates to our use case. We will also describe some of the challenges with using different types of data, as data are not always standardized. We will also introduce the focus of our project, which is the potential and current use of solar and wind power in communities as alternative forms of energy.

2.2 What is open data?

A datum is considered open when, "...anyone is free to use, re-use or redistribute it, subject at most to measures that preserve provenance and openness" (The World Bank, 2019). Furthermore, data must be made available legally, and must be published in a manner which allows consumers to access the datum using common software applications, tools, and data formats like API, KML, and GeoJSON. Open data can be categorized into many types for social use within our communities, including environment, news, transit, health, social services, retail, security, and events. This vast amount of information is provided by sources such as governments, institutions, and private sectors. The information is only impactful when the data are made usable, and for this reason, there is a push by governments and other institutions to make open data more accessible and easily understood by the public (World Bank, 2019).

2.2.1 Government open data

In recent years there has been a push globally for governments to create open data portals. The United States has enacted many policies regarding open data to create "greater transparency and accountability," long standing conceptions of participatory democracies (Wilson, 2021). One of these policies was an executive order, implemented by the administration of Barack Obama, that made open and machine renewable data the standard for government information (Obama, 2009). The reasoning behind this movement was stated in a memorandum by Obama which claimed, "Transparency promotes accountability and provides information to citizens about what their government is doing" (Obama, 2013). The government also promoted data in a 2017 bill, brought forward by then Speaker of the House Paul Ryan requiring the government to keep an open data repository, detailing the best practices, tools and standards allowing other government branches to publish their data in an accessible way (H.R.4174). Due to this bill becoming a law in 2018, a repository on GitHub, a cloud-based hosting service for code, was opened by the federal government. The GitHub repository is open to the public and even has tutorials so that anyone can access any published data. Another, more recent, example of the push for government open data is data.gov, one of the federal government's open data site. This site helps to bridge the gap between open data and the public (Open government, 2019). The Obama administration was aware of the impact government open data can have on the public and those ideas have further pushed open data initiatives; however, there are challenges with the application of open data in the public sector.

We looked at a study that determined the impact open government data sources had on cities in three categories: operational and technical, economic, and political and social. This study relied on 26 semi-structured phone interviews with government staff, civic technologists, and private sector stakeholders (Wilson, 2021). When speaking about the operational and technical impact, the study noted that government open data needs a better system for sharing open data, since currently the existence of this information is unknown to many members of the public. In creating a platform to better communicate this data to the public, we will make this

data more useful, with a higher potential to foster civic engagement. While discussing the political and social impact of government data, one interviewee spoke on the fact that in its current format, government open data is not presented in a manner that is ingestible or insightful (Wilson, 2021). Even though there is a push by the government for open data, it is not communicated effectively enough for it to create an impact within the public. Government open data is making a push to become more accessible, but there still lacks an effective medium to communicate those ideas to the public. Our team wants to help bridge the communication gap between open data and the public, by communicating our ideas in a public manner that engages and is understood by all users.

2.2.2 Environmental data sources

For the purposes of our project, we will be focusing on environmental data related to energy sustainability, more specifically renewable energy generation and potential. Environmental data can be defined as any data pertaining to climate, water, air, animal population and soil. These kinds of data are primarily provided to the public through government monitoring, but private sectors have also taken interest. A few notable government organizations that provide this data include the Environmental Protection Agency (EPA), Data.gov, Environmental Information Agency (EIA), and the National Renewable Energy Laboratory (NREL). These sources contain a large variety of environmental data, with multiple sources pertaining to our focus. One source of information we found pertaining to our focus on renewable energy sources through the EPA was the eGrid, or Emissions & Generation Resource Integrated database. This is a comprehensive source of data pertaining to characteristics of all the electric power and gas pollution generated in the United States. This annually reporting data source is used to track the amount of electricity and pollution a given region, state or power plant within the United States generates. This includes all producers of electricity and greenhouse gases, including landfills and factories which pollute a disproportionate amount. Particularly important in our project's case, these data allow for a direct comparison between the outputs of renewable and non-renewable sources of energy.

As mentioned, our team is focusing our search for data sources containing information on renewable energy potential and generation, and specifically solar and wind power. The goal of displaying this information is to educate the public on renewable options within their area. Our team hopes we can help reduce carbon footprints within communities by getting people to think about sustainable behaviors they can implement. The above databases include sources with environmental data relevant to our project. However, we are unable to utilize this information if the source does not meet the technical requirements for use by Roadify. For example, energy and carbon emission data as mentioned above are only updated annually, which is not dynamic--that is, frequent-enough to bremain relevant over time. The data are also often gleaned from large regions and states. We desire local, dynamic sources to maintain consumer interest in the sign created. Another challenge when finding these data sources is the accessibility to the information as it must be in a format which can be ingested by Roadify's platform. This requires the information to be standardized and made available in an excel spreadsheet, a csv file, or a GeoJSON file. Environmental data sources can be difficult to work with in our use case. However, as open data grows more information that works within the scope of our project is becoming available.

2.2.3 Institutional open data

Academic and other private institutions play a significant role in shaping public involvement with social issues. Often released for educational purposes, academic open data is one-way universities can show transparency and honesty. Open data that is accessible through universities has created an impact felt through many sectors of society (Wilson, 2021). The interviews described in the Wilson study state that universities could play a key role in shaping and sustaining government open data. The study also stated that by pushing for more data through research at universities, there would be a greater amount of open data available. Institutions are not required to post sources of open data to the public. There is still a push to make academic and institutional data open and accessible to promote public transparency within these organizations. Like government data, academic institutional data may not reach a broad audience, and may not

be used as effectively as possible. An example of this is university sustainability plans, such as WPI's sustainability plan, which includes valuable information regarding environmental sustainability around campus (WPI, 2014). One objective through this plan is integrating sustainability concepts into WPI academic programs. Our project similarly aims to foster green initiatives by making sustainability data accessible to a broader audience within the campus community.

This push for sustainability is felt in the private sector as well. Many companies including Amazon and Exxon have had public backlash from their level of pollution. In response to this, companies have begun to make a push to openly display data related to their environmental impact to show public transparency. One of the ways in which Amazon did this was by co-founding a climate pledge with Global Optimism. This outlines a plan for the company to be carbon neutral by 2040. In relation to this, Amazon produces carbon pollution reports to give the public insight into how Amazon is operating (Amazon, 2019). Similarly, Exxon produces a sustainability report that discusses the environmental and social impacts the company is causing based on their business practices (Exxon, 2019).

As this push for sustainability continues, a number of companies have begun to focus on solar and wind energy impacts to help create a smarter and more carbon neutral America. One of the companies our team has been focusing on is a company called Mapdwell. Mapdwell provides information on solar potential and current usage in areas across the United States. This helps solar installers understand where their areas of focus should be (Mapdwell, n.d.). Mapdwell's goals are similar to ours in trying to identify solar potential and the possible impact associated with that. Mapdwell aims to share this information with solar installers, and we wish to make it available to the public. This made it difficult for us to partner with this company. We feel that by working with different companies along with other data we can help educate the public on sustainable energy options around them.

2.3 Data standardization

Open data can be structured differently to support dissimilar needs, often creating a challenge to aggregate data into a single model. Data aggregation is the process of gathering data and presenting it in a summarized format. It is much easier to work with data that have a standardized structure, as they can be processed, searched, combined, and analyzed straightforwardly (Kitchen, 2014). Structured data are organized within a file or record and stored in a relational database. This allows for computer software to display the data using visuals such as graphs and maps. For example, the EPA published a dataset called RE-Powering Mapper Region 1, a structured data source based in the northeast part of the United States (EPA, 2014). This data source includes information for potential viable locations for renewable energy sources like solar, wind, geothermal or biomass. The datum of this source is provided in structured formats allowing it to be easily readable and decipherable by humans and computers. Data which are unstructured or semi-structured, refers to qualitative data such as text, photos, videos, and other social media posts. We see this data in many existing large-scale databases such as Facebook and other social media platforms, which contain a massive number of photos, blogs, videos, and posts (Kitchen, 2014). Studies estimate that unstructured data are growing at a rate fifteen times higher than structured data. This can make things difficult for companies like Roadify that aggregate data from multiple sources. Roadify uses APIs, or Application Programming Interfaces, to aggregate structured data from hundreds of sources. Unstructured data exists in large quantities, but it is not easily read by a machine (Kitchen, 2014). We will be working with structured data which contains information for a specific geographic location on a national scale in the U.S. This data also must be dynamic, meaning it should be updated on a consistent basis.

Once a high quality and well-structured stream of data is identified, it can be distributed to the public using an API. An API in the most basic terms is a way for online services to communicate with each other. These interfaces enable companies and people around the world to share data. We use APIs every day when browsing on the internet. PayPal, a company which hosts a secure website that allows you to store credit card and bank information for faster online purchases, uses an API to pull private user data from their highly encrypted servers (API Glossary, n.d.). Due to their widespread use, APIs have become the backbone of companies with any online presence. Companies and governments have exploited the versatility of APIs to create an easily accessible stream of data. Despite the wide stream of data from institutions and open

sources, we will focus our efforts into working with government open data sources. Due to the United States' effort to standardize open data, it has become increasingly easy for developers to work with these data sources. This has led to a sharp increase in the number of companies and third parties which rely on open data for their services, website, or applications. Developers can use a line of web-based code to make a request for specific elements from the data source, an API call. Once data are requested from a source they can be viewed and used to create end user experience in several formats. The most common and preferred format for this project is JSON or JavaScript Object Notation. The JSON format organizes data by predetermined variables and is easy to read by both machines and humans. The data provided in a JSON format of a PayPal web page may include encrypted bank data and personal information. In our case, our API call is contacting a stream of open data and pulling the required information based on our specified criteria. These criteria can be based on location, keywords or any other variable type the information can support.

2.4 Link between open data and signage

Digital signage is an underutilized tool for communicating valuable information to the public that relates to the community around them. One way this method of information distribution can be effectively used is in the setting of smart cities. Smart cities are built around ICTs, or information communication technologies (Logeswaran,2021). These ICTs are implemented to monitor, improve, and support infrastructure within the smart city. Digital signs are an effective means to communicate common and accurate information to the public. The goal of sharing this information with the public is to show the transparency and accountability of the government, while also enhancing the health and well-being of the people. The focused categories of information these smart cities are looking to display are in education, energy management, health, and infrastructure (Logeswaran,2021). Some examples in these categories are the monitoring of electrical devices, efficient management of heating and conditioning; and socially sustainable campuses (Piro, 2014). Presenting the public with engaging information that is related to daily life, will let them know if the conditions around them are beneficial to the

community or if things could be done better. Our project will educate people on renewable energy potential in the US to reduce the community's carbon footprint. Through displaying this data our goal is to get people thinking about sustainability options and renewable energy. Our hope is to reach individuals who may not have given their environmental impact much thought in the past. We want to increase awareness of sustainable energy options in communities around the US through digital signage.

2.4.1 The stumble-upon use case

Displaying this data on a digital sign works very well for our project's use case, the stumble-upon use case. Roadify's CEO, Scott Kolber, describes the reasoning for this use case as, "why make people look it up when they can just look up" (Appendix A). The idea is that an individual will pass by this sign in a public setting and, by "stumbling upon it" engage with the displayed data effectively. This means that the datum must be easily understood in communicating an engaging story to a viewer who will see the sign only briefly. The datum must also be local information of benefit to the viewer, as this will create a stronger connection to the content.

Given that 55% of the world's population lives in cities, and most urban environments have a large amount of foot traffic, digital signage in cities has the potential to amplify the impact of the stumble-upon use case (United Nations,2016). Kolber explained this as the idea of a "15-minute city," which he described as a location where most residents do not have to travel a large radius to meet their daily needs, involving localized foot traffic that leads to frequent interaction with the sign (Appendix A). Digital signage will be our tool to create awareness on this topic.

This use case allows people who may not have personally sought out the information displayed to see it. This will allow the data to reach and engage people who may have had no interest in the topic beforehand. The viewer may also not have the ability to find this information. This use case can help bridge the digital divide between those who have resources, education, and skills necessary to effectively use information technologies, and those who do not

(Servon, 2002). This divide is a barrier that can often keep less-wealthy people with a diminished access to technology from participating in these smart cities. This is summarized very well in an article speaking about the change to a mostly digital transportation system in Skåne län, Sweden:

> In December 2019, the regional public transport system, Skånetrafiken, phased out the physical travel card that has been part of the traffic system since 2009. Paper tickets can still be purchased at stations, but multi-day tickets and most discounts are only available through the app (Ryneveld, 2021).

Despite efforts to use technology to make ticketing data more accessible, it ended up having the opposite effect. Our team believes by utilizing our stumble upon use case and digital signage we can bridge the digital divide within communities. In reaching the widest possible audience our signage will have the most impact possible. With this information reaching a wider variety of demographics, the whole community will be incentivized to take more action when it comes to sustainable habits.

2.4.2 Solar and wind energy on public signage

A display featuring local data on actual and potential uses of solar and wind energy has the potential to increase understanding of an issue that many people care about. A Pew Research Center Survey showed that 77% of Americans believed it was more important for the U.S to develop renewable energy sources, such as wind and solar power, then to produce more fossil fuels (DeSilver, 2020). Fossil fuels such as coal release toxins such as carbon dioxide, methane, and nitrous oxide into the atmosphere. These chemicals are known as greenhouse gasses, or GHG, as they trap Earth's outgoing energy, thus retaining the heat (EPA, n.d.). This imbalance of energy received from the Sun and emitted from Earth alters the climate and weather patterns on a global and regional scale, affecting human and environmental health (EPA, n.d.). A warmer climate can potentially cause a rise of heat related illness and an increase in certain types of air pollution. An increase in severe floods, droughts, and heat waves will have negative

environmental effects and potentially impact crop yields. Climate change can also alter ecosystems as organisms change how they live and interact (EPA, n.d.).

The U.S meets its energy needs primarily through domestic production, only relying on about 4% of its energy supply from net imports. Fossil fuels still dominate this market as they were used for about 80% of the United States's energy consumption in 2018 (DeSilver, 2020). This represents the large reliance of fossil fuels that exists today. Although the use of solar and wind energy is growing rapidly, as wind and solar power accounted for 66% of the growth in the energy sector in 2016, these sources are currently highly underutilized, as they consisted of just 4% of the total energy consumed in 2018 (DeSilver, 2020). It is important that these forms of renewable energy are being used as there is large potential in the U.S for their utilization. According to a study, if 35% of the United States' electricity came from wind energy, the GHG output would be reduced 23% (University of Michigan, 2020). Similarly, the entire United States could be powered by solar panels covering 0.6% of U.S. lands. (Energy.gov, 2019). Even though these technologies are not at the point where they can fully supply the U.S. power grid, increasing awareness, and creating a sense of community engagement will hopefully increase the use of these technologies.

By displaying current sources of energy used locally, as well the potential for local production of solar and wind power, we will spread awareness of the underutilization of these renewable energy sources. End users will be able to visualize the widespread use of fossil fuels and appreciate the vast potential for using renewable energy. Electricity production is relevant to most Americans as it is a utility used daily and is the largest allocation of the US's energy consumption, as 38% of energy flowed into this sector (DeSilva, 2020). Educating people on the current state of electrical energy production and the potential production by solar and wind power can increase public demand for renewable energy.

2.5 How Roadify distributes open data

Roadify is a small company that aggregates and distributes real time transit information, available through open data, via digital signs and Roadify's mobile application. Roadify uses an API aggregated from more than 400 sources of information such as train schedules, live service alerts, transportation modes nearby, directions, and other user comments (Roadify, 2016). Roadify's application enables simultaneous viewing of data from various sources, providing a publicly available hub of information that is accurate and concise. Another feature of Roadify is RoadifyTV. RoadifyTV is a software-as-a-service tool (SaaS) that provides signage services with a single point of access via Roadify's API to location-based open data. Users can build customizable displays about different types of content incorporating this data. Roadify currently informs users on civic and transit data but aims to communicate other forms of information that are available through open data sources. By displaying content in various categories Roadify will be able to reach a wider audience of people and create more interest in its customer's signage.

Recently, Roadify has begun to focus on the health content category, as massive amounts of COVID-19 data have been provided through government and other open sources such as Covid Act Now. Covid Act Now is a database that Roadify recently started aggregating information from, which includes local and national information relating to the COVID-19 virus through its service, RoadifyTV. This enables users of RoadifyTV to view county-based data including total cases, positive test rates, ICU bed availability, and in some cases vaccine information. Instead of focusing on the health content category we will be looking to help the environment through the education of the potential and current usage of solar and wind power in the United States. Reducing carbon footprints can influence people's health as well, through better air quality. Keeping the environment in better shape by reducing our carbon footprint will continue to benefit generations down the line.

2.5.1 Social impact of environmental data

Globally over the last two decades, there has been an increased awareness and concern for environmental issues. In the United States, since the 1960s, a more diverse group of participants has entered the fight to protect the environment. In the U.S, the movement's emphasis has shifted

to the cleaning and control of pollution (Silveira, 2004).” The EPA provides the public with an abundance of environmental open datasets stored in their environmental dataset gateway. The data provided through sources such as the EPA can be displayed to spread environmental awareness regarding pollution and foster this social movement. Three variables that relate to the initiation of environmental activism are the perceived importance of problems in the local environment, the individual's perceived responsibility of organizations to prevent health risk, and the amount of information concerning health risks and issues received by an individual from various sources (Pellitier, 2015). We will be focusing on reduction of the community's carbon footprint through education on renewable energy sources. These variables are addressed by displaying the information in a public setting. Our team will show appropriate information in these public spaces, enabling the information to influence consumer behavior. We will be researching datasets pertaining to energy sustainability and determining which data will be engaging with the public. We also will be making sure our information is being taken in the correct context by conducting interviews and focus groups. One major reason we will focus our efforts on solar and wind energy potential and current utilization is because, “Our production and use of energy (most of which comes from fossil fuels) also contributes to climate change, accounting for more than 84% of U.S greenhouse gas emissions” (EPA, 2017). This snapshot report from the EPA illustrates how important a shift to more sustainable methods in our energy production is needed to keep the planet in good health. Excess production and release of greenhouse gasses is one of key contributors in climate change, it is imperative we become aware and take seriously the effect we are having on the environment (EPA, 2017). Our datasets compliment this information by showing the potential and actual generation of solar and wind power. Showing this information can help to educate a wide variety of people on the lack of usage of solar and wind energy within the United States. These comparisons can also be bolstered by displaying information about the carbon footprint of renewable and non-renewable energy sources. Displaying this information in an engaging and appropriate manner will be key to making our impact felt through education.

2.5.2 Environmental ethics

The social impact of environmental data has the potential to cause meaningful change in a local community when displayed properly. However, if ethical concerns and context are not considered, the data displayed may go unnoticed or incorrect conclusions may be drawn. An article titled, “What is data ethics?” speaks about the paradox of ethical considerations in data:

> On the one hand, overlooking ethical issues may prompt negative impact and social rejection, as was the case, for example, of the NHS care.data program. On the other hand, overemphasizing the protection of individual rights in the wrong contexts may lead to regulations that are too rigid, and this in turn can cripple the chances to harness the social value of data science (Floridi & Taddeo, 2016).

When considering what data elements to display in our final deliverable, the team will take into consideration the context of the information. We have used this quote as a guide to help us identify and narrow down our data sources that are appropriate for the use case and show the story we are trying to display. If we can find relevant sources of high-quality data and create engaging displays, we believe the impact could be felt over different demographics across the United States. Environmental data has correlation to the entire community, so if it is distributed equally, it can give equal footing to the entire community. This addresses the issue of the digital divide, which as previously mentioned we are trying to fill. Anyone that is walking by our display in the public setting will have access to this information. This is also why making sure the information is accurate, is important. Our team is using the stumble-upon use case in an ethical manner to alleviate the digital divide and make an impact on the community through education about opportunity and usage of renewable energy sources around them.

2.6 Conclusion

When effectively displaying data more effectively. Amid increased awareness of environmental impacts around the globe, we will focus our search on datasets in the United States. Due to the transparency of the United States government, sources of open data are now

more standardized and useful. Organizations such as the EPA provide the public with many environmental datasets which can be easily extracted and displayed. Within this environmental data category, we will further focus our research on data pertaining to solar and wind energy potential. Our social research will then allow us to identify the pertinent data to display, as we study how certain data spark emotion and engagement among viewers. We will target data that will spark this emotion and engagement. With the stumble-upon use case, the information selected must be concise and comprehensive so the user can internalize the information quickly. Our next chapter will explain the methods with which we will identify relevant datasets to display.

3.0 Methods

3.1 Methods introduction

The goal of this project is to create a narrative for the display of open data pertaining to the usage of solar and wind power in the U.S. The following objectives structured our research, and will be detailed further in this chapter:

Objective	**Goal**
Identify and organize usable data sources from which to extract data.	Identify which data sets and elements we will be using in our signage design.
Conduct expert interviews with business and sustainability experts to gain understanding of metrics used and the display of data.	Obtain expert opinions as to the best way to display our data sets for interaction with the public.
Create mock displays to use in surveys.	Produce a prototype of two digital signs designs based on talks with our sponsor and our interviews: for use in our survey and our final deliverable.

Conduct a survey analyzing public interaction with our sign.	Obtain feedback on our prototypes and public reactions that will inform our final design and help with recommendations.
Create a complete Airtable for our sponsor	Finalize our Airtable (Airtable, n.d.) for our sponsor that contains relevant sources for future exploration.
Refine final deliverable.	Create four signs that serve as models for displaying our data and a proof of concept.

Table 1: Project objectives

3.2 Identifying and organizing data sources

We evaluated approximately 250 data sets from a variety of government and private institutions, and data portals. To ensure that we selected relevant data sources that fit within Roadify's system and our use case, we created criteria for selecting data. We then organized the sources found using Airtable (Airtable, n.d.). This spreadsheet-database hybrid software allowed us to create categories and group our sources of data. We narrowed our sources to focus on creating a complete story, based on energy generation using the most relevant information.

3.2.1 Our criteria

In selecting data sources, we focused on those pertaining to the production and potential energy for both solar and wind. We developed criteria for determining which data sets in this sector fit within Roadify's system and our use case. Our criteria and the reasons for them are:

Criteria element	Reason
Relevant information	Our data must be relevant to the story we are trying to tell through the data sources.

Format must be: JSON, CSV, or spreadsheet	This will allow Roadify's system to ingest our data sources so they can be displayed.
Must be updated frequently	Our data sources must be updated at least monthly in order to make it interactive within the community, and not become static or stale.
Must be scalable by specific location	By having our data sources be location based on a regional, but preferably county, level, the data will be relevant to the area where they are displayed, while also scalable to include similar data for a broader area.

Table 2: Criteria for identifying open data sources

These criteria have allowed us to create categories within our Airtable spreadsheet in order to better organize and funnel down our data sources.

3.2.2 Funnel data sources

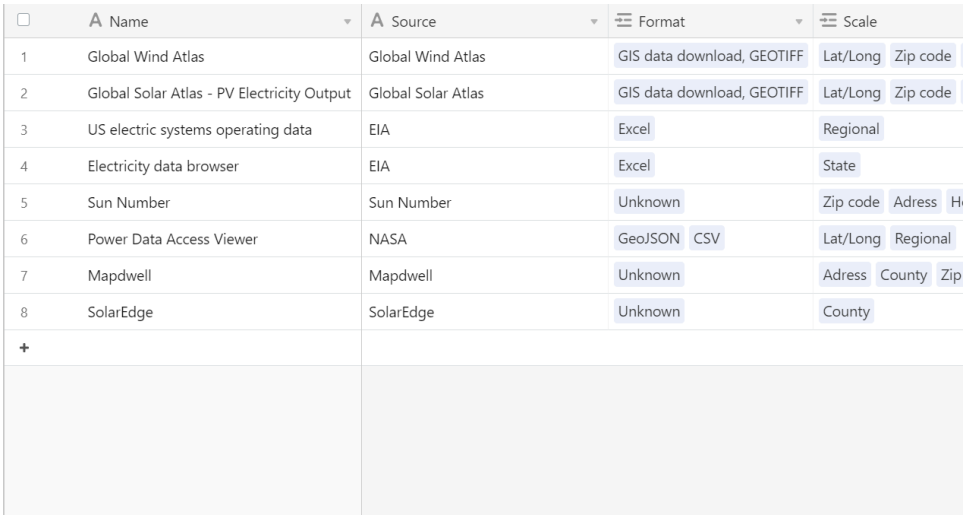
The first step in the funneling process was looking at which area of interest our team wanted to focus on with our data sets. Our team ended up choosing to work with sources of data relating to the environment, since many environmental sources contained standardized information that would be accessible to the team and Roadify. Many environmental data sources identified by our team contained information relating to solar and wind energy, which became the focus of our project in relation to environmental information. After we began to focus on sources relating to solar and wind renewable energy, we used our criteria described above to choose the best sources within this sector of information. Once we had a data source that fit our criteria, we then had to funnel through that source looking for individual datum elements. Our sign integrates individual elements from a multitude of sources to tell a story about renewable energy potential and usage. To help us funnel data sources and elements we made an Airtable (Airtable, n.d.) to better organize data sources and elements.

3.2.3 Organize data sources in Airtable

Airtable is a spreadsheet software that our team used to organize our data sources. This software allows someone to create categories that can link different elements of data together (Airtable, n.d.). For example, Roadify links Covid-19 vaccination information together in their Covid-19 Airtable. We have created our own table for our data sources with categories based on the described criteria above and including pertinent information. Here is a list of categories contained within the Airtable:

- Data source
- Data elements (Ex. Electricity kW-h, Methane Emissions, Power Plant IDs)
- Format (Ex. JSON, CSV, spreadsheet)
- Frequency (Ex. Daily, Monthly, Quarterly)
- Scale (Ex. State, county, city)
- Description of the source
- URL

These categories allowed us to quickly funnel and link data sources to one another to get a complete story through our data sources. This is the Airtable we used in our funneling process.



	Name	Source	Format	Scale
1	Global Wind Atlas	Global Wind Atlas	GIS data download, GEOTIFF	Lat/Long Zip code
2	Global Solar Atlas - PV Electricity Output	Global Solar Atlas	GIS data download, GEOTIFF	Lat/Long Zip code
3	US electric systems operating data	EIA	Excel	Regional
4	Electricity data browser	EIA	Excel	State
5	Sun Number	Sun Number	Unknown	Zip code Adress
6	Power Data Access Viewer	NASA	GeoJSON CSV	Lat/Long Regional
7	Mapdwell	Mapdwell	Unknown	Adress County Zip
8	SolarEdge	SolarEdge	Unknown	County
+				

Image 1: Preliminary Airtable

We have funneled our Airtable down to the data sources that contain elements we want to display within our mock signs. This also allowed our team to organize our final group of sources in an updated Airtable in our final deliverable.

3.3 Expert interviews

We conducted remote interviews with WPI professors Paul Mathisen and Micah Chase, experts in the fields of environmental sustainability and marketing, to better understand environmental data and effective ways to display the information.

Paul Mathisen is the director of the WPI Office of Sustainability. The team began by asking for his perspective on the best way to communicate our information by showing him our initial mock sign designs. We also inquired about any other possible sources of information, such as groups working with data from this sector. The interview ended with us asking if our final deliverable could benefit sustainability initiatives in the WPI community.

From Micah Chase, we gained an expert viewpoint on how to clearly display information so any user can view it, including methods for refining the display to draw users in through the stumble upon use case. Specifically, the team learned about incorporating colors and graphics to alleviate the confusion of plain text. The team also learned how to target specific audiences through marketing techniques. The following table includes sample questions from our interviews.

Question #	**Paul Mathisen**	**Micah Chase**
Question 1	Do you think the WPI community would benefit from students and faculty being more aware about solar and wind potential in our Worcester area?	What initiatives pertaining to sustainability and moving to renewable energy have you seen making their way into the business world?

Question 2	After being shown our mock signage: Are you familiar with these statistics? Are there any other statistics you are familiar with that would be useful in displaying this data?	Do you see digital signage to be an effective form of informing consumers about a product, event or anything in their local area?
Question 3	What story are we trying to tell on our mock signage? How clear was this message?	What are the keys to making an effective advertisement or sign?
Question 4	Do any potential sources of information or groups come to mind that we could reach out to regarding this topic?	How can we measure the short-term success and patterns found in our end user survey? How can we expand that philosophy to measure long term effects?
Question 5		How can you target a select audience with a broad marketing tool such as digital signage? How can you ensure the intended conclusion is being drawn from the information displayed?

Table 3: Expert interview questions

In these interviews we wanted to understand if our research into this type of information could be beneficial to the communities we want to improve. As well as assisting us in creating our mock displays, by helping us further understand how to display the data we are working with.

3.4 Create mock displays for survey

Using the information gathered through our interviews we created two final mock displays to represent a possible display in Roadify's system. These mock displays are a visual prototype featuring our chosen data elements, created to display our data in the intended format. These mock displays were used gauge public interest and allowed the team to get feedback on the format of our display. One of our mock displays showed state level data. This data is currently available in spreadsheet format directly from all our chosen data sources (Appendix F). There was minimal manipulation of units converting from kilowatt to Megawatt. This data is currently available for use within Roadify's system in the form of CSV files. This is our state level mock display that we included in our survey.

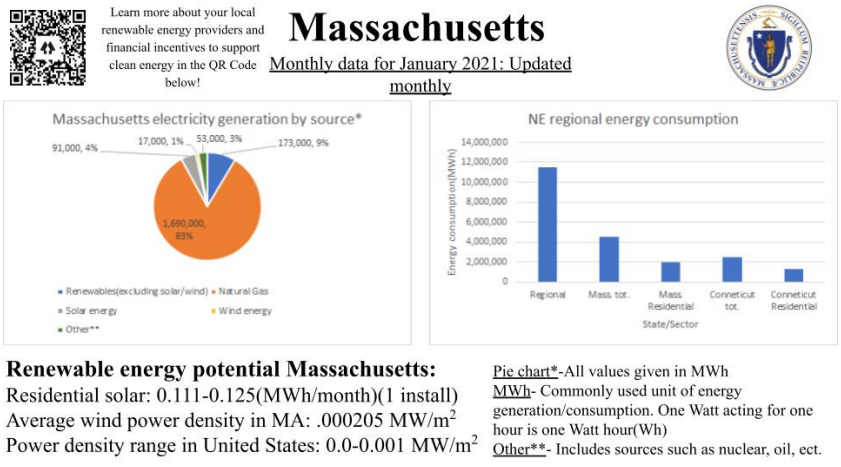


Image 2: Massachusetts state mock sign

The second mockup was for county level data. The team used calculations based on our state level data, available through the EIA electricity browser (EIA Database Beta, n.d.), to scale down from Massachusetts state to Worcester County level. These data elements were calculated

by passing our actual data points through several rudimentary equations. The EIA state level data were divided by 14, the number of counties in Massachusetts and then converted from kilowatts to megawatts. The Global Solar and Wind Atlas data took more calculations to manipulate. The units of solar potential were given in kwh/kwp, to covert to kilowatt hours the potential solar energy is multiplied by three, the average panel number for an American home (Solarae, n.d.). This new number was then multiplied by the area of the county and converted into megawatts. To calculate the potential wind energy a bounding box for Worcester County was manually drawn which also calculated the approximate area of the county. The mean potential power density is given in watts per meter squared and must be converted into megawatts per kilometer squared. Finally, the megawatts were multiplied by the area of the county in kilometers squared, giving a rough estimate of the average energy potential over the entire county. This information is estimated and not reliable enough to be considered viable to RoadifyTV. Despite these rudimentary calculations used on the data for this sign it still had value, since it is an idealized version for displaying our data sources using the available information. We used this mockup as a comparison for the sign that includes our actual data points. This is our second mock display that was included in the same survey as our state level sign.

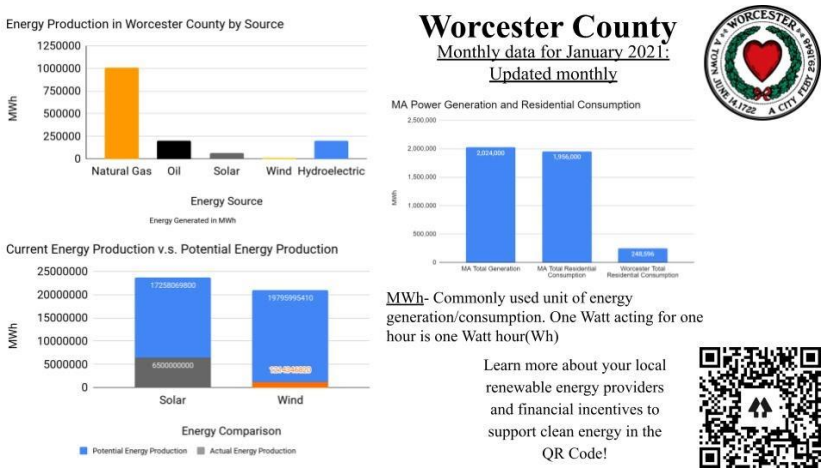


Image 3: Worcester County mock sign

These mock displays were based on data relating to Massachusetts to focus on displaying information relevant to our test population. Showing our signs in interviews with members of the Office of Sustainability and Data Science faculty helped us ensure the information we compare is correct and displayed concisely. As prototypes, these mock displays enabled us to test the story we want to tell with our data elements.

Our mock displays were used on multiple different levels within our project. One use for these signs is displaying our data elements in the intended format to the experts we interviewed, to try to gain their opinions on them. The second, is for use in our survey that will look at public interaction with our sign. Following the survey, we also adjusted our mock signs to try to further refine our designs which are represented in our final deliverable. Furthermore, these mockups demonstrated our proof of concept, and can be used as a template for further research in this area.

3.5 Analyze consumer engagement

We used 27 members of the WPI community as a test population to study consumer engagement with our data. WPI is a model location for a "15-minute city" as well as a scalable model for the concept of smart cities. Currently WPI's signage is primarily focused on displaying events around campus, but these signs could also be used to display information like environmental data. Members of the WPI community are involved in sustainability initiatives around campus and our project could be beneficial. Mockup digital displays created a visual representation of the information our datasets contain. These mock displays enabled the individual to encounter and decipher the information as intended: through the stumble upon use case. We used these mock signs to gain public opinion about our design and concept, and they allowed us to refine our design throughout the project.

3.5.1 Use-case oriented survey

We sent a survey (Appendix D) to a wide demographic of WPI community members such as students, faculty, and staff. Our team sent these surveys electronically by providing 10 links to different teams, fellow students, and discussion boards relating to the WPI community. Our team wanted to reach a variety of people to gain as broad a sample as possible. The survey began with three questions relating to the subject's identity. We asked the subject's gender, age, and their role at WPI: student, faculty, or staff. These questions allowed us to understand the

subject pool and better ensure that our results were as a representative of the campus community as possible. The electronic survey showed participants a mock-up display involving data elements presented in different formats. We then asked questions to identify patterns in their perception and the clarity of the information we are displaying. The first two questions asked, “What was your takeaway from viewing our sign?” and “What information does this sign convey?” These two questions looked at how our population was absorbing our information through the sign. We then asked our subject to rank the clarity of our information on a scale from 1-10 to get quantified data on the information we are displaying. Finally, we asked the question, “Were there any confusing elements of the sign?” This question was meant to identify any specific elements of the sign that can be removed or better communicated. This line of questioning was done with two different mock signs so we can compare the two and see patterns within our responses. We used this information from this survey to create the most comprehensive designs in our final deliverable.

3.6 Create final Airtable

As part of our final deliverable, we created a finalized version of our Airtable (Airtable, n.d.) for use by our sponsor. This Airtable contains all the data sources the team identified as useful over the course of this project. The sources are useful for the available data or the possibility that the sources may prove useful to this project moving forward. In the Airtable we provided the information on the categories we created in our original Airtable. We also added a section that gives our recommendations for what we think Roadify should do with each of our identified sources. This Airtable serves as an assistant and guide for utilizing our identified sources within the RoadifyTV platform.

3.6.1 Create final sign designs

Using the data collected from our surveys and interviews, we developed four final designs that serve as guides for displaying the type of information our team has been working

with. The final designs are based off all the results we have collected throughout our interviews and surveys as well as from talks with our sponsor. Our first two signs are updated versions of the mock signs we created for our surveys. These serve as models for how to ideally display the data we have currently available through our sources, either directly or through manipulation. Our third sign is the same model as our state level Massachusetts sign, but the information is for Connecticut. This sign shows how our concept is scalable to not just Massachusetts, but the United States. Our final sign is a demonstration of the data our team would have ideally found in our research. This sign is used as a tool to discuss what types of information our team feels Roadify should focus on finding. This data may be contained in the sources we identified in our Airtable or may need further research to find sources. We believe our designs serve as a guide for displaying information related to our project and help with recommendations moving forward with this project.

3.7 Conclusion

When conducting research for this project, we identified open data sources that follow criteria as closely as possible, while fitting within our story. To further determine effective data sources, we conducted interviews with experts to gain insight on working with digital signage and this data. We also developed a survey to analyze the end user experience within our test population. After collecting results from interviews, surveys, and further talks with our sponsor, we were able to create final designs that best represent the goal of our research.

4.0 Data analysis and results

4.1 Introduction

Our team identified four data sets to use within our digital signage. Within these data sets we have chosen a total of ten data elements that we felt demonstrated our story. With these data elements our team, along with input from interviews and our sponsors, created mock signs that

would demonstrate our story in an understandable manner to the public. We used these signs in our surveys to serve as a proof of concept for our idea. The results from our survey allowed us to redesign our mock signage to a format that was more understandable to the public. Our final design for the data elements serves as an ideal model for representing the data elements we have identified.

4.2 Data collection results

As previously mentioned in our methods, our team spent the majority of our IQP term looking and funneling through hundreds of data sets. Out of these many sources, the final datasets we have chosen are:

Data Source	**Description**
EIA Electricity Data Browser	This source gives state level data on energy consumption, production, cost, and revenue by source. These data are updated on a monthly basis and are available as an Excel spreadsheet.
EIA U.S. Electric Systems Operating Data	This source gives regional energy demand on an hourly, daily, monthly, and quarterly basis. This source also gives forecasted data and limited information on energy production. It is available as an Excel spreadsheet.
Global Solar Atlas	This source allows for the worldwide analysis of data pertaining to location based solar electricity generation, potential and various other pertinent data elements. The data are updated on a monthly basis and is available in CSV format.

Global Wind Atlas	This source allows for a worldwide analysis of global wind speeds, wind power densities and power capacities of a selected area. The data are updated monthly and is provided in a JSON or CSV format.

Table 4: Open data source results

Within these data sources, ten data elements were selected for use in our mock signage and final design. The U.S. Electric Systems Operating Data (Hourly Electric Grid Monitor [computer software], n.d.) gave us information on the consumption of energy in the New England region. From the Electricity Data browser (EIA Database Beta, n.d.), we took information on the generation and consumption for the state of Massachusetts. The datum displayed the generation of electricity by source which allowed us to compare the production of solar and wind energy to that of fossil fuels. Ideally, we desired a source that reported this information on a county level; however, such data did not exist in any of the data portals we sifted through. Displaying this datum was important to the story that this display was meant to show. To further show the underutilization of solar and wind power in the United States, we used the Global Wind Atlas (Global Wind Atlas [Computer software], 2021) and Global Solar Atlases (Global Solar Atlas [Computer software], 2021) for vital information related to the potential to generate solar and wind energy over any specified area. These sources provided us with data elements such as mean wind power density and direct solar irradiation. The sources use this information to provide elements showing the theoretical generation of energy from a solar panel or windmill install. To obtain regional data from these sources, an area must be selected manually. This enabled us to display local information on the county level as well as on the state level. A quick comparison between the potential amount of electricity that can be generated, and the actual solar power generation figures demonstrates an underutilization of solar and wind power facilities. This comparison allowed us to demonstrate to consumers an accurate estimate of how impactful solar and wind power can be if they are utilized appropriately.

4.3 Interview results

Our team conducted two interviews over the course of our project. First, we interviewed Micah Chase, a part-time professor for WPI's Foisie Business Program, who has over 25 years of experience working with and leading startups. This interview was used to ensure that our signage would reach a broad audience and be easily read by the general public. Our second interview was conducted with Paul P. Mathisen, the head of the sustainability board at WPI. Professor Mathisen is a registered professional civil engineer in Massachusetts who has conducted extensive research on environmental issues regarding water quality. The main purpose of this interview was to ensure that our data was being displayed in a manner that allowed for equivalent comparisons and produced clear conclusions. Both interviews assisted in creating our mock and final designs for our signage.

4.3.1 Micah Chase results

Our interview with Professor Chase (Appendix B) allowed us to gain an expert opinion on how to target our data to our desired demographics. During this interview we specifically spoke about targeting advertisements and measuring the short- and long-term success of our surveys and signage. When talking about the targeting of data to demographics Professor Chase spoke about the importance of clean visualization and easy to understand data elements. Specifically, he pointed out his lack of interest in staring at seemingly random numbers on a screen. Through this we discussed the use of bar charts and other visuals to provide end users with understandable information. Next, we spoke about how to measure our success with both our surveys and our final piece of signage. We discussed how measuring the success of our survey may be tricky, due to respondents having different writing styles and mindsets when viewing our sign. We have incorporated the information we have learned in this interview by making our survey questions easy to understand with more concise answer constraints.

4.3.2 WPI Sustainability Office results

To help gain expert opinion on how to better use our data elements we met with WPI Office of Sustainability director, Professor Paul Mathisen. In this interview we showed our initial mock signage design to help give us an idea how to better use our data elements for public understanding (Appendix C). One of the main suggestions that Professor Mathisen made was for us to utilize graphics in order to better exemplify our data. We acted upon this within our mock signage design by using multilayered bar graphs to compare data elements. He also recommended reworking our wind power density statistic. In response to this comment, we made a range for the power density to try to show a comparison between low- and high-density areas. This interview provided information that helped us refine our mock displays and overall final design.

4.4 Survey results

We conducted a survey (Appendix D) to look at how the public might interact with our sign, using mock signs as prototypes. Our team attempted to reach a full representation of WPI's campus with our 27 responses. We were unable to reach a representation of the full WPI community in this survey. For example, 93% of our responses came from students ages 18-22, meaning we were unable to represent the faculty and staff sufficiently. Also, ages 23-59 only represented 7% of the survey responses as none came from anyone 60+ years old. Although about 67% of our responses were male, this is not far from WPI's male to female ratio, as 63% of undergraduate students are male. While the representation did not truly reflect the community's population, our data nonetheless revealed how members of the public interact with our concept and data elements. Furthermore, while it is beyond the scope of our project, these data could be compared to additional responses if the survey were administered to a broader sample of the WPI community.

When looking at the first sign we mocked up (Image 1), most of our respondents understood that Massachusetts uses primarily natural gas as a means of power production. Only four respondents, when asked about their major takeaway from the sign, noted in their response a relation to renewable energy. One of those respondents was under the impression that, "Most

energy comes from wind," meaning they may not have understood the data elements clearly enough. However, seven respondents understood that our sign was trying to convey information about renewable energy sources and that we should be relying on them more. Seventeen people who rated the clarity of the first sign scored it between 5 and 8 out of 10, with 10 being the clearest. The most common score, with 8 responses, was an 8. Four respondents felt that our titles and graphs could be better organized to understand how the pieces of information fit together. Also, three respondents said that we should better define and represent the statistics we are working with, putting the definition of MWh in bigger writing. Overall, regarding our first sign people were confused on how all the graphics connected, or what the true potential for renewable energy in Massachusetts was. In this first prototype the team felt that the overall story was getting across to most of our test population, but improvements needed to be made for the data we are working with.

Our second sign (Image 2) was the more popular out of the two signs and people felt that it was the clearest overall, with three respondents saying they thought this sign was better than the first. Eight people noted as their takeaway the fact that there is potential for renewable energy to be the primary source of energy in Worcester County. This was confirmed in the rankings with 22 respondents ranking the sign between 7 and 10 on clarity and conciseness. The most frequent answer was again an 8 level of clarity with 9 responses; however, 8 respondents also ranked the sign at a level of 9. When asked about what the sign is conveying, 14 respondents understood we were trying to relate solar and wind power production to its potential to demonstrate its underutilization. Three respondents felt that the data could be better organized and could have better titles. Two respondents also thought that there was unnecessary data contained within the sign. The response from our test population was overall much more positive in relation to our second sign. This was anticipated since this sign was a more idealized version of the data elements the team would have liked to find.

Our team also asked people to make general comments when it came to our signage. These comments mostly focused on the fact that people liked the message our sign was trying to spread, in relation to solar and wind energy. The comments also reflected that they enjoyed the second sign more. As previously mentioned, our team anticipated that our second sign would be clearer and better received, since we saw this as a more idealized version of our current datasets.

Based on all these responses and recommendations, our team was able to adjust our mock signage in order to clarify our message and best represent our data. Our team made specific changes to focus on either production or consumption and to clarify our graphics through better titles. We also created better metrics for displaying Solar and wind potential for the State level sign we created. Our findings from the responses gave us valuable feedback on our prototype design from the public's point of view. This point of view was essential in creating the best sign design possible. This design was essential in selecting the data elements for our final design and our recommendations for ideal data elements.

4.5 Final Airtable

We constructed a final version of our Airtable (Airtable, n.d.) that gives descriptions based on the categories described within our methods. These categories will allow Roadify to quickly sort through our data sources for desired elements. We also included a recommendations section to help our sponsor understand what future work can be done with each source. This completed Airtable will help Roadify in making current data available as well as future research. This is a snapshot of our completed Airtable.

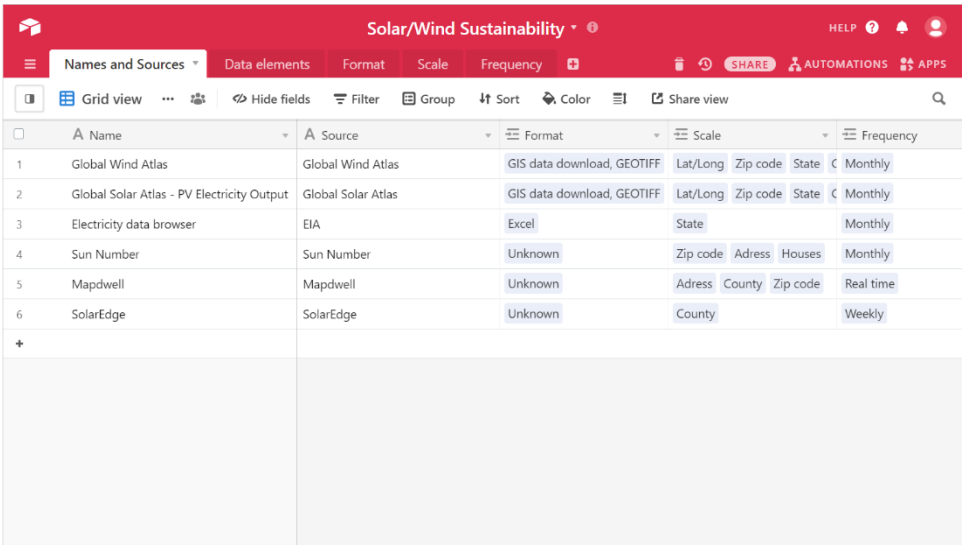


Image 4: Final Airtable

4.6 Final sign designs

Our team used information gathered through talks with our sponsor, interviews, and surveys to create four final sign designs. These work as the best representation of our current data elements, a proof of concept and as model moving forward. Our first two signs are updated versions of the signs we created for our surveys.

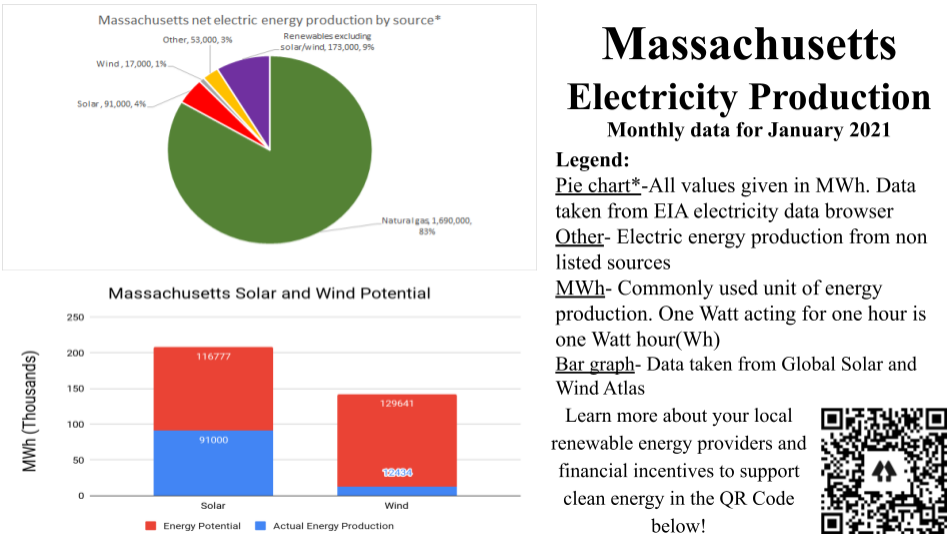


Image 5: Final Massachusetts state sign

This is our updated version of our initial Massachusetts state level data sign we created for our surveys. We decided to focus on energy production data rather than consumption data. We made this decision since our current data sources had more complete information on energy production. We also decided to change the format that we were displaying our solar and wind potential information. We decided to display the information in the same way it was displayed in our Worcester County sign, since it was clear in our surveys that people understood the potential for renewable energy communicated through that sign. We also changed the titles of our graphs to make it clear what information we are displaying, which is net electric energy production by source. Finally, our team wanted to expand our definitions, change scales on graphs, and include

where the information is coming from. This helped clarify the information in our sign. We feel this is the best possible format for displaying the current available data.

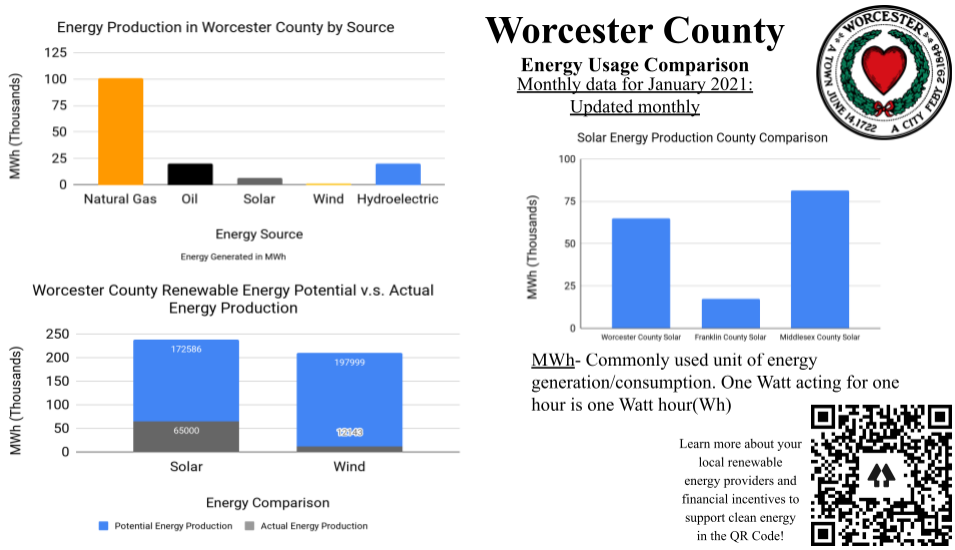


Image 6: Final Worcester County sign

This is the updated version of the Worcester County sign displaying the same data sources updated based on our survey results. The titles of all graphs and the signage title have been changed to clarify the data being presented and the scale at which said data is on. The third graph on the right has been changed from “residential consumption” to a comparison of solar energy generation between different counties. To compliment this, the scales on the graphs were changed to MWh (Thousands), this gives viewers more time to focus on the visuals instead of how large the numbers are. Finally, the definition of MWh has been increased in size and moved up to make the definition easy to find. The changes made help strengthen the clarity of the data displayed and have reduced the time viewers need to fully understand the data story.

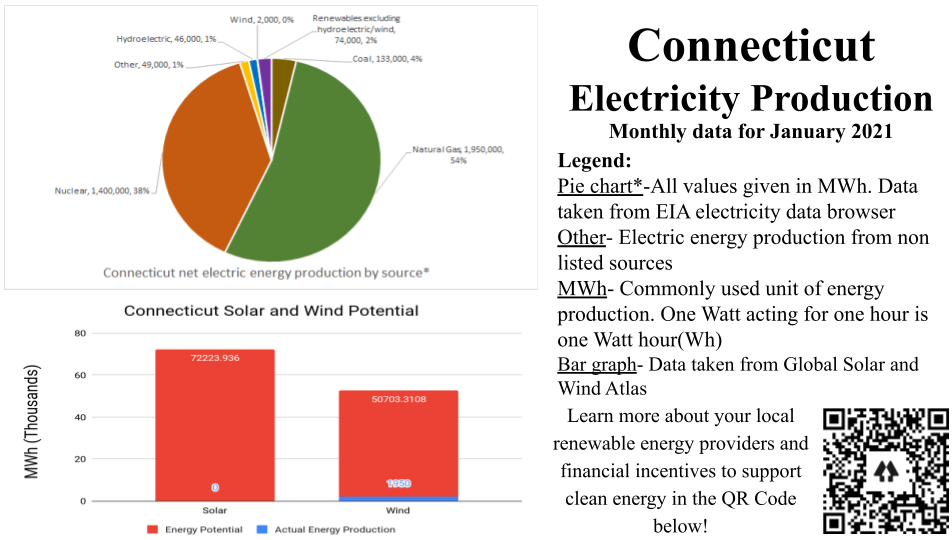


Image 7: Final Connecticut state sign

Our team designed this sign in the same format as the Massachusetts state sign with data from the same sources. This sign shows that our current data and concept are scalable to other parts of the United States other than Massachusetts. We feel it is important to maximize our sign's impact by reaching most people possible.

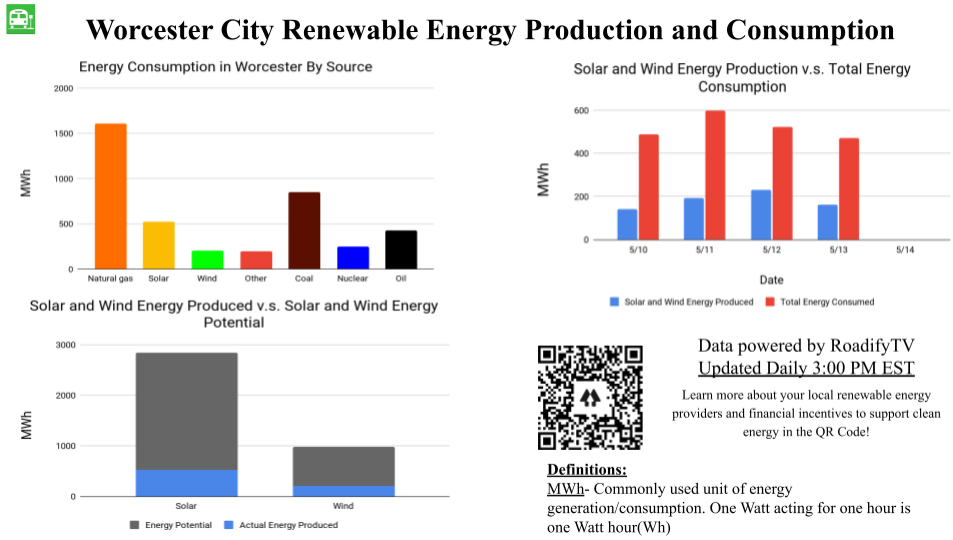


Image 8: Ideal sign

This final sign design is an ideal representation of the data our team would have liked to find through our research. Unfortunately, our team was unable to locate all the data elements, we would have liked. However, this sign represents the missing data elements on a localized basis.

The first data element shown in the top left corner, shows consumption of energy for Worcester City by source. This element will give people an understanding of where the energy we consume comes from. Below that, we compare the potential energy that could be generated by solar and wind energy, to what is being produced. This will allow community members to see the underutilization of solar and wind energy compared to its potential capabilities. Finally, on the right side we compare total energy consumption to the solar and wind energy produced. This graph will allow people to make quick comparison between the total amount of energy consumed and compare how solar and wind energy relates to that. Within the sign we also included the definitions of a MWh and a QR code from our previous signage. Finding this data that updates daily and making it location specific will allow this sign to have the greatest relevance, allowing for the most potential impact.

These signs exemplify how this type of information can be displayed to raise public awareness. They also work as a proof of concept for our research and show that more interest and work should be done into this area of open data by our sponsor Roadify.

5.0 Discussions and Recommendations

5.1 Discussions and Recommendations Introduction

Over the course of the project the team has come across several problems related to finding relevant and useful data sources. The team had to work with data sources that were currently available to us based on our criteria. Due to the scope of this project our team was unable to fill these gaps in information but would hope that emerging data sources, and future projects, are able to do so. Our team was also unable to make a final design within Roadify's system. This final design would not have been like our mock displays due to shortcomings in Roadify's current ability to make graphics. The team feels that by reaching out to certain groups and adjusting software within RoadifyTV this project will have the ability to create an even greater impact across the entire United States.

5.2 Feasibility of current concept

Although our team was able to create several prototypes and designs for our digital signage, the data available to us had significant gaps. The three major criteria each data source needed to fill to be considered were that the data needed first to be location based specified down to a county level, second to be dynamically updated within a month, and third to be available in an easy to process format. The third criterion was easily dealt with, since the data were often presented in numerous formats making it easy to find ways around problematic formatting. The first two criteria were out of the team's control and therefore not possible for the team to overcome.

Our first challenge came in the form of acquiring data sets at the desired county level scale. There is an overwhelming amount of open data on energy consumption and production across America, which the U.S. government aggregates by source. However, these data are often only provided per state. For instance, the EIA Electricity data Browser (EIA Database Beta, n.d.), one of the sources used in our mock signage (Appendix E), provided power generation information for the entire state of Massachusetts by source. In our research into different data sources relating to energy production by source our team was unable to identify county level information we desired. This problem arose in the majority of the other data sources we found during our research. Data sources for energy consumption and production in the U.S. are currently not scaled to the level this project desires, to present county specific information. With time for this industry to continue its development and the involvement of private companies, such as solar installers, this concept may become easier to execute.

The second challenge we faced when procuring data sources was the dynamic nature of each data set. Our criteria stipulated that data must be updated within a month to be considered. This became a challenge once we realized that most government sources only provide electricity data in annual reports. This immediately disqualified several government sources for consideration leading us to begin looking at private companies and other organizations. Once we shifted our focus to other organizations, we were able to get the data that was updated at regular intervals. In the end the most frequently updated data we were able to identify was monthly.

Overall, our team was unable to identify data sets that fully met the needs that were described to us in our project description. However, our team was able to identify data sets, such as the EIA electricity data browser, that prove promising for acquiring more specific information. Other private companies, such as Mapdwell (MapDwell, n.d.), are also working at similar goals and have information that would have provided useful data to this project. Therefore, this information our team was looking to acquire may exist, but more work is needed within current data sources to acquire this information. Our team's direction with this project is feasible but would need a larger scope to reach its full potential.

5.2.1 Proof of concept

Even though our team was unable to find sources to make a sign available within RoadifyTV the signage our team developed for the final deliverable showed that this was a possibility. These signs along with our Airtable (Appendix E), and survey and interview results, show the proof of our concept. Even with the limited data available, the survey data (Appendix D) we collected suggests that signage for this purpose is useful. Our interviews agreed with this idea, as the Professor Paul Mathisen thought this project was interesting and could benefit the WPI community. Even though we primarily focused on data related to Massachusetts, we also created a sign for Connecticut to show how our idea is scalable to other areas within the United States. Our team used three other mock signs to demonstrate the ideal format for displaying data elements showing that this type of data can be displayed for the stumble upon use case. Finally, our final Airtable contains 6 sources that are useful to Roadify. Even though currently these sources are not useable directly in RoadifyTV they demonstrate that this data exists within some capacity; and that looking into more groups to work with could prove beneficial. Our project demonstrates that this is a feasible concept that should be explored for future options and improvements.

5.2.2 Ideal sources

An ideal data source for the scope of this project is one that fits all three major criteria: location based, dynamic, and formatted correctly. In addition to fitting all the necessary categories, the team recommends identifying four specific data points:

- Localized data for solar and wind electricity production
- Localized data for non-renewable electricity production
- Localized data for the consumption of electricity by power source
- A more functional data source with comprehensive elements of solar and wind energy potential

Finding data for localized solar and wind electricity production on a county level rather than a state level would be more relevant to the end user. Pairing this with a source relating to local production of electricity based on non-renewable sources can then be shown in comparison, this demonstrates to local population the disparity between our use of renewables and non-renewables. We also suggest finding an ideal data source that looks at the consumption of energy from a variety of sources. Localized electric consumption data provides a perspective of where the end user's energy is coming from. This is another avenue of data storytelling that allows the consumer to make a conclusion about their personal energy use. Finally, a more localized source of solar and wind potential will relate this potential to the user's consumption of energy. While we do already have a source of this variety in the form of the Global Wind and Solar Atlases, this data is difficult to work with and requires a considerable amount of manipulation to be meaningful in the context of the overall display. Combined, finding these 4 recommended data sources would lead to the most ideal piece of digital signage.

5.3 Recommendations

Our team was able to create a final display that was able to show our found data elements to the public. Our ideal sign design was not currently feasible within RoadifyTV from a technical standpoint. We were also unable to find relevant information from available sources that satisfied

all our criteria. The following recommendations made by our team involve different groups to contact for more relevant information, approaches to displaying this type of information within RoadifyTV, and strategies for making the signage more interactive.

5.3.1 Groups to reach out to

To find some of the ideal data sources we mentioned above, Roadify may need to reach out to private companies to make its environmental signage a success. Some companies we have found that may be able to provide data through corporate sponsorship are solar installers and product providers. One company the team found was SolarEdge (SolarEdge, n.d.), SolarEdge has a network of solar installers, connections to private energy companies and a line of in-home solar products which makes them a good potential source. They offer several smart home features and products that allow for the tracking of electricity production and consumption in real time across the United States. SolarEdge provides these services to its customers, installers, and other qualified partners. If it is possible SolarEdge may be able to provide localized data for a county, town, or even exact address. The team also feels reaching out to the EIA (EIA Database Beta, n.d.) may prove useful in gaining access to new and more focused data sets. The EIA has a public and a private beta program for its new data sets and APIs, with another corporate partnership it may be possible to gain access to APIs still in development. Furthermore, the team also recommends reaching out to a company known as MapDwell (MapDwell, n.d.), this company currently provides private information on solar potential to solar panel installers. We feel this data could make an impact to the public and could be mutually benefited for both our sponsor and MapDwell, depending on which data elements they would be willing to share. Finally, our team suggests reaching out to SunNumber (SunNumber, 2019) this company works to give people a solar score based on different aspects of their house and compares this number to the surrounding area. They also work to put people in touch with local solar providers. This company follows a similar mission to our project, but their data is currently inaccessible to our team in a format that can be ingested by the Roadify system. We feel this company may be interested in a partnership if further contact was made. Reaching out to the described companies

and other local solar installers and groups could prove useful in bringing this project to a level where it could provide real impact. Our project showed that this concept is doable and would provide benefit to the community, and if more qualified data sources were found this concept could grow.

5.3.2 How Roadify should display this data type

Within RoadifyTV's current format data elements are displayed as numbers with various units and labels, and simple graphics. These current data elements allow for only simple formatting changes with little customization ability. In this current format, RoadifyTV is unable to create or customize graphics in a way that would allow our team to create our ideal display shown within our final deliverable (Appendix E). We suggest that Roadify works within its system to create more customizable graphics to allow for a wider variety of displayed data. This displayed data will also work better within Roadify's model as it will allow for a quicker understanding of the displayed metrics.

5.3.3 How to make signage more interactive

Our team felt it would be useful to discuss how we can make our sign more interactive to make it more impactful on the community. One way to do this would be to compare different statistics between counties or cities, such as how much solar energy is being produced there. This has the potential to create a sense of competitiveness which will drive the push for renewable energy. Our team also included QR codes within our signage design, and we suggest making those codes relate to local installers and benefits of renewable energy to have the most impact. Roadify could also track how often the barcode is scanned to see the impact the sign is making within that community. Our team felt that making the sign more interactive would improve user experience and overall impact.

5.4 Discussions and recommendations conclusions

Through these recommendations we feel that the project our team completed could be taken to an even higher level. We feel that this information is relevant to the communities and that the concept behind this digital signage could really benefit the push for renewable energy sources. There are currently some obstacles with achieving its full potential. To help remedy these issues it would be beneficial to identify and partner with groups that hold relevant information and work on changing display capabilities within the RoadifyTV service. If these obstacles are overcome this project will have even more potential to have a significant impact on the American public.

6.0 Conclusion

Although open data is widely available, finding ideal solar and wind energy datasets for this use case proved challenging. Open data sources pertaining to the focus of this project were not as local or dynamic as the stumble-upon use case requires. The data was most often given in reports over a previous time periods rather than being updated real time. Specific data elements needed to communicate our story were also frequently found on a scale larger than desired for our use case. Datasets with these qualities will not maintain relevance in a community over time. Through interviews and surveys using displays representing the concept of our signage, we found that displaying data relevant to our research topic would be of interest to the consumer. We also saw that this information could have an educational benefit to potential end users. Although measuring the impact created by a sign of this nature is challenging, this platform for education on the local use of renewable energy would be beneficial to society. Although we only had a small sample for our survey, subjects expressed interest in the concept and saw the benefit, further justifying the benefit of this project. As open data continues to improve, and smart cities begin to grow, digital signage will continue to become more prevalent. Our project demonstrates that using digital signage for this purpose can have an impact and should continue to create sustainable changes in communities across the United States.

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Appendix:

Appendix A: Interview with Scott Kolber

Question	Reasoning
How does Roadify's signage make an impact on the communities it is available in? Where do you see the future of digital signage in the community moving and how will its impact grow?	• Leave time for follow up questions, expand upon the **impact** of Roadify as a social entity not as a company. • We want to focus on the social impact here. We know his stance on how important open data is and how much of an impact it can make socially but we need to have him outright say it.
What social research did Roadify do to choose its locations in New York and other cities?	• Not direct methods. Looking to see how they evaluated each city (what criteria such as data availability, most impact, easy to work with city government) • Do the unique needs of New York city amplify the importance of Roadify to the local community in New York?
How can the impact of Roadify transcend its role in the transportation market and expand into other sectors?	• How does Roadify plan to expand its social impact from transportation to have an even greater social impact? • Mention RoadifyTVs ability to list soup kitchens and restaurants and other places.
How did Roadify identify effective locations for the stumble upon use case? What main things are used to draw a user to signage in this use case?	• For background purposes have scott **DEFINE** stumble upon first. We know what it is but for the purposes of our expert interview the readers may not know. • Ask how he views the stumble upon use-case and how he has transferred that vision to Roadify
What are some challenges you guys have faced when working with the covid dashboard?	• Try to relate some of the struggles and solutions Roadify had to our project.

Appendix B: Interview with Micah Chase

Questions:

Question
What initiatives pertaining to sustainability and moving to renewable energy have you seen making their way into the business world?
Do you see digital signage to be an effective form of informing consumers about a product, event or anything in their local area?
What are the keys to making an effective advertisement or sign?
How can we measure the short-term success and patterns found in our end user survey? How can we expand that philosophy to measure long term effects?
How can you target a select audience with a broad

marketing tool such as digital signage? How can you ensure the intended conclusion is being drawn from the information displayed?

Transcript: Using Zoom Closed Captions

12:08:00 Dang and there we go.

12:08:02 Okay. So, just to give you a little bit of background on our project, so that you get a little bit more insight into what I'm going to actually ask you, um rota fi is a company that has partnered with us, that organizes and displays information about

12:08:22 transit. So public transit like buses subways specifically in New York and all over the US on digital signage and their main goal with this IQP project and how they've partnered with us, is to kind of increase their expand their kind of feet and dip their

12:08:39 feet into the world of social impact. So they are working with another team over at john hopkins working on covert data, and they want to work with us to work with environmental data.

12:08:53 So specifically, our main goal is to talk about the under utilization of renewable energy such as solar and wind power.

12:09:01 So when I say digital signage what I actually mean is I'm going to just going to share my screen real quick, saw this out in the wild.

12:09:12 And my both my advisor said that it would be wise to share it with you so you get a good idea of the use case.

12:09:19 There we go. So this was at a rest stop in New Hampshire, and the rest stop is actually powered by solar power.

12:09:28 And this talks about using Lino live real time data to be able to generate electricity. And then there's also information about how much car us co2. It saved and different statistics related to the power, power of the actual building and the generation

12:09:45 that has happened, that talks about their solar panels. Is that right, yeah so talk bankrupt school has that in there.

12:09:55 You know they're powered by a lot of solar and they have a display like that it's pretty cool.

12:09:59 Yeah, we kind of wanted to kind of just, you know, give it give a little bit of context because the other people that we've spoken to on this journey of an IQ p have been very confused on what we mean by digital signage and I just want you know i was

12:10:27 was picturing a billboard on the highway. Hang on a second, can I just yell at my dog, your dog.

12:10:28 Sorry, I have, I have to move up one level of severity with them. So I thought you meant, which I have her like a vibrating color thing

12:10:40 he just he just left the yard sorry.

12:10:43 Sure, I'll get I get it. That's our pets are a handful.

12:10:54 I think you might have three billboards on the highway.

12:10:58 And that's not you. It doesn't matter where you're going to do it, because I'm not sure It matters not not necessarily we're using this is so the project is more of a proof of concept for this company to show that it's possible.

12:11:11 So like we were thinking on the scale of like the the fuzzy big like jumbotron thing Yeah, that's beautiful.

12:11:20 But it doesn't it doesn't necessarily matter where it is because it'll just be specific to wherever it ends up all of our data that we're using is scalable for us.

12:11:30 Yep.

12:11:31 So, okay.

12:11:33 So all of that is, this is more of just a proof of concept and then he will be able to pitch that.

12:11:39 Yep. Yep, we're freezing up a little bit so that was trying to move closer, thinking you must be me.

12:11:46 Maybe it is me I'm not sure.

12:11:48 Okay. So, okay, how can I, how can I be of assistance here. So the main thing that I kind of wanted to get an kind of an insight into was the initiatives and kind of culture that's been going around in

12:12:07 in quotes the business world I know that's a very broad term towards moving towards towards like sustainable energy, a lot here, way I'm sorry.

12:12:17 You know what I'm gonna try to lock. I don't know if it's me. Where are you are you on campus, no I'm in my apartment, but I'm plugged into Ethernet so I'm not sure if it's my rotary think it's me.

12:12:27 All right, let me. I'm gonna just try logging on to my computer, because I saw your message and immediately hit it on my phone right, whereas before I tried my computer.

12:12:38 So, so let's keep talking but you're going to get a second me in a second to make emphasis on any points I have you'll have to have me.

12:12:47 So, Yeah, I think that works you can zoom in three times and really getting plenty for us.

12:12:56 I know that like something that we've talked about but not here the purpose so how I can help yet, I have a question though if you're hearing me Okay.

12:13:05 Yes, absolutely.

12:13:06 Okay, great. And that question the first batch that came up when I saw your notes was, what is the action.

12:13:13 You know, typically, I want it, what is the what is the action requested from the, what is the call to action for the, for the viewer.

12:13:23 So if you just show them information about, you know, gee, look at how much energy is being wasted but there's no action item for them.

12:13:35 What's the point.

12:13:36 So that is actually what I was, I was going to mention this, we have a QR code that or at least we're developing currently a QR code with the link tree.

12:13:46 That will take you to a government website that details local installers and all of the financial incentives to actually switch to solar or wind.

12:13:57 So that whether that be tax breaks or not ugly, they're called.

12:14:05 Okay, so let me, let me stop you on one

12:14:17 better.

12:14:20 So they're called sx which is SRC which is a, an abbreviation for solar renewable energy credits. So every time you return a certain amount of energy to the grid you get paid, you know, and that's the action item, it's more of the way that we've envisioned

12:14:36 it and the way that I kind of like our partner codify specifically the CEO, Scott Colver has envisioned it is, we've kind of presented it as an educational thing, kind of like something on the side of the side of the road but something that you see that

12:14:55 flashes for 10 to 15 seconds that kind of just like, oh that's curious, let me wait for this to come back around maybe I'll see what that QR codes all about.

12:15:02 It's not necessarily something that's going to cause someone to completely re evaluate their perspective of the environment and the current energy market, but something that is going to just kind of have them say give them like a ha moment, and possibly

12:15:20 engage, even a few people

12:15:24 just maybe answering Why just just, even if it's a very small amount of people just to engage them in even doing research into solar or wind or any of that.

12:15:35 What does the QR code do again because you were breaking up when you said that before, but now so connection. So it takes you to a link tree, which is basically just like set of five to 15 links depending on whichever ones we finalize one would be like

12:15:49 a government website that details the like financial incentives. One is from a just basically a free online service that helps you find the five most local solar installers, and then everything else about the basics of solar power so like a really easy

12:16:06 to read article on photovoltaics and a really easy article on electromagnetic generation of turbines and things of that, that nature to kind of just bring people into that even more like educated standpoint.

12:16:21 All right.

12:16:23 Good.

12:16:23 Alright.

12:16:27 So, back to my back to my first question. I'm in the very broad window of the business world. Have you come into any contact with any kind of initiatives or pushes by even small companies to to move towards renewable energy or sustainability to kind of

12:16:45 get ahead of that climate change curve or has not really been brought into maybe the corporate world yet.

12:16:52 Oh no.

12:16:56 I see it everywhere I mean a lot of, you know, I just mentioned bankrupt school which is a nonprofit, but they were looking to do both.

12:17:07 O'Connor's restaurant down on Route 12 which is kind of a popular restaurant around here.

12:17:20 They put solar power up I don't know a bunch of years ago I was talking to him, and I said, because I'm right down the street from him, and we have a great roof for solar power and we get a lot of people coming in saying, Oh, you know, we, there's there's

12:17:35 a, there's all sorts of government incentives, would you like to do this and I, I often look at it.

12:17:42 And it doesn't, the incentives don't work as well in in our town that I can go into why that is in a minute but let's just say, except for the moment that the town doesn't give those incentives.

12:17:54 So, I was looking at how long does it take to pay for these solar panels and it took a really long time. So I was talking to the guy who owns O'Connors that restaurant down the road and he said yeah it's about finding your payoff, which is a very long

12:18:07 time. Yeah, it's you know you typically don't make an investment that's going to take you don't do that.

12:18:14 If profit is your only incentive, you know, typically we're looking for a couple years back, three, four. So, he did it so that tells you that he did it.

12:18:30 He took the effort to do that knowing that it was a long payout because he thought it was the right thing to do. I think that's enough that's an example of what you were just asked to I think it's in so I just gave an example of a small business and a

12:18:36 school.

12:18:38 You know, you look at, oh my gosh you look at Microsoft and, and they're doing amazing things right so there's a corporate there's a big corporation, who are paying growers not to cut their trees, because that's how they're offsetting their usage.

12:18:55 Yeah, I was, I'm actually really happy that you brought up, specifically O'Connor's because that I can mention that in like the local section when we end up writing our paper, because like we're kind of looking for small businesses so like the bankrupt

12:19:08 school as well, is going to be interesting because we can, something that I've been kind of thinking of, like you said is, who's going to invest on, you know, a 20 year payout when it comes to solar panels and an even greater amount of time when you get

12:19:21 a small scale wind turbine.

12:19:24 And I think that like as much as I show the financial incentives of like, oh yes you get X amount of money off of your, your property tax and X amount of money off of you know whatever else and you get loan guarantee and all that.

12:19:36 It's still so much money that that's one of our big hurdles that we're, we're struggling with when it comes to not just homeowners but businesses like if we were to put it in a city.

12:19:47 Yeah, I see happening a lot of places and Westboro the Westboro tennis club is another example if you want a local one, and I can connect you to the person if you want, Justin.

12:20:01 He put in a while ago, and I think he sold the business and he kept the building and, and then they had to pay him for electricity, like they had to work that into the contract so if you're a, and I'm a landlord.

12:20:10 If you're a landlord, typically the tenant is paying their own electricity. If you put solar panels up, then you have to work out some bring with them but I see it happening more and more, and the incentives.

12:20:22 At least were attractive enough, in most cases, you know, the 20 year payout was rare I think it's because I was in a town called West Boylston down the road, and and they, they have a small municipal electrical company and they just don't offer the same

12:20:36 incentives as, as the bigger cities, so that I haven't done it, you know, I'm feeling guilty now that I'm talking to you. Yeah, no, not so what I'm trying to do.

12:20:47 I know that I know.

12:20:48 And the other piece that keeps coming to me is boy the solar, the solar solar world's pick whatever it is that they use to capture the, the seller will pay excels Am I saying that right, that's, you know they're they're just getting so much better over

12:21:04 You know they're they're just getting so much better over time so it's a little.

12:21:08 I have talked myself into waiting a little longer.

12:21:12 That's not bad, because I see a lot of businesses doing it.

12:21:17 I think that that that's like something that we kind of knew in the back of our minds but just hearing it from someone in general with local examples just really kind of hammers at home for me because that means that that in my head at least there is

12:21:33 some kind of base that we could put this up and people may say like, Okay, well, yeah. Yeah, I would say I'm kind of, you know, I'm probably a good bad guy and a good candidate.

12:21:45 Because you know if I see enough of it I'm like, I can't deal with that, you know, So there is something to that.

12:21:51 And I do think most people want to do the right thing. We all see the world is is you know the problem.

12:21:58 So, I don't, I do think people care.

12:22:03 So to kind of move on to the other end of what I plan on asking is, how do you see the growing of digital signage, whether it be on the side of the highway like you were originally thinking or, you know, something more akin to the Time Square advertising

12:22:19 boards or even the giant Boise screen. How effective Do you see that to be as a form of, whether it be advertising a product marketing and event, or just providing information to consumers about anything in their local area.

12:22:43 I'm not sure if I'm hearing this right but the way I interpreted that question was, hey that's kind of a broadcast medium. It's localized geography, but in all other ways, it's to everybody.

12:22:48 So I think you know since, since internet advertising has begun.

12:23:02 One of the really strong selling points is I can target exactly who you want.

12:23:02 So if you're going to spend $1 you, the old method would have been to pay a lot of money to be in the Super Bowl ad.

12:23:11 When I was starting, we started we I need an example that that was that would have been an old way of reaching a lot of people, oh no this is a great example.

12:23:20 Hey I made wedding invitations, and I sold them online really early in 97 we started going online and we were, we were one of the first but there was another company, so 97 Amazon has not is selling books, Google has not founded been founded yet.

12:23:36 The context was put your phone into the cradle to listen to the internet type thing. Maybe a little past that, but there was a company that was getting some funding.

12:23:48 It was an internet e commerce boom starting, and people were giving my internet companies and they were selling wedding invitations and they advertise on Super Bowl because that was the natural way to advertise with the Super Bowl is kind of a funny place

12:23:59 to advertise wedding invitations.

12:24:01 What is the subset of people that you're broadcasting to that are likely to buy it, it's pretty small. And if they spent 1 million to $4 million, and as a small company that was there, that was the thing, you know, and then they were at a business.

12:24:17 So it was a poor broadcast was a poor form of advertising for this niche thing, a much better way of advertising, you know, so that wasn't around quite then but a little later, is paying Google or Facebook to say to show it to people who are shopping

12:24:35 for wedding related things, or who are already engaged, like that is a really targeted audience, so I don't have to pay $4 million to get that subset of people.

12:24:48 I have to pay me $1, each time I show it to a person who is qualified. So the Internet has allowed us to get to qualified customers broadcast, not so much bulletin boards, you have the advantage of, well at least it's geographically, you know, depending

12:25:05 on where that bulletin board is, it may be targeting if it's a Western restaurant and the bulletin boards and Wister, that's a pretty good targeted audience.

12:25:19 On average people like restaurants, so you've got a large group of them and they are local.

12:25:20 So I don't know if that if that answers your question, well enough,

12:25:26 kind of, I mean I'm, I'm thinking of following it up.

12:25:31 Sorry, I'm sorry you broke up for a second.

12:25:34 I was saying, I was just summarizing and saying a bulletin board is less targeted.

12:25:42 In general, but depending on where you located it, it may become targeted in as an advertiser I tend to like a targeted at targeted meaning going to people who are likely to buy my product qualified.

12:25:59 Got it. Yeah, okay that answers the question in a, in an interesting way that I didn't think was going to come around. I didn't think about like the targeting of it.

12:26:10 I think the way that we originally saw it and this has definitely opened my eyes to like a new, a new way of thinking about it, which is like exactly why we have these interviews, is like we kind of saw it as like, Okay, if we were to put this up alongside

12:26:26 our partner companies transit signage, that changes every you know 10 to 15 seconds from like an actual like McDonald's add to, you know, oh, this bus and the green line subway are going to be two minutes late because of train traffic or something along

12:26:41 those lines.

12:26:53 Is that a highway sign What is it transitions so a transit sign Let me try and see if I can pull up a good image of,

12:26:56 you know, I have.

12:26:57 Sure. Okay.

12:26:58 Um, this is just the app yeah they don't like to put pictures of their, their actual signage on it.

12:27:15 Um, so say I was in your Oh good, good. Hold on one second. Yep.

12:27:12 You have one.

12:27:26 Sorry my phone.

12:27:28 Shannon let's go

12:27:33 here.

12:27:47 Sorry about that.

12:27:48 Timing because we started our call and I had somebody coming year ago.

12:27:53 Okay.

12:27:55 Um, so to kind of jump off from that I didn't really think of it on like a targeted versus broadcast standpoint.

12:28:05 What is the transit time you were saying right right

12:28:10 and just tell me.

12:28:11 Like when you're near a store that's near either a bus stop, or a subway, like if you're getting like food at a train station or something along the lines of that, the signs that show.

12:28:25 You know when arrivals and departures are occurring. And then stuff that's a little bit more public would be like on the side of the road in New York City, somewhere near like the Barclays Center and Central Park.

12:28:39 It was a great article. Oh no, I know those signs that you're talking, I think I know the signs that you're talking about, there are there's these stand up ones in New York right along this city streets I forget what they call a metro something, and you

12:28:52 get all kinds of information and there's a nice article how Google has cameras and they're monitoring, who's going by and doesn't matter, the only the only thing I know is that the, that these transit signs they have like live, live feed data that effectively

12:29:10 sometimes will have like adds up for whatever companies want to pay for the ad space, and then they'll show you like this bus is late, and it is here.

12:29:19 Yeah. And we were kind of thinking on the along the lines of, like, oh just throw us into one of those 10 to 15 minutes. Second, like if you wanted to make this into a real thing and partner with a solar company at some point.

12:29:31 So like, it's definitely on the more broadcast than a local side of it, because all of our data is geographically based.

12:29:41 It's kind of targeted to a geography, but I do think, I do think that that it's, it'll be an interesting thing to talk to our sponsor about targeting ad targeting this kind of dashboard versus

12:29:56 kind of a higher level, how we might think about that is what do I want to accomplish. It sounded like in the beginning, we really want to accomplish is to have people convert from gas from

12:30:10 gas and oil to solar, whether it's businesses or consumers, that was the action item you wished, like, how would you know if you're.

12:30:19 How would you measure success.

12:30:22 I don't know if I got it right but let's just say it was how many people converted over to solar solar from, from some non renewable energy and. And then, you know, gee, maybe that's hard to figure out because that doesn't happen for two years, Micah

12:30:38 Chase has been talking about putting on his building for years. This may just be one more thing that helps them go there. And so, you know, often in marketing will will go one step back from that and say well all right how many people looked at it and

12:30:51 actually scan that barcode because at least showed interest.

12:30:54 Right, was kind of a funnel from when I show them something to when I get them to do the action they want. Sometimes those that funnel is so long microchip is putting a solar panels on his on his roof that you can attract way points along the way to see

12:31:09 my getting there.

12:31:11 But I think the important question is matching up, what you want to accomplish, and the audience that you want that you think is going to do that. So the transit sign may be great for what you want to do.

12:31:25 I mean it was good for McDonald's.

12:31:28 You know even even highway signs are good for McDonald's I guess because they're very narrow highways.

12:31:36 Just.

12:31:36 I think that the act of thinking about what actually what do I want to accomplish.

12:31:41 Who targeting and who is that, and is this location that I'm allowed to put it up, is that those people go by there.

12:31:52 Do you know what I mean like if you put up oil changes, next to a train station in a big city, oil changes for your car, that feels like the wrong audience right like very few of those people are likely to need to change the oil in their car.

12:32:10 Some of them may have a car. But, but it's almost an audience that doesn't use cars for the most part.

12:32:18 Yeah, so that would be the wrong, add for them.

12:32:20 But, but, but solar power, you know, I don't know what percentage of those people can affect it. If they're all apartment dwellers. And they and they rent, it's not going to help you.

12:32:31 Yeah, that's because they can't go or power on.

12:32:35 So it depends on what you, you know, think about what do I want to accomplish, who looks at it and then trying to think about, well, where would science be that at least some of those would be that audience and that greater the concentration, the better.

12:32:47 If it was all apartment owners, great attitude, building owners, great.

12:32:54 It was. Yeah, I got it. Yeah, that makes a lot more sense I guess we were thinking that like in. I think the funniest thing that we said once in a presentation was like who wouldn't want to learn about solar.

12:33:06 But then we were like actually talked about it later and we were like, yeah, that's not really like an accurate statement that we can just say, because you know you can learn all about solar you want and then just not be able to do anything and it's what's

12:33:21 important, right, and is your point to talk about it is that your goal.

12:33:27 Our goal like what what the data that we're actually going to be showing is the potential amount of generation of solar and wind energy versus the actual generated solar and wind energy over, hopefully a county basis but we haven't been able to find any

12:33:45 data sources that go down that specific, so you do not describe a goal there you describe the information you're about to show.

12:33:55 Yes, you do.

12:33:59 Yeah, I see.

12:34:01 But a goal nine. And I don't think this is yours a goal might be to increase the number of installations in that area of solar power, I don't know that that's your goal, it just.

12:34:14 In, after you state your goal, we're set you have to start worrying, thinking about how will I measure if I'm there.

12:34:26 Right, if I'm achieving it right so that one would be harder to measure I think by but do you see the difference between I'm going to present this information and.

12:34:31 And the goal. Yes, I do. Yeah.

12:34:35 Yeah.

12:34:38 So, or that's a question you might want to start really. So I think, I think that our actual goal is to educate various demographics about it.

12:34:50 We're using. So the main thing that we've that we've spoken about, because we are also doing a survey that's going to be sent out to some targeted clubs.

12:35:00 Actually I think by the end of the day to day, and some staff groups and things of that nature. Because we talked to our advisors, Professor advisors specifically about reaching homeowners versus college students versus people that may be you know late

12:35:16 later on in life and things of that nature and see how they respond differently to the data that we're presenting because the goal I would say the main goal of our sign is to engage people in a way that it might make a college student say okay well that's

12:35:32 something that I need to think about when I move out or a homeowner might say, oh hey look, I might be actually able to afford, getting the solar panels, feeling more and more like your goal is not.

12:35:42 So when you say my goal is to educate, I will watch my face because you can see it wins.

12:35:56 Because educating is not like who cares for what purpose, you want to educate people and then you're going a little further and said, well when they leave college I want them to go to a place that was bad when they buy their first home or I want a homeowner

12:36:02 or I want a homeowner to buy it so it does feel like your goal is to in some way increase the use of renewable energy versus non renewable, yes I not to educate, in a very in a very get you there.

12:36:18 Got it. Yes.

12:36:20 Okay, yeah.

12:36:22 I don't think any of our team members thought of it in that way but that is like a very roundabout way of.

12:36:30 Yeah, I guess you're right I guess that is something we probably should start asking yourself, it becomes a really important point to get to that to get to the right answer, of what are you trying to accomplish, because that will determine where those

12:36:44 signs go targeted audience, and what you what the action item you want them to do is so that you can check if you're accomplishing your goal.

12:36:55 Right. Yes, because there's no way to measure success if you don't even have the goal in the first place. Typically, when people try to just do an educational project and they don't really have a way of measuring success.

12:37:08 It is useless.

12:37:09 Sorry.

12:37:11 No, you're right, though it doesn't get it doesn't get you anywhere. You really need to know what you're trying to accomplish and some way of measuring whether you're getting there.

12:37:22 That Yeah, that makes a lot of sense I completely agree with the fact that just teaching somebody something and not giving them the resources to even do anything with it is nothing.

12:37:31 We're teaching them something that they really don't even have the ability to influence is irrelevant.

12:37:39 Yep, so you know whether teaching them or not as the right tactic that is actually a question after that comes after what are you trying to accomplish.

12:37:46 So if you were trying to accomplish getting solar power on everybody's roof and you were a dictator, or teaching them as a Roman, you could just command it right wouldn't have to teach them.

12:37:56 It's an extreme example, but you know his teaching his education the right answer, I don't know.

12:38:02 You know the government says I actually give financial incentives and remind teaching.

12:38:10 I think a really really easy way to people's like head when they want to install it, it is talking about financial incentives because it makes talking about money and the reduction of costs, even if it is a 20 year investment like return on investment.

12:38:24 Just, I think makes it easier for people to stomach the idea of making that 20 year investment.

12:38:29 But either either way, I think, I think that the reevaluation of goals is like going to be key because when we actually go ahead and present this to notify in this company.

12:38:39 I have a feeling that's going to be one of his main questions just because he tends to think like that as well.

12:38:46 But to kind of move on to just because you'll be able to say can I put in these places. This is where I think it makes sense.

12:38:55 Part of our final deliverable because we're kind of getting in on here at the end of the term is besides the signage design which is going to be something.

12:39:09 The next the next thing that I asked you about which I'm going to keep relatively brief is kind of like an attached paper to the actual report that we're going to be handing to him about where we think would benefit from this and I think that this in

12:39:19 invert this inadvertently has just been everything that we needed to know about how to actually go about writing that and how to persuade him that all the work that we've done is actually have any use.

12:39:30 And I think that that's like really helpful is his goal. What is his goal, out of this. So, specifically what they've been doing with covert data is they've been aggregating and presenting covert data in various rural areas through digital signage or

12:39:48 live boards on the town's website or things of that nature. And they were working with a student from john hopkins to aggregate all the covert data so whether that be positivity rates death rates vaccination rates and anything.

12:40:00 His main goal is the CEO of rotor phi is to expand rotifer from just a transit aggregation company to also any form of open data aggregation.

12:40:13 So he's trying to get his name out socially by doing coded.

12:40:17 And then, has effectively test us at the beginning of the term when he gave us the proposal for what he wanted us to do. He just said use open data to tell a story in a community that's a localized, and were like, cool.

12:40:29 All right, we have to figure that part out, and we decided to go with demons and nothing.

12:40:35 You decide to go with the environment. He didn't say how he just want. Okay, so he's trying his goal, what do you think his goal is, Personally, you told me again.

12:40:45 Yeah.

12:40:47 I think that he's in China you.

12:40:51 Sorry. There's a time delay. Yeah.

12:40:55 I'm gonna answer. Okay.

12:40:59 He's kind of sees this as, as, like I said before, a proof of concept and just kind of an affirmation of what he's doing to expand his company that last piece sounds good, expand company like I can see a CEO wanting to grow his company.

12:41:18 I also happen to think that he has a good head on his shoulders and a good heart and I think that when we brought up the environment, he got kind of excited because it was something that he personally holds true to his heart but I think from the SEO standpoint

12:41:32 I do think that the main thing that he's doing is he's rebranding the company from ratified transit to ratify data, I think is the actual name change that he's not planning, like like Apple going from Apple computer to Apple because they want to get into

12:41:46 other devices. Absolutely, yes.

12:41:50 Yep. And I think growing your company is a very good to your heart kind of thing by the way I do not see it as evil. That's I'm not saying that I'm just saying, from a purely environmental standpoint.

12:42:01 He was very excited.

12:42:03 As a capitalist I couldn't help it.

12:42:07 Right.

12:42:14 So it sounds like he's saying can you get other people interested in this way of advertising by showing examples of it outside of my traditional marketplace.

12:42:20 That's what I think I heard you say yes that's a very professional way of saying that, but he I mean, so he purposely doesn't want it to be in the same place as it used to be.

12:42:29 Is that right, I want to say yes but he hasn't been very clear on that will expand it.

12:42:35 Can you, you said, which I recorded it you said.

12:42:39 His goal was to engage a community in other ways.

12:42:44 So, so the way that he that again that he that he pulled it off to us was that he wants to expand his reach to areas of open data that are not related to transit

12:42:58 areas means content, you know, different areas of content. Yeah, different areas where he meant different geographic locations because I'm stuck right now in transit only.

12:43:11 So he's all over the US and also in Germany, so geographic locations is not is not his limitation, it's the content.

12:43:19 Only by trains and buses and he would like to get into anything laces is what he said anything.

12:43:27 Where is he now like if I was only a train even if I was international and I was only at train stations, I might wish to get into grocery stores.

12:43:36 Oh, he is he's in like storefronts he's in train stations he's on site of real kiosks he's in malls, specifically with dad if you're trying to.

12:43:50 I'm not sure if he's specifically trying to change where the signage is just the content that can be displayed.

12:43:57 In, why would you do that more business because you can put it in places that it wasn't previous oh yeah wow yeah you could put it in places that it wasn't previously.

12:44:08 That was the one I was thinking about a second ago but the other reason might be advertisers, I'm only get I'll stand, I'm not sure which it is you may want to ask him I want to get into other locations, or he may want to attract other advertisers.

12:44:21 So, currently if the only shows one sort of content, only certain people look at it but if I showed other kinds of content I might get more eyeballs in.

12:44:38 So, if that if a million people walk by that sign a day, And right now chose a certain kind of content, maybe only you know 1000 look at it with any interest.

12:44:42 But if he showed content that interested more people he might be able to get more eyeballs and the way you sell advertising in magazines, newspapers, any of the broadcast media is, is, is, is you say this is how many people looked at it.

12:44:59 So, if you can show that more people are looking at assigned, you can get more advertisers.

12:45:08 So I don't know which of those two it is. I want to different locations but I'm not in now, or I want to, but I think knowing what he wants is really, because that is your for your project that is in fact your goal that sign up of solar, as I'm listening

12:45:24 to this, it sounds like the goal is, whatever he wants. And we need to be clear I mean in my mind it would be nice to see more renewable energy but yes for the goal of the project it's to give him what he wants.

12:45:36 Well, it may be that he wants to be known as the environmental company and that is right in line with his goal that's part of his branding, you know.

12:45:43 Absolutely. Yep, but knowing what he wants. I would think, is the start.

12:45:51 So I'm going to move to a very open ended question that is just solely based on opinion, you do not need to give any reason why or any form of actual analytical data.

12:46:01 Have you ever seen a piece of signage. So again, whether that be like a Time Square advertisement, even a super bowl add something that you have just thought like that was a really good ad.

12:46:13 Yeah.

12:46:15 Like, can you give one example specifically I know I said I said no like that. Yeah, sorry.

12:46:22 Of course, you've seen an ad that's really good. But one that's really stuck with you.

12:46:31 I mean I know I have the fact I can't recall it now does not negate that I have.

12:46:36 That's why I was saying it's a very open ended question so I'm saying like take your time. And then

12:46:48 it's just not coming to me right now. Can we is there more questions like this, there's just there's just two more questions but we'd also like come back.

12:46:57 Yeah, it's a yeah it's not a necessary question and we're just on on a visual standpoint when I showed you that piece of digital signage which I'm actually going to bring back up from the rest of

12:47:10 the next thing that I'm actually going to ask pertains to the visual.

12:47:16 The visuals of this piece of signage. So when we, when we hand in our final deliverable will actually be designing a piece of signage kind of in this nature, something that might be up in a public space.

12:47:30 Yeah, we've taken a lot of inspiration from this from this piece of signage because it's exactly what we want. Really bowl it's something along along the lines of what we want just with one piece of data that's missing which is the potential energy that's

12:47:43 been not necessarily like we have the energy that's been generated this sign just does not show the potential energy that could be generated.

12:47:54 You know what I'd say my initial, isn't this, you know, just take me as a, as a one of many data points.

12:48:02 My initial reaction is wow, there's a lot of information on there I'm gonna move on.

12:48:07 I'm not going to look at this sign.

12:48:09 That's exactly what I was afraid of hearing. Yeah, yeah. So,

12:48:15 I think you have very little time you very very little time it's in, you know, a second to three seconds.

12:48:29 Something like that. To make me care enough to dig deeper. So, it is a common thing to try to put all the information that you might need. If I had caught your attention there, but if you don't catch my attention, it's not happening right so that that,

12:48:43 and that's what I see here. I mean, I see the weather Oh, that might be something that would catch my attention, because I do care about the weather right so that I that I got to think is the only reason that that's there is, it might catch my attention,

12:48:56 maybe it's to say gee it's sunny and solar works but I doubt it. I think it's more. Here's a useful piece of information that anybody. I'm a lot about to catch your attention.

12:49:06 But after I see that whether does that bar chart mean anything to me that I care about as a part of my relevant day No, no I'm not gonna look at that hey there's some words above it that are right at the crack of the screen there under system performance

12:49:17 does that mean anything to me. No, not really.

12:49:20 I'm not going to take the time to figure out what that means. I currently when I'm looking at it, there's a line going through it because it's between two, four screens.

12:49:38 So the example I often use in my class, which is a video that I'll describe it for you instead. Hey, there's this company in south.

12:49:42 In, I forget where somewhere in Africa was in South Africa.

12:49:48 And, and they make airplanes, they were using drones to deliver blood faster than you could any other way.

12:49:58 You know the roads aren't going to do it and blood only last so long, and these drones is really amazing thing they can they get the blood to the person really, what a heartwarming What a great use of of technology What a wonderful company that's doing

12:50:14 that. And he starts his lecture with a woman talking about how, how her baby was dying, and it was saved.

12:50:24 Somehow in the first three or four seconds they communicated this woman.

12:50:28 This woman's story, and it was a compelling story. And it was only in a few seconds and you grab it out in those few seconds. All I heard was a woman's baby was being saved.

12:50:38 I did not hear anything about drone technology blood delivery, blah blah blah. Right, but it was enough to catch my attention to want to hear more.

12:50:46 That's what an ad has to do you have to in 10 seconds shows in not 10 seconds, not 10 seconds in a glance in a glance you tell me something that makes me interested not, whereas I think this sign is showing me one level deeper than that, which is.

12:51:05 Well now that you're interested. Here's something.

12:51:11 Go ahead. sorry, something that was important to note that I didn't have a chance to contextualize is that each, each piece. So this was not just a static display.

12:51:21 It was showing like an ad for GNC and ad for Hummer something else, something else about like the rest stop information like oh the bathrooms are that way the something else something else.

12:51:30 This really only flashed for 10 seconds because I my idea was that maybe people just aren't interested in a graph, and not.

12:51:39 Yeah, and then like I freaked out when I saw it because I was driving someone to their vaccine and we saw this and I was like this is perfect for my copy I can't believe that I saw this and they were like, What even is that.

12:51:51 Can we go. Do you remember oh you probably won't, but when I was little, they were when I was little, years ago, I don't know if I was a little or not, but years ago they had an ad to stop wasting water, and they showed a fish in the sink, having less

12:52:04 and less space as or in a in a in a pond. The pond was draining as the person was brushing their teeth, and the water was running like at the same time I could see the fishes pond getting smaller, and this guy just brushing his teeth and the water running,

12:52:18 and so like in that instance, they were able to make a correlation between you know you're doing that thing, brushing your teeth let the water run when you leave the sink on which was something we should do a lot more back then, you're actually killing

12:52:29 fish. it was such a great image.

12:52:32 It was really effective in explaining what's the consequence.

12:52:36 And that caught our attention.

12:52:40 So something that we've kind of done to you know alleviate that kind of that the boringness of kilowatt per hour per meter squared or whatever units graphs and whatever is we've found a company that works with solar providers to kind of gamify it a little

12:53:02 bit and create like a solar score, and a renewable energy score for a county or a given address or a region, and we kind of want to incorporate those metrics into our pieces of signage, and we have like ways of doing that we've done enough research into

12:53:18 how, like that's actually calculated even though it's not like a real like number, but we have a way of kind of using those metrics to gamify this solar score in this Wind Energy Score into existence.

12:53:33 And what we're going to do is like the potential wind score could be like an 85 out of 100% possible versus the actual wind score is just like a 22 or something online to that and we were going to show that sort of thing on signage that was going to map

12:53:50 to real time data, what do I do with that when I look at it. That's the see that that's the problem that we go back to what is the call to action. What are you trying to get the person to do.

12:54:01 Yep.

12:54:02 Yep.

12:54:03 So yeah so that yeah that's that's what I was thinking. Once you started mentioning that because I was like wow okay so this.

12:54:10 That's going to take care of that question later which is why I was like well alright this is going to take a little shorter than I thought it would. Um, I guess, then that I mean that was that was two questions in one, so you've kind of accidentally

12:54:21 close out the interview.

12:54:23 up the interview. You come up with your images, you come up with your ideas.

12:54:26 You could have.

12:54:28 You could show it on a piece of paper printed out and show it to people for two or three seconds, or you could show them that and to others for two or three seconds, take it away and say what do you get out of this.

12:54:40 And if they didn't get what you're after you define your goal. If they didn't get anything related to your goal, start again. And, Oh, but the important thing is you can't influence them before after in any way you can say hey I'm doing this project about

12:54:55 You can't say hey I'm doing this project about wind energy can't say that you can't say doesn't this show how the wind energy doesn't show how, if I show that we're not efficient here would that make you can't ask anything like that.

12:55:05 And then after they answer, you can't criticize per se but didn't show that you. First of all, you've kind of burnt, the person wants you say it like you can't use them again in anything.

12:55:15 So, the hardest part of what I just said is not influencing them, the easiest part of the signs in front of them.

12:55:22 Put it down and say what you say, you know what is this me know he said the way that we've kind of tackled that problem by not influencing them and making sure that it's just a glance, is we're using time to Google surveys, so they fill out their information,

12:55:36 just like whether or not their staff, faculty or a student at WP because specifically reason why is like an incubator.

12:55:44 They get the first piece of signage, which is an actual piece of signage that road five will provide to us hopefully by the end of the night that they've mocked up with fake data about solar and wind energy.

12:55:57 And then there's questions about that and that sign will only be shown for 15 to 20 seconds, then there will be our piece of signage, that will be shown.

12:56:06 Our mock up I should say because it's not really a, um, that's going to be shown for 15 to 20 seconds and then they have like a multiple choice question afterwards like the order of those

12:56:19 members when you already. Well you already queued him in on by the time I get to my second one I know what you're after wind energy, the first time I didn't know if you're gonna tell me but you know diapers steaks, or, or something else but the second

12:56:31 one I already know what the topic is, and in roughly what I'm trying to get at. So, if that would be, I would think that if you're doing a 10 times it should be five one way five the other way.

12:56:42 Right and see if we can get in the middle find them.

12:56:49 The main thing that we were that we're actually going to meet about a little, a little later today I feel like is going to be pertaining to whether or not we should just have one piece of signage on each survey and kind of just sent send out a link that

12:57:01 that randomized Is it because that's possible using Google service. So, yeah, I mean, in my experience, you can do you can get a really accurate answer by manually holding up that time to five people like you know i don't know that you have to go through

12:57:18 all that large number of people randomized stuff. Usually you can figure it out really quickly and with just five to eight people.

12:57:31 It'll get, especially in the beginning, you're trying to now in our in our when. In the example you gave they were forced to look at that even for the 15 seconds you didn't capture whether it caught their attention on on its own.

12:57:43 That's true. Yeah.

12:57:46 So just as an example. Yeah.

12:57:51 Okay.

12:57:51 That's that is something that typically advice is one picture.

12:57:56 Three, four or five words. That's all you get.

12:57:59 Got it.

12:58:01 You know, like, three seconds, so that's why that the example of that sink and fish one like that one picture told a pretty good story in a really rudimentary easy to capture way enough to make you think about it, that picture was more effective than

12:58:19 a bunch of graphs or numbers would ever be. Yeah.

12:58:23 Because it plays it plays to emotion and it plays to something that someone can understand without having to do the same amount of research that we've done with.

Appendix C: Interview with Paul P. Mathisen

Questions/Answers:

Questions	Responses
Do you think the WPI community would benefit from students and faculty being more aware about solar and wind potential in our Worcester area?	• Though that this would be a beneficial topic to educate communities about.
After being shown our mock signage: Are you familiar with these statistics? Are there any other statistics you are familiar with that would be useful in displaying this data?	• Would be useful to display this information using Bar Charts. • Make sure you correctly group statistics for comparison. • Look for information regarding consumption of energy by source to show a comparison. • Look for a better way to communicate solar/wind potential information.
What story are we trying to tell on our mock signage? How clear was this message?	• Understood we were trying to talk about energy production and consumption as well as the underutilization of renewable energy sources.

Do any potential sources of information or groups come to mind that we could potentially reach out to regarding this topic?	• American Wind Energy Association • Clean Energy Center • NASA

Appendix D: End User Surveys

Questions:

1a. Gender?

1b. Age?

1c. What is your role at WPI?

2. Mock Signage 1 Displayed here

3. What was your major takeaway from viewing this sign?

4. What information does this sign convey?

5. How concise and clear is the information displayed?

6. Were there any confusing graphics/information displayed?

7. Mock Signage 2 Displayed here

8. What was your major takeaway from viewing this sign?

9. What information does this sign convey?

10. How concise and clear is the information displayed?

11. Were there any confusing graphics/information displayed?

12. Any other thoughts or comments about the mock signs/project?

Responses:

1a. Gender
Male
Female
Male
Male
Male
Male
Male
Male
Male
Female
Male
Male
Female
Male
Female
Male
Male
Male
Male
Male
Female
Male
Female
Female
Female
Female
Male

1b. Age
18-22
23-40
18-22
18-22
18-22
18-22

18-22
18-22
18-22
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18-22
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18-22
41-60
18-22
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18-22
18-22
18-22
18-22
18-22
18-22
18-22

1c. What is your role at WPI
Student
Faculty
Student
Student
Student
Student
Student
Student
Student
Student
Student
Student
Student
Student
Staff
Student

Student
Student
Student
Student
Student
Student
Student
Student
Student
Student
Student

3. What was your major takeaway from viewing this sign?
MA primarily utilizes natural gas to supply its energy consumption
MA doesn't use much renewable energy by comparison to other power sources, I wonder why?
Most electricity is generated from natural gas in Massachusetts
Messy
The big orange piece of the pie graph
Clean energy isn’t efficient enough yet have to rely on NG
Not sure what I was looking at, colorblind so pie chart is indecipherable
Massachusetts generates a lot of energy from gas
We mostly use natural gas
Too much information splattered across the sign. It’s difficult to understand what is important or what the major takeaway is. I also don’t know where this sign is supposed to go
Massachusetts uses a lot of natural gas
83% of electricity generated in Massachusetts’s is from natural gas.
Too much information splattered across the sign. It’s difficult to understand what is important or what the major takeaway is. I also don’t know where this sign is supposed to go
It’s about renewable energy
Most energy comes from wind energy
Massachusetts generates a lot of energy from gas
Natural gas is largest generator in mass, mass consumption of this energy is higher than conn.
Massachusetts uses a lot of natural gas for electricity
Natural gas is largest generator in mass, mass consumption of this energy is higher than conn.
Natural gas is largest generator in mass, mass consumption of this energy is higher than conn.
Most energy comes from wind energy
Massachusetts generates a lot of energy from gas

Natural gas is being used the most and that Mass in total contributes the most to NE energy consumption
Most of MA electricity is generated by natural gas
A bit jumbled, but generally speaking coveys the different types of energy production and consumption in New England.
MA consumes more energy than CT. MA uses the most natural gas
That natural gas is the most electricity generation in mass and the consumption is the most in regional

4. What information does this sign convey?
this sign conveys information about the utilization of power sources in MA along with the potential to use renewable sources
The amount of power generated by different power sources, avg wind power generated in MA vs. the range available in the US, the amount of power that a rooftop solar array could produce, the amount of energy consumed in MA versus in CT and all NE
Breakdown of electricity generation sources, energy consumption per state, some seemingly less connected information about power density?
Electricity Generation numbers by source
Renewable energy potential for MA
We rely on natural gas a lot
I believe it is about renewable energy and Massachusetts
Energy consumption in new england and energy generation in massachusetts
We need to use more renewable resources
Energy consumption i believe
Energy usage
This sign shows us the levels of energy that we use in Massachusetts and the New England area. It also displays how much energy comes from different sources.
Energy consumption i believe
Where it comes from
Renewable energy potential in mass
Energy consumption in new england and energy generation in massachusetts
Energy generation and consumption
Information on the energy use and source for Massachusetts and New England
Energy generation and consumption
Energy generation and consumption
Renewable energy potential in mass
Energy consumption in new england and energy generation in massachusetts
Mass electricity generation by source and NE regional energy consumption
Energy generation by source in MA and regional energy consumption
different types of energy production and consumption in New England.
how much of each type of energy is used
It is all about the electricity consumption

5. How concise and clear is the information displayed?
10
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6

6. Were there any confusing graphics/information displayed?
definately not the metric MWh
I'm not clear why I should care about solar or wind power if they're such a tiny share of the energy market (that is to say, I'm not sure what their *potential* energy supply is for MA)
I'm not sure what argument you're trying to present with these graphics and information. There is no clear connection being made between the three that supports renewable energy, sure its all data about energy consumption, sources, and what can be produced by renewables... but the way this information is presented doesn't readily show a need to transition to renewables.
no
The labels on the bar graph we small so it was confusing as to what I was look at, at first

Be more specific with regional in the bar graph is that NE region? Or is it worcester region
The title didn’t make sense and the charts also didn’t make much sense
no
It was hard to read
The title doesn’t include what the information is about and the numbers are big and hard to understand
No
No
The title doesn’t include what the information is about and the numbers are big and hard to understand
No
I know you explained the units but it’s still a little hard to follow unless you read the bottom key first
no
Not really
Not sure why CT data is needed for the bar graph when the first graph is focused solely on Mass
Not really
Not really
I know you explained the units but it’s still a little hard to follow unless you read the bottom key first
no
no
Yes I wasn’t sure what these things implied
The wording at the bottom defining the kwh should be more upfront
not really, but would take a few minuted to read and understand
The one they put in about where the consumption was

3. What was your major takeaway from viewing this sign?
Natural gas is the primary source of energy in Worcester and solar is used much more than wind power
Man, we really aren't using as much renewable energy as we could/should
The numbers are a bit hard to see, but it seems that the potential power generated from solar and wind energy could supplant the current power generation for residential consumption.
better than first
There is more data to support your research
Nothing
Way better than the last one
Worcester count produces a lot of its energy from natural gas
We have a lot of potential ability to convert to renewable resources instead of natural gas
same as above, a lot of information splattered. there can be a little better content organization and visuals to display the data
The wide availability of potential energy production
The current output of solar and wind energy in Worcester could exceed all others if more focus was given to those energy resources.

same as above, a lot of information splattered. there can be a little better content organization and visuals to display the data
It’s about energy priduction
Natural gas has the highest energy production in Worcester
Worcester count produces a lot of its energy from natural gas
We could be producing much more energy
Massachusetts uses mostly natural gas for energy, but they have a high potential for wind and solar energy.
We could be producing much more energy
We could be producing much more energy
Natural gas has the highest energy production in Worcester
Worcester count produces a lot of its energy from natural gas
We're not using as much energy as we could, natural gas is still the most used
Supporting cleaner energy sources
Theres a lot more solar and wind energy potential than we are using!
worcester produces a lot of natural gas
That natural gas has the highest energy production

4. What information does this sign convey?
this sign conveys the underutilization of solar and wind in Worcester
Worcester uses so much gas! Our solar and wind energy outputs are pathetic compared to their potential, and also Worcester makes up a sliver of residential energy produced in MA
Renewables are a small source of energy production but could provide all the power consumed residentially at their fullest potential
Worcester County Energy Production
Energy consumption for Worcester county
Yes
Energy sources and energy consumption in Worcester
The energy consumption of worcester county. Potential energy production and the power consumption v production in Worcester
We can easily depend on sustainable resources
energy related things again
Energy Production
The sign tells us about the potential energy wind and solar carry and how these could easily replace the use of natural gases with the right tools.
energy related things again
Natural gas has the most
Worcester county energy
The energy consumption of worcester county. Potential energy production and the power consumption v production in Worcester
Energy production in Worcester vs mass and potential production vs actual
Massachusetts data on energy usage/sources and potential energy sources

Energy production in Worcester vs mass and potential production vs actual
Energy production in Worcester vs mass and potential production vs actual
Worcester county energy
The energy consumption of worcester county. Potential energy production and the power consumption v production in Worcester
energy production in woo, current vs potential energy use, MA power consumption
More specific information
The types of energy we produced and the potential to move to greener energy
how much energy worcester produces and that much more energy could be produced than is being produced now
Energy consumption and price

5. How concise and clear is the information displayed?
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9

6. Were there any confusing graphics/information displayed?
Certainly not confused about MWhs
I'm not clear on other forms of consumption in MA. What about industrial facilities?
The power generation and residential consumption graphic seems to present some information that isn't necessarily needed to build the argument for renewables (the total power generated doesn't help much with the argument, whereas the focus should be on the amount consumed residentially when compared to the potential generation of renewables).
no
The current be potential graph has long number and some are hard to read
No
Still probably needs a better title than just “Worcester county”
Graph in bottom left
Not really. Just took a few second to understand all the graphs I was looking at. A little overwhelming at first glance
like i mentioned above, the data seems to be spread out randomly and not very well organized
No
No
like i mentioned above, the data seems to be spread out randomly and not very well organized
No
Nope
Graph in bottom left
No
Seems clear to me
No
No
Nope
Graph in bottom left
no
Just what this implies
No
bottom left- the wind bar is colored in partly orange and i think it is supposed to be grey
Not really, maybe the current versus the potential energy production

Any other thoughts or comments about the mock signs/project?

I like the second one much more. I would suggest drawing a more direct comparison between the potential power generation of renewables and the residential consumption (perhaps an overlay or placing them on the same graphic). I would also like to see you present some idea of what it means for these renewables to reach their "full potential" as I have no idea what this would look like or entail. The breakdown of power sources could also be more targeted at renewables, in that you don't necessarily need to have non-renewables shown next to the % renewables. Just stating that renewables make up X% of the power sources (and maybe give a breakdown of what the renewables are within that percentage) gives the impression that renewables are much less developed in the infrastructure, which is what I assume is the purpose behind that graphic. Also your statement on the time the data was collected could be more concise, i.e. "Data for January 2021: Updated Monthly", I already know the data is monthly from the statement on when its updated, so the extra "monthly" at the beginning is just unnecessary, also if its updated monthly- why isn't it for May, the current month? The data update statement just doesn't add much, maybe state it differently... also the statement on MWh and "learn more" could be more concise so as to take up less space and put more emphasis on the graphics. Hope this helps! :)
For bottom left graph maybe where this information is presenting . Can’t tell if it’s US or world
I think that the mock signs were really informational. Natural gas has been the front runner for all of our energy. It is amazing to see the possibility of switching that out for sources like wind and solar to protect the environment.
Quality signs that got my attention
I know having lots of graphs is a major factor but having a lot of graphs makes it a little hard to follow, if you can maybe one graph then bullets or graphics of other information would make it a little easier to follow
For bottom left graph maybe where this information is presenting . Can’t tell if it’s US or world
Overall I would pick mock signs 2
I know having lots of graphs is a major factor but having a lot of graphs makes it a little hard to follow, if you can maybe one graph then bullets or graphics of other information would make it a little easier to follow
For bottom left graph maybe where this information is presenting . Can’t tell if it’s US or world
I like the second one more. Idk if it necessarily has better info or what you want to convey but it looks nicer and the potential energy thing is interesting
Could it include the implications of these kinds of energy consumption
Looks great!
N/A

Appendix E: Images

	Name	Source	Format	Scale
1	Global Wind Atlas	Global Wind Atlas	GIS data download, GEOTIFF	Lat/Long Zip code
2	Global Solar Atlas - PV Electricity Output	Global Solar Atlas	GIS data download, GEOTIFF	Lat/Long Zip code
3	US electric systems operating data	EIA	Excel	Regional
4	Electricity data browser	EIA	Excel	State
5	Sun Number	Sun Number	Unknown	Zip code Adress H
6	Power Data Access Viewer	NASA	GeoJSON CSV	Lat/Long Regional
7	Mapdwell	Mapdwell	Unknown	Adress County Zip
8	SolarEdge	SolarEdge	Unknown	County
+				

Image 1: Preliminary Airtable

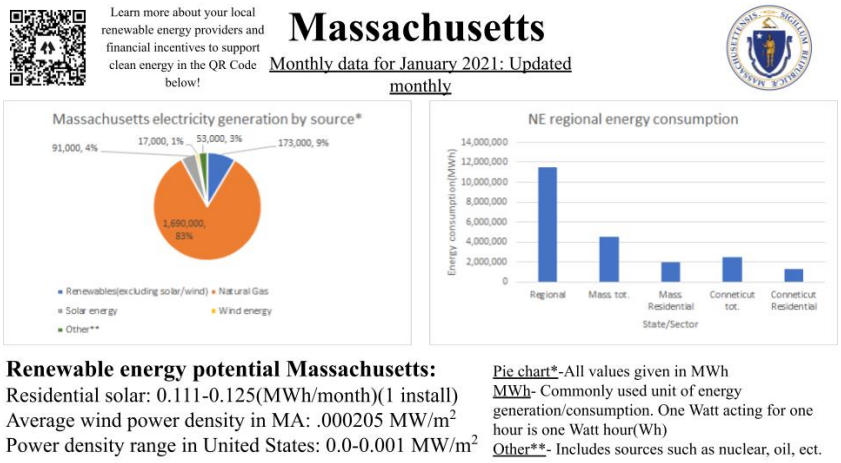


Image 2: Massachusetts state mock sign

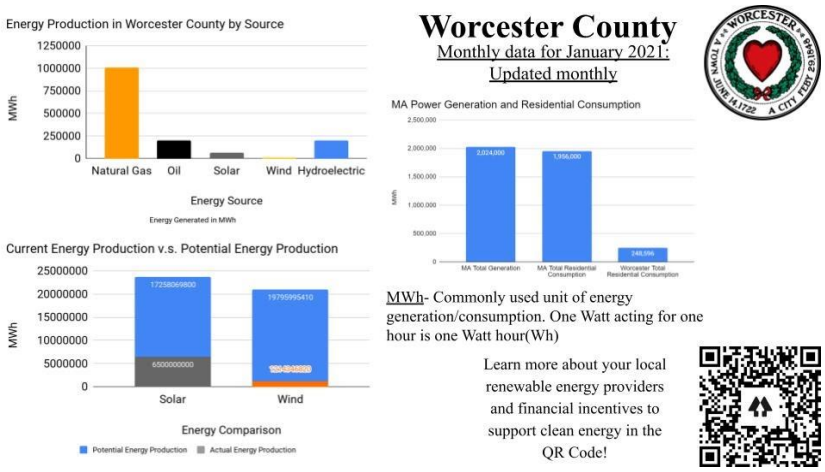


Image 3: Worcester County mock sign

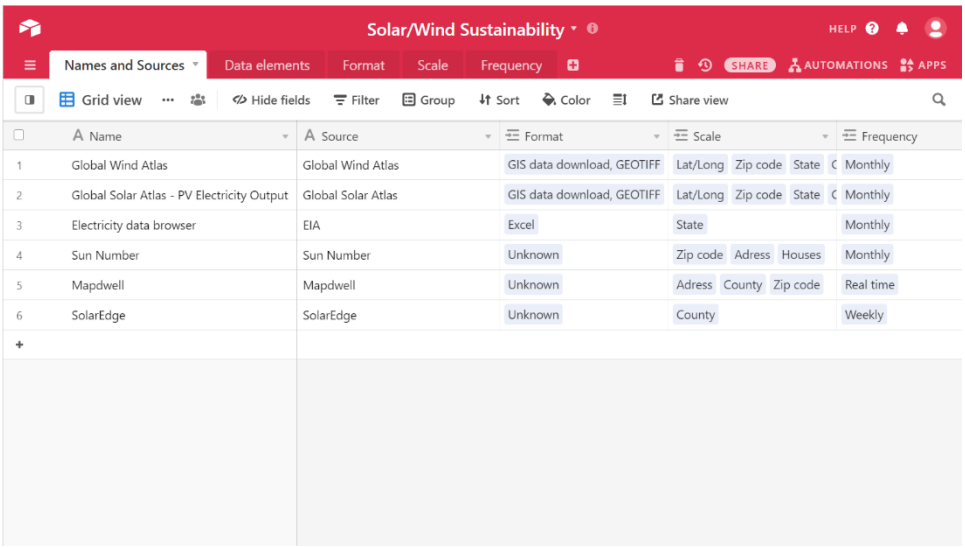
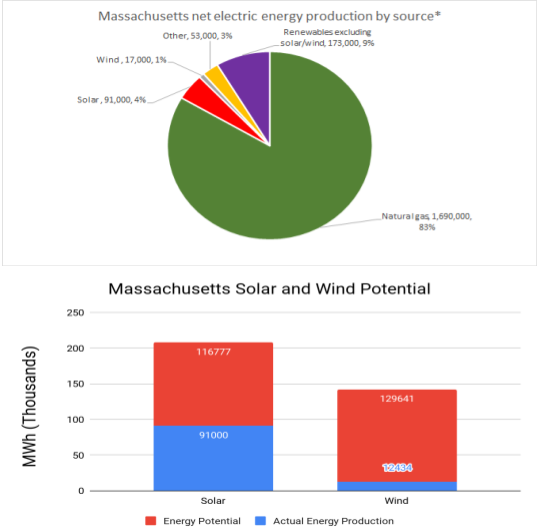


Image 4: Final Airtable



Massachusetts
Electricity Production
Monthly data for January 2021

Legend:

Pie chart*-All values given in MWh. Data taken from EIA electricity data browser

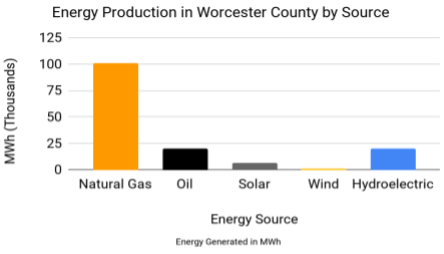
Other- Electric energy production from non listed sources

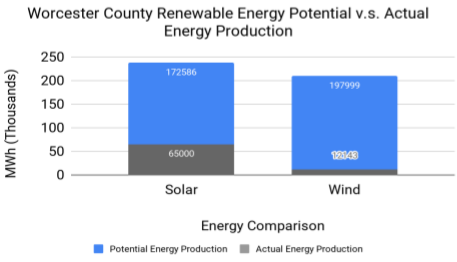
MWh- Commonly used unit of energy production. One Watt acting for one hour is one Watt hour(Wh)

Bar graph- Data taken from Global Solar and Wind Atlas

Learn more about your local renewable energy providers and financial incentives to support clean energy in the QR Code below!

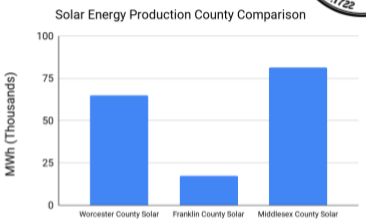
Image 5: Final Massachusetts state sign





Worcester County
Energy Usage Comparison

Monthly data for January 2021: Updated monthly



MWh- Commonly used unit of energy generation/consumption. One Watt acting for one hour is one Watt hour(Wh)

Learn more about your local renewable energy providers and financial incentives to support clean energy in the QR Code!

Image 6: Final Worcester County sign

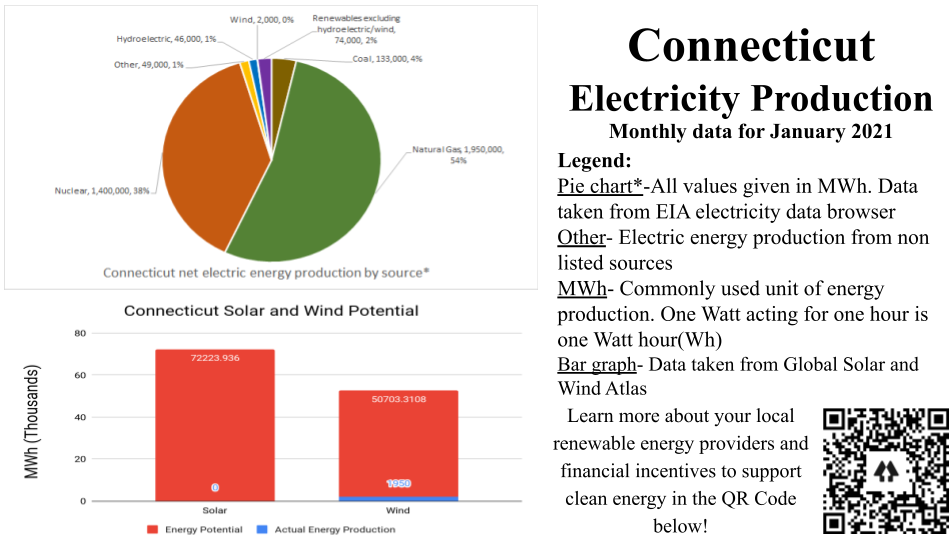


Image 7: Final Connecticut state sign

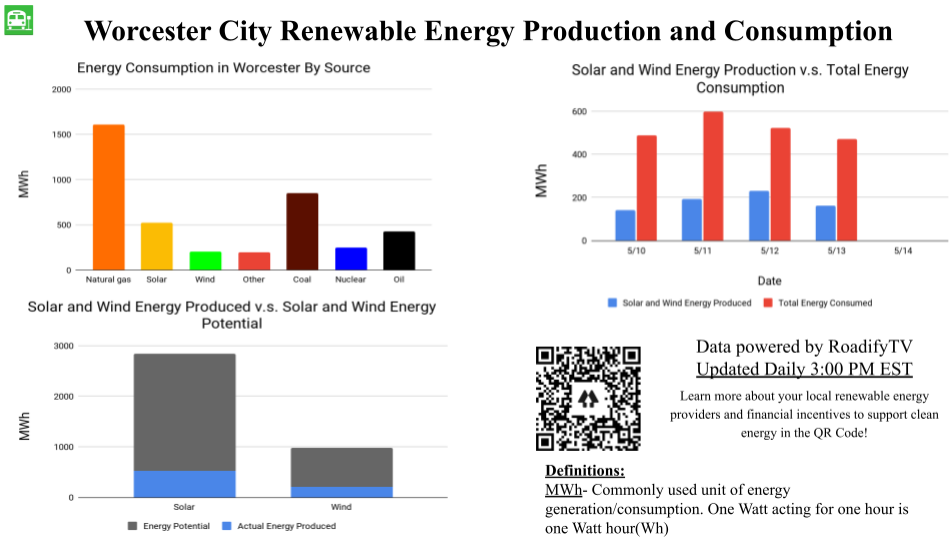


Image 8: Ideal sign

Appendix F: Tables

Objective	Goal
Identify and organize usable data sources from which to extract data.	Identify which data sets and elements we will be using in our signage design.

Conduct expert interviews with business and sustainability experts to gain understanding of metrics used and the display of data.	Obtain expert opinions as to the best way to display our data sets for interaction with the public.
Create mock displays to use in surveys.	Produce a prototype of two digital signs designs based on talks with our sponsor and our interviews: for use in our survey and our final deliverable.
Conduct a survey analyzing public interaction with our sign.	Obtain feedback on our prototypes and public reactions to it that will inform our final design and help with recommendations.
Create a complete Airtable for our sponsor	Finalize our Airtable for our sponsor that contain relevant sources for future exploration.
Refine final deliverable.	Create four signs that serve as models for displaying our data and a proof of concept.

Table 1: Project objectives

Criteria element	Reason
Relevant information	Our data must be relevant to the story we are trying to tell through the data sources.
Format must be: JSON, CSV, or spreadsheet	This will allow Roadify's system to ingest our data sources so we can create our final deliverable.
Must be updated frequently	Our data sources must be updated at least monthly in order to make it interactive within the community, and not become static or stale.
Must be scalable by specific location	By having our data sources be location based on a regional, but preferably county, level, the data will be relevant to the area where they

	are displayed, while also be scalable to include similar data for a broader area.

Table 2: Criteria for identifying open data sources

Interview Question	**Paul Mathisen**	**Micah Chase**
Question 1	Do you think the WPI community would benefit from students and faculty being more aware about solar and wind potential in our Worcester area?	What initiatives pertaining to sustainability and moving to renewable energy have you seen making their way into the business world?
Question 2	After being shown our mock signage: Are you familiar with these statistics? Are there any other statistics you are familiar with that would be useful in displaying this data?	Do you see digital signage to be an effective form of informing consumers about a product, event or anything in their local area?
Question 3	What story are we trying to tell on our mock signage? How clear was this message?	What are the keys to making an effective advertisement or sign?
Question 4	Do any potential sources of information or groups come to mind that we could potentially reach out to regarding this topic?	How can we measure the short-term success and patterns found in our end user survey? How can we expand that philosophy to measure long term effects?

Question 5		How can you target a select audience with a broad marketing tool such as digital signage? How can you ensure the intended conclusion is being drawn from the information displayed?

Table 3: Expert interview questions

Data Source	**Description**
EIA Electricity Data Browser	This source gives state level data on energy consumption, production, cost, and revenue by source. These data are updated on a monthly basis and are available as an Excel spreadsheet.
EIA U.S. Electric Systems Operating Data	This source gives regional energy demand on an hourly, daily, monthly, and quarterly basis. This source also gives forecasted data and limited information on energy production. It is available as an Excel spreadsheet.
Global Solar Atlas	This source allows for the worldwide analysis of data pertaining to location based solar electricity generation, potential and various other pertinent data elements. The data are updated on a monthly basis and is available in CSV format.
Global Wind Atlas	This source allows for a worldwide analysis of global wind speeds, wind power densities and power capacities of a selected area. The data are updated monthly and is provided in a JSON or CSV format.

Table 4: Open data source results