Assessment of Massachusetts' Waste-Sites for Potential Photovoltaic System Development

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Abstract

Massachusetts plans to produce 1600 MW of renewable energy by 2020 to help combat climate change. The Massachusetts Department of Environmental Protection (MassDEP) is supporting this goal by identifying unused waste-sites for photovoltaic (PV) system development. Our team used renewable energy viability software, site visits, stakeholder interviews, and MassDEP databases to determine that 43 of the 83 analyzed sites are potentially viable and sustainable for profitable PV development. We discovered that usable acreage and distance to transmissions lines are the primary factors determining if a site is potentially viable and sustainable. Further, a positive developer-community relationship is important to engage community support.

Acknowledgements

We would like to sincerely thank those who contributed to the completion of this project. Special thanks to Thomas Potter for accommodating us in the Massachusetts Department of Environmental Protection (MassDEP) office, providing us with everything we needed, and allowing us to visit existing solar panel sites and interview the developers who are in charge of managing projects. We would also like to thank Alice Doyle for her efforts in creating the ArcGIS layer for us to double check the information we were researching. Finally, we would like to thank our advisors, Professor Seth Tuler and Professor Jennifer deWinter, for constantly providing us with substantial feedback, direction, clarification, and support throughout our project.

Executive Summary

The Commonwealth of Massachusetts has identified climate change as a major threat. In 2011, the state legislature passed the Clean Energy Results Program (CERP) which is meant to increase the production of renewable energy within the state by 1600MW by 2020 (MassDEP, 2012). Climate change has negative effects on the environment, human health, and the economy (Maibach, 2015). Amongst the effects climate change has on the environment are warmer temperatures and altered precipitation patterns. Climate change results in increases in droughts, air pollution, sea-level rise, coastal flooding, ocean acidification, and disrupted ecosystems (Maibach, 2015). Climate change has negative effects on human health due to increasing the impacts from extreme weather events, decreased air quality, and illnesses transmitted by food, water, and disease-carriers such as mosquitoes and ticks (Maibach, 2015). Due to Massachusetts having a vast coastline, the state is expected to experience significant economic impacts caused by sea level rise. A sea level rise of 0.65 meters (26 inches) in Boston by 2050 could damage assets worth an estimated $463 billion (Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee, 2011). A step Massachusetts is taking to mitigate the effects of climate change is through CERP, and an increased focus of renewable energy within the state.

The installation of photovoltaic (PV) systems on waste-sites is a viable way of decreasing the use of fossil fuels within the state of Massachusetts (MassDEP, 2012). A waste-site in the context of this project is defined as a parcel of land that has been artificially contaminated and poses a danger to humans and the environment and, as a result, it cannot be used for many redevelopment purposes. A possible option for cleaning up and redeveloping these waste-sites is the installation of PV systems. These PV systems can benefit society by producing renewable energy and decreasing the emissions that current sources of energy create (Solar energy: The way of the future, n.d.). The Massachusetts Department of Environmental Protection (MassDEP) identified waste-sites all over the state that lack a redevelopment solution, and may be viable for PV development. PV installation has been proven to not only promote renewable energy development but also site clean-up.

The goal of this project was to identify waste-sites that are viable and sustainable for PV development, depending on each site's environmental, economic, and social characteristics.

Methodology

To identify sites with potential for a PV installation we conducted an assessment of 83 waste-sites. These sites were classified as Tier1D zoning sites, meaning they are areas with contamination that have not been remediated because the owner does not have the financial means to do so. Each waste-site was evaluated by the team to determine its environmental, economic, and social viability and sustainability using three different methods.

First, each site was analyzed using the RE-Powering America's Decision Tree Tool to determine if the site would be environmentally viable and sustainable. Variables like usable acreage, distance to transmission lines and graded roads, wetlands, and sloping were considered in order for the site to pass the environmental assessment. We used Google Earth Pro, ArcGIS, and the Release Tracking Number (RTN) database to find the answers required by the Decision Tree Tool.

Second, the National Renewable Energy Laboratory's (NREL) PVWatts economic tool was used to obtain estimates for the revenue and power output of a site. The tool required mapping the location of the site and used the weather information from a nearby big city to obtain the estimated values. The report gave values for solar radiation, AC energy, and energy for each month of the year, as well as giving an annual value for the site.

Third, to assess the social viability we conducted a number of interviews with developers and town officials from towns that already had a PV system in a site, to investigate the community support or opposition encountered. The purpose of this step was to create guidelines for developers to use in order to meaningfully address community concerns and opposition when proposing a new project to another town. Reducing community opposition is important because it can significantly reduce the development time of a project if the developer approaches the community in the most appropriate way.

After analyzing the environmental, economic, and social viability of each site we printed relevant information related to it and organized individual folders for each site. The folders consisted of RTN database article used, a Google Earth Pro overview of the site, the evaluation of the Decision Tree Tool, and, if the site was considered to be environmentally sustainable, the report from the PWatts economic tool. These files were presented to MassDEP for it to make them public and attract developers into being interested in developing new sites.

Findings

Of the sites analyzed for PV development, 51% (43 out of 83) were determined to be viable and sustainable. Developers will have to conduct more calculations in-house in order to completely determine if a site will be viability and sustainability in their financial plan. When analyzing the characteristics of each site we used the following resources:

- RTN database
- Google Earth Pro
- ArcGIS
- RE-Powering America's Land Decision Tree Tool
- NREL's PVWatts tool
- Town/City officials, MassDEP
- Interactions within communities

These resources had varying impacts on determinations of sites' viability and sustainability. The findings discuss the most influential and common characteristics that impact the viability of a site for PV development.

- **Usable Land:** Usable land on a potential site is important when determining the estimated energy production on the site. We determined usable land on the sites using Google Earth Pro and ArcGIS layers. Wetlands and shading pose huge impacts on sites as well because PV systems need optimal sunlight and Massachusetts does not allow any installations within 100 feet of a wetland area (310 CMR 10.00 wetlands protection act regulations, 2014). Economic profitability is directly related to the usable size of the site. Using NREL's PVWatts tool an estimated projected revenue was produced from the size of the site. This indicates the financial output of a PV development on a waste-site. Factors such as construction and labor costs, solar panel costs, and Payment in Lieu of Taxes (PILOT) can also be factored into this analysis when developers look further into a site for redevelopment.

- **Transmission Lines:** Transmission lines are developer's number one concern for any new project. It is very expensive to upgrade transmission lines and install new grid infrastructure (~$500,000/mile) so determining the distance of a waste-site to transmission lines is critical (Zensky, 2017). Sites evaluated varied in locations from rural areas to urban environments often in industrial areas. This distance between waste-sites and transmission lines was determined from Google Earth Pro images. Obtaining more detailed information about grid capabilities was not completed because a developer must contact the local utility and complete applications to gain insight on the specific capabilities and capacities of the local grid. That information was not available to the team, so further analysis will need to be completed by the developer if they wish to pursue a site.

- **Distance to Graded Roads:** Similarly, to how distance from a waste-site to transmission lines is often prohibitive to PV development, the distance between a waste-site and the nearest graded road is also often prohibitive to PV development. For many rural waste-sites, there are large distances between where a site is located and where the nearest graded road capable of supporting traffic necessary for the construction of a PV system is located. This distance was determined by analyzing a Google Earth Pro image and estimated the distance between the edge of a waste-site and the nearest graded road. If this distance is greater than a half mile, the cost of constructing an interconnection is often prohibitive to developing a PV system on that particular waste-site. Graded roads are important for PV development because they are the main access point to the site for construction vehicles and workers.

- **Redeveloped or In-Use Land:** Through our analysis of the 83 waste-sites we have identified nine cases in which the waste-site is still in use by the site owner. In these cases, the site is still being actively used and it is unlikely that the owner would be willing to cease activity for the purpose of PV development. Some examples of waste-sites that are still in use are junk yards and manufacturing facilities. Ten of the waste-sites analyzed had already been remediated and redeveloped with something other than a PV system. Examples of redevelopment included housing developments, a post office, and a grocery store. Google Earth Pro images were studied to determine if a site was redeveloped and in use again.

- **Conservation Commission Contingencies:** Finding from interviews with developers and town officials showed that Conservation Commissions can impose a financial burden on developers. For example, at the General Latex/DOW property in Billerica the Conservation Commission reassessed the land because it was located near wetlands and discovered new wetlands which made the development plans change from a 4MW installation to a 3.74MW installation. The Conservation Commission also required the developers to leave some trees on the parcel at least 12 feet in height and not cut the entire tree down. These requirements lowered the power output and therefore the potential profit the developer saw from the site, as well as imposing an increased development cost.

- **ITC Tariffs:** Another factor that plays a role in a developer's decision is the International Trade Commission’s (ITC) solar panel tariff. The new tariff proposed by the ITC wou ld place a $0.40/watt surcharge on PV cells and a floor price of $0.78/watt on modules (Hill, 2017). The tariff would force many developers to purchase more expensive solar panels made in the United States, raising development costs, and as a result an estimated 88,000 jobs could be lost in the US Solar Industry (approximately 1/3 of workers). In addition, this has the potential to put a stop to billions in private investments for solar development, causing 2/3 of expected installations in the next five years to completely cease (Hill, 2017). If the tariff is approved the progress of renewable energy development in the United States is predicted to slow down drastically (Hill, 2017).

- **Community Relationships and Interactions:** Developing municipal owned land can often cause community kerfuffle if the PV development can be viewed from their homes, roads, or walkways. First impressions and good information are essential when developing waste-sites located on public land because residents who might be against an installation will bring forth their concerns and fight the process of development, prolonging the project (Martinage, 2016). In the cases of developments built on private land, these complaints do not impact the project because the land is privately owned and the owner can choose to develop the land with little community engagement and interaction.

Steps for Viable and Sustainable PV Development

Through our analysis of waste-sites for PV development, as well as our findings from interactions with developers and town officials, we have identified a number of key points that will contribute to reducing the obstacles faced when attempting to install a PV system. The recommendations provided below are intended to help with the work done by the developer when interacting with a community and dealing with concerns and questions from the Conservation Commission in different towns.

Engage Conservation Commission: Due to widely varying Conservation Commission regulations, we recommend that MassDEP suggest developers be proactive and engage with local Conservation Commissions early in the development process to determine if there are environmental permitting or other requirements for PV development. We recommended that MassDEP notify developers on how to contact local Conservation Commissions, through email, phone, or attendance at Commission meetings, enabling developers to learn the requirements and actions that must be taken to gain approval and permitting for a PV development. Contact information can be acquired through municipality websites.

Alert residents to PV development: Through interviews with developers, we have determined that the most common opposition to PV development is the aesthetic of the installation itself. The community members most likely to cite aesthetics as the primary reason to oppose a PV development are those neighboring the site. Therefore, we recommend the MassDEP encourages developers to notify residents within 500 feet of a potential PV installation of the details of the development, as well as the dates and times of local government discussions regarding the development. Such communication helps provide the community with factual and accurate information regarding the site, as well as giving residents an opportunity to voice their opinion on the development at a local government meeting, helping to create healthy developer-community relationships.

Improve aesthetics with tree buffer zone: While community opposition surrounding the aesthetics of a PV installation usually does not prevent the development of a PV system, creating a healthy developer-community relationship is still important. Addressing community concerns helps create this healthy relationship. As a result, we recommend the MassDEP encourage developers to include a buffer zone of trees in their development plans if the site is in a location where the PV installation has a major aesthetic impact on the area.

Determine development cost through in-house financial tools: The PVWatts economic tool determines the potential profit generated by a PV development from the useable size of a waste-site. Determining the cost associated with developing PV on a waste-site varies depending on characteristics such as choice of EPC, transmission line distance and condition, and distance to graded roads. We recommend MassDEP be transparent about the profit estimated by PVWatts so that developers can consider the information when doing an in-house financial analysis to determine the costs of development. With an in-house analysis, a developer can compare costs and projected profit to determine if the site is worth the investment.

Consult utility to assess transmission line status: Determining the condition and distance of the nearest transmission line to the waste-site is one of the most important aspects of determining the viability of a site. While the distance to transmission lines is relatively simple to determine, and the condition of a transmission line can be guessed by the local development, it is impossible to determine the specific capabilities of the local grid without engaging in discussions with the local utility. Therefore, we recommend that MassDEP encourage developers to contact local utilities immediately at the start of the PV development process, to determine the condition of the process, local grid as early in the development process as possible.

Highlight lessons learned from previous PV developments: We recommend using highlights of previous PV site development to promote PV development on future waste-sites in Massachusetts. Highlighting the benefits of PV development in communities across Massachusetts can show the communities of potential future PV sites the benefits they might also experience by developing PV systems in their local waste-site. MassDEP can highlight the success of waste-site redevelopment with PV, boosting community support for such redevelopment. These highlights can include greenhouse gas emission reduction, number of houses powered, and the number of equivalent vehicles taken off the road based on greenhouse gas emission reduction, and how targeting waste-sites for PV development helps clean up local contaminated land.

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CECP- Clean Energy and Climate Plan
CERP- Clean Energy Results Program
CREST- Cost of Renewable Energy Spreadsheet Tool
EPA- Environmental Protection Agency
GIS- Geographic Information System
GWSA- Global Warming Solutions Act
IPCC- Intergovernmental Panel on Climate Change
IQP- Interactive Qualifying Project
JEDI- Job and Economic Development Impact Model
MA- Massachusetts
MassDEP – Massachusetts Department of Environmental Protection
MW- Megawatts
NREL- National Renewable Energy Laboratory
PILOT- Payment in Lieu of Taxes
PV- Photovoltaic
RPS- Renewable Energy Portfolio Standard
RTN- Release Tracking Number

1.0 An Introduction to Using Waste-Sites for PV Development

The Commonwealth of Massachusetts has identified climate change as a major threat. In 2011, the Commonwealth legislature passed the Clean Energy Results Program (CERP) which is meant to increase the production of renewable energy within the Commonwealth (MassDEP, 2012). Climate change has negative effects on the environment, human health, and the economy (Maibach, 2015). Amongst the effects climate change has on the environment are warmer temperatures and altered precipitation patterns. Climate change results in increases in droughts, air pollution, sea-level rise, coastal flooding, ocean acidification, and disrupted ecosystems (Maibach, 2015). Climate change has negative effects on human health due to increasing the impacts from extreme weather events, decreased air quality, and illnesses transmitted by food, water, and disease-carriers such as mosquitoes and ticks (Maibach, 2015). Due to Massachusetts having a vast coastline, the Commonwealth is expected to experience significant economic impacts caused by sea level rise. A sea level rise of 0.65 meters (26 inches) in Boston by 2050 could damage assets worth an estimated $463 billion, and evacuation costs alone in the Northeast region resulting from sea level rise and storms could range between $2 billion and $6.5 billion (Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee, 2011). A step Massachusetts is taking to mitigate the effects of climate change is through CERP, and an increased focus of renewable energy within the Commonwealth.

The installation of photovoltaic (PV) systems on waste-sites is a viable way of decreasing the use of fossil fuels within the Commonwealth of Massachusetts (MassDEP, 2012). A waste-site in the context of this project is defined as a parcel of land that has been artificially contaminated and poses a danger to humans and the environment and, as a result, it cannot be used for many redevelopment purposes. A possible option for cleaning up and redeveloping these waste-sites is the installation of PV systems. PV systems can benefit society by producing renewable energy and decreasing the emissions that current sources of energy create (Solar energy: The way of the future, n.d.). The Massachusetts Department of Environmental Protection (MassDEP) identified waste-sites all over the Commonwealth that lack a redevelopment solution. PV installation has been proven to not only promote site clean-up but also provide a renewable energy source for many uses.

Attempts to redevelop waste-sites with PV systems across the United States have been varying degrees of success. A common practice is to install PV systems on large waste-sites because they provide the most energy in the most condensed area on land that can be used for little else. In states such as New Jersey and Georgia, waste-sites have been identified and successfully redeveloped for PV systems to provide renewable energy. With the case in New Jersey, a site was redeveloped to produce 6.1 Megawatts (MW) of power supplying the local school with 90% of its electricity (Duffy, 2012). In Georgia, a waste-site was developed producing 1 MW of energy and powering 225 homes in the area (Boyd, 2012). An unsuccessful attempt at installing a PV system on a waste-site occurred in Amherst, Massachusetts. This proposed PV system would have put the endangered grasshopper sparrow that lived on the land at an increased risk of dislocation, causing the project to fail (Merzbach, 2016). This example displays just one variable that can make an attempt to develop a solar farm unsuccessful. Across the United States, efforts to develop these waste-sites have been made in an effort to produce clean energy and reduce carbon emissions.

The sponsor, MassDEP, is currently in the process of identifying potential renewable energy sites on waste-sites throughout Massachusetts. The challenges the group faced were finding viable and sustainable waste-sites, attracting developers to install profitable PV systems, and reducing community opposition of a project. The reason for the MassDEP to pursue renewable energy is due to the increase demand for energy, and the current reliance on fossil fuels, which results in the emissions produced by fossil fuels increasing by 29% in the coming years (Elias, Jorgenson, & Katz, 2006). MassDEP has been tasked through CERP to help Massachusetts reach a goal of 1600 MW of renewable energy production by 2020. To meet this goal, MassDEP is aiming to develop PV systems on waste-sites throughout Massachusetts (MassDEP, 2012). When identifying locations to redevelop, MassDEP works with developers to analyze the viability as well as the sustainability of each site. Analyzing the viability involves examining the economic, environmental, and social obstacles each site would face during the development process, while analyzing sustainability involves examining the social, economic, environmental impact that such development would have both short term and long term.

This project supported MassDEP with their goal of identifying and analyzing the viability and sustainability of waste-sites for potential PV installations. First, the team determined the environmental impact and any environmental obstacles by using screening tools that help identify locations depending on the environmental characteristics of each site, such as acreage, proximity to wetlands, and proximity to utilities. Second, we analyzed the economic feasibility of each site which takes into account the estimated power production and revenue generated by the system. Finally, we analyzed social characteristics in the local communities of sites that have been developed, such as relationships and possible opposition towards the installation of a PV system on waste-sites. The information collected is then used to determine the viability and sustainability each site will likely face. Files detailing specific information for each waste-site are presented to MassDEP at the conclusion of our project, identifying whether the sites assessed are viable and sustainable for PV development, energy output and income estimates, and a universal method to maximize community support.

2.0 Importance of Developing Renewable Energy in Massachusetts

The Commonwealth of Massachusetts has created the goal of producing 1600MW of renewable energy by 2020 through the introduction of the Clean Energy Results Program (CERP). MassDEP is working to reach this goal and solve the challenges that have arisen from it. The reason CERP was passed into law in Massachusetts is to "promote renewable energy, which has tremendous benefits to air quality and climate protection by reducing harmful air emissions associated with the burning of fossil fuels" (MassDEP, 2011).

2.1 Climate Change in Massachusetts

Climate change directly impacts the environment, human health, and economy of the Commonwealth. The effects include extinction of wildlife, increase in warm climate diseases, and destruction of infrastructure.

Impacts of Climate Change on the Environment

Climate change is a great environmental challenge with potentially profound effects on Massachusetts' environment. Average ambient temperature in Massachusetts has increased by approximately 1°C (1.8°F) since 1970 and sea surface temperature by 1.3°C (2.3°F) between 1970 and 2002 (Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee, 2011). The Environmental Protection Agency (EPA) estimates the average temperature in Massachusetts will rise 2.2–2.78°C (4–5°F) by 2100 (Boslaugh, 2012). This change in temperature is expected to have extreme effects on the natural environment: Barrier Islands would be engulfed in rising sea levels; many native species might shift their breeding range out of state; conifer and mixed forests would become temperate deciduous forests with some species, including the sugar maple, disappearing entirely (Boslaugh, 2012). Massachusetts' coastline makes it especially vulnerable to climate change. Sea level is rising and is expected to continue rising. Under the Intergovernmental Panel on Climate Change (IPCC) High Emissions Scenario with Ice Melt, sea level rise will reach 6 feet by the year 2100 (Boslaugh, 2012). Since a large percentage of the Commonwealth's population, development, and infrastructure is located along the coast, the impact of sea level rise is expected to be catastrophic, putting the Massachusetts economy, health, natural resources, and way of life at risk (Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee, 2011).

Table 1 below shows current changes in temperature and predicted changes in Massachusetts. Based on Table 1, it is evident that climate change is happening now and its impact is projected to get worse.

Table 1: Changes and Predictions in Massachusetts' Climate (Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee, 2011)

Parameter	Current Conditions (1961-1990)	Predicted Range of Change by 2050	Predicted Range of Change by 2100
Annual temperature (˚C/˚F)	8/46	2 to 3 / 4 to 5	3 to 5 / 5 to 10
Winter Temperature (˚C/˚F)	-5/23	1 to 3 / 2 to 5	2 to 5 / 4 to 10
Summer Temperature (˚C/˚F)	20/68	2 to 3 / 2 to 5	2 to 6 / 4 to 10
Over 90˚F (32.2˚C) temperature (days/yr)	5 to 20	-	30 to 60
Over 100˚F (37.7˚C) temperature (days/yr)	0 to 2	-	3 to 28
Annual sea surface temperature (˚C/˚F)	12/53	2/3 (in 2050)	4/8
Annual Precipitation	103cm / 41in.	5% to 8%	7% to 14%
Winter Precipitation	21cm / 8in	6% to 8%	12% to 30%
Summer Precipitation	28cm / 11 in.	-1% to -3%	-1% to 0%

Impacts of Climate Change on Human Health

Higher temperatures, especially the higher incidence of extreme heat days, can have a negative impact on air quality and human health. In general, current impacts from climate change on human health include respiratory illnesses, increase in severity of allergies and asthma, and an increase in vector borne diseases (Maibach, 2015). Climate change also influences extreme weather events that can disrupt power, sanitary and health care services, and access to safe and nutritious food, while damaging homes and property (Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee, 2011). If nothing is done to combat global warming, it is predicted that impacts of climate change on human health include the potential for:

- Increased heat stress
- Increased respiratory and heart diseases
- Elevated levels of ozone and particulate matter
- Increased vector-borne diseases
- More outbreaks of waterborne diseases
- Degraded surface water quality

Impacts of Climate Change on the Economy

Massachusetts may experience large-scale catastrophic events due to climate change. Events similar to Hurricane Katrina in New Orleans (2005) and the ice storm in Massachusetts (2008) could have long-term impacts on freshwater resources, fisheries, food crops, and coastal properties, leading to disastrous effects on the economy (Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee, 2011). Due to sea level rise from climate change on the Barrier Islands and on wildlife breeding grounds in Massachusetts, the loss of wildlife would severely impact hunting, fishing, and wildlife viewing; activities which brought over $1.5 million in revenues to the commonwealth in 2006 and supported over 24,000 jobs (Boslaugh, 2012). In addition, floods from surges of coastal waters and high intensity precipitation events also threaten the Commonwealth; if these events occur with greater intensity and frequency the damage could be more severe and cumulative, straining local and state resources and the ability of government agencies to adequately respond (Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee, 2011).

2.2 Current Efforts to Address Climate Change Through Renewable Energy Development in Massachusetts

The implementation of solar energy installations in Massachusetts has begun replacing fossil fuel energy consumption within the Commonwealth. The Commonwealth has also seen regulatory and legal actions to combat climate change through renewable energy development.

2.2.1 Development of Renewables in Massachusetts

Massachusetts has been a leader throughout the last decade in developing and expanding the use of renewable energy in the Commonwealth to replace power production by fossil fuel sources in an effort to reduce greenhouse gas emissions. As seen in Figure 2, over a quarter of Massachusetts' power comes from alternative energy forms, and this percentage is continuing to grow (Muyskens, 2015). Figure 3 shows the energy produced by renewable energy sources has continued to expand over the past decade, while the production of energy by fossil fuels has remained stagnant or decreased (Energy consumption in Massachusetts, 2014). At the same time, energy demand has increased in Massachusetts, and will continue to do so. Estimations predict that by 2040, the world will be consuming 48% more energy than it was in 1990, increasing the importance of developing clean energy sources (Doman, 2016). Massachusetts will be experiencing this increasing demand, and is actively working to meet the demand through renewable energy sources rather than fossil fuels.

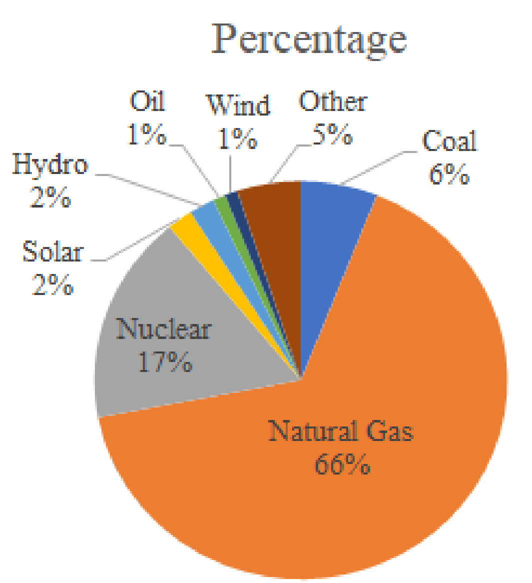

Figure 1: Sources of energy production in Massachusetts (Muyskens, Keating, & Granados, 2015)

2.2.2 Government Programs Combatting Climate Change and Encouraging Renewable Energy Development

Government programs and actions have been established to address and combat climate change and to increase the amount of renewable energy production within Massachusetts.

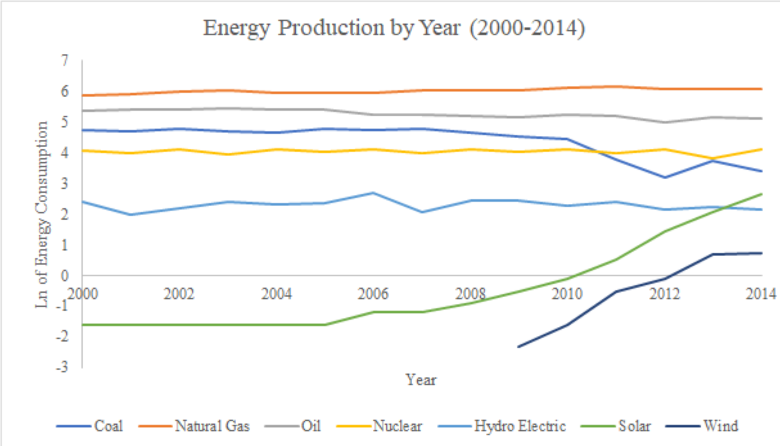

Figure 2: Yearly energy consumption, 2000-2014 (Energy consumption in Massachusetts, 2014)

Global Warming Solutions Act of 2008

The Global Warming Solutions Act (GWSA) made Massachusetts one of the first states to enact a comprehensive regulatory program to combat climate change. GWSA set forward goals of decreasing greenhouse gas emissions by 25% by 2020 and 80% by 2050. To achieve the desired emissions decrease, the Massachusetts government enacted a series of regulations and tasks through GWSA. Regulations that require the reporting of greenhouse gas emissions were signed into law, helping to provide data about the types and amounts of greenhouse gases being emitted within Massachusetts. The Climate Protection and Green Economy Advisory Committee was established to advise on measures to reduce emissions, and the Climate Change Adaptation Advisory Committee was established to study and make recommendations on how to adapt to climate change. These committees help project future greenhouse gas emissions and develop plans for reducing them to the desired levels under GWSA. This includes the Clean Energy Results Program, which is working to develop methods and strategies for dealing with, mitigating, and combatting climate change (Global warming solutions act background, 2012).

Clean Energy Results Program

The Commonwealth of Massachusetts has encouraged the assimilation of renewable energy sources into the energy production of the Commonwealth to achieve the GWSA. Of particular note is the Clean Energy Results Program (CERP), set forward by MassDEP and the Massachusetts Department of Energy Resources (DOER). Beginning in 2011, CERP set out goals to help promote and develop renewable energy in the Commonwealth of Massachusetts. CERP tasked the DEP with increasing the use of renewable energy sources in Massachusetts. The purpose of this is to reach the Renewable Energy Portfolio Standard (RPS) goal of 1600 MW of solar photovoltaic power production by 2020 (Potter, 2017).

Clean Energy and Climate Plan for 2020

In 2016, Massachusetts Governor Charlie Baker announced an update to the Clean Energy and Climate Plan for 2020 (CECP). Under this plan, Massachusetts continued the goals set by GWSA of reducing greenhouse gas emissions by 25% by 2020 and reducing greenhouse gas emissions by 80% by 2050. Energy production is a major component in the production of greenhouse gases, and in order to reach the stated goal, the Commonwealth of Massachusetts will continue to expand its renewable energy production industry through programs such as CERP and goals set in the GWSA (Massachusetts clean energy and climate plan for 2020, 2016).

Financing and Tax Incentives

The Massachusetts government has incentivized construction of solar fields with significant tax breaks, loans, and net metering. These tax breaks and loans help developers and landowners offset the high costs of installing photovoltaic systems on waste-sites, encouraging development and implementation of solar power facilities in Massachusetts (see Appendix F for more information regarding financing and tax incentives).

Regulations and Permits

Through CERP and MassDEP, a streamlined process of gaining the permits for developing a commercial solar field has been designed and implemented, further accelerating the process of expanding solar power production in Massachusetts. They have also provided a checklist of requirements and permits that are required to gain approval for the installation of a solar facility on the waste-sites targeted for such development under CERP (Bureau of Air & Waste, 2016). This has helped keep potential solar energy sites from becoming bogged down in government regulation and has further accelerated the process of developing renewable energy in Massachusetts to offset power production by fossil fuels (see Appendix F for further information regarding regulations and permits).

2.3 What Has Been Done Before

Development of Photovoltaic systems has been done in various different locations, not only Massachusetts. As shown in Figure 3, the NREL has identified the solar resources of each state in the nation. In addition, Environmental America has identified the top ten states with the ability to produce the highest amount of renewable energy through solar systems. These states achieved this classification due to the average sunlight they receive per year and the total capacity for solar energy they are capable of generating within the city limits of their metropolitan areas (Burr, Dutzik, & Schnider, 2014).

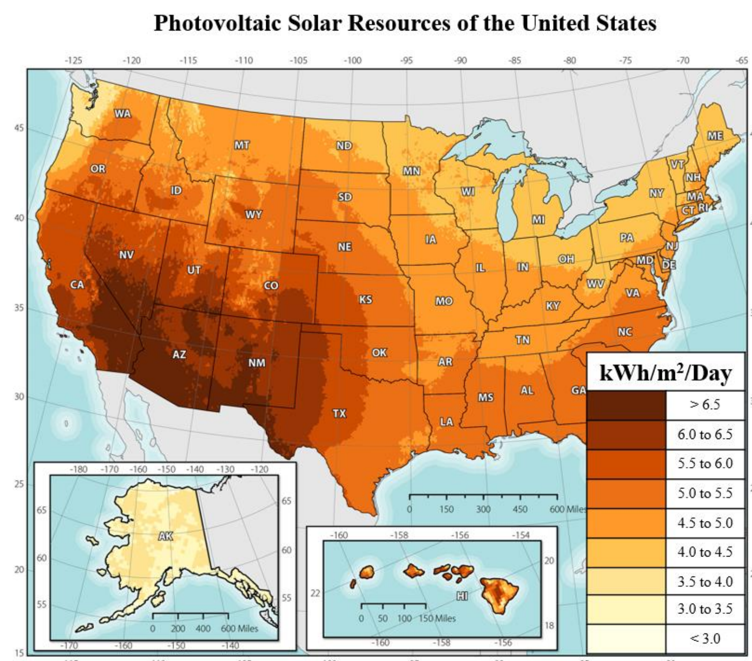

Figure 3: Top 10 solar states in the United States (U.S. solar resource maps.)

Cities like Denver, Colorado, Albuquerque, New Mexico, and Phoenix, Arizona are amongst the top 20 solar cities in America (Burr, Dutzik, & Schnider, 2014) and used the government incentives shown in Appendix F to continue implementing renewable energy. These areas matched the characteristics necessary for implementing the solar panels in order to get an amount of energy that will be profitable for the town and developer. By implementing more sources of renewable energy in these states, the influence of greenhouse gas emissions can continue to be diminished (US EPA, 2016). MassDEP has a number of waste-sites identified that have potential for having a PV system built on them and is pushing forth to have more of these systems built due to the environmental benefit and reduction of fossil fuel emissions (Carbon lock-in: Types, causes, and policy implications, 2016). Figure 4 displays the increased amount of solar installations in Massachusetts in past years.

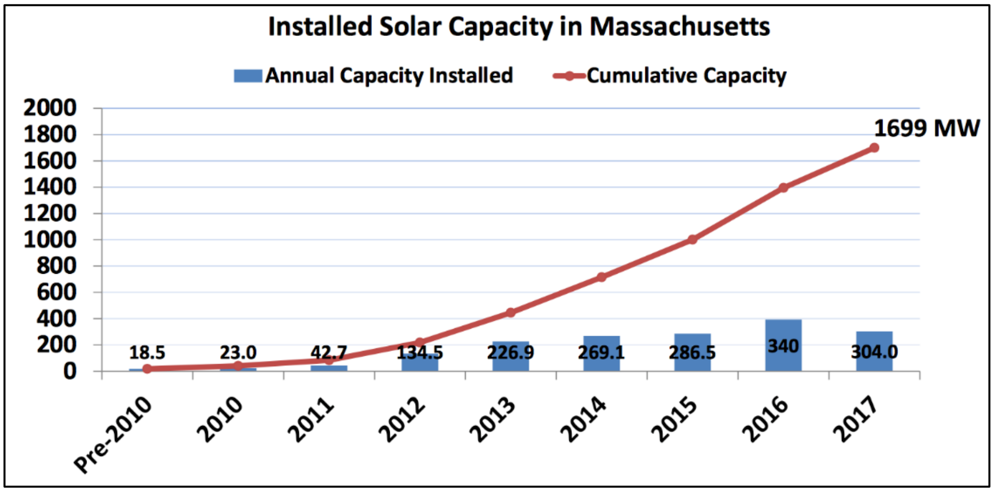

Figure 4: Yearly installed solar capacity in Massachusetts (DOER, 2017)

2.4 Social Opposition for PV Development

Community and developer relationships are one social aspect we would like to discuss, because sites need to be socially sustainable in order to continue solar expansion in towns across Massachusetts. This section will highlight two different situations where opposition prevented the development of solar arrays by forcing developers to reassess the land, or create new regulations to prevent property devalue and community opposition.

Community Opposition

The social sustainability and community concern of a project is often what developers don't focus their efforts on. A solar company based out of Boston is planning to utilize solar energy production on a waste-site off Burnett Road, in Chicopee, Massachusetts. There is strong opposition, however, because the residents believe it could devalue homes, affect the aesthetics of the land, and people feel like they are being taken advantage of by developers. Southern Sky, the solar company involved, plans to lease 13.5 acres of land from the city, paying taxes to the city, and supplying Chicopee with the energy production as well (DeForge, 2016). City Councilor Timothy McLellan stated, "...biggest concern is the traffic from the construction vehicles..." because Burnett Road has heavy traffic already (DeForge, 2016). Neighbors complain that they have no say in the project, as well as the open space being transformed into a solar array in their backyards. This problem is unlike the Amherst instance, because the Chicopee landfill was capped properly, and records from 2000 show it has been capped since then without problems (DeForge, 2016). One month later, the resident's voice was heard, and a new ordinance was sent for approval that would require Southern Sky to plant trees and have fences to block street views of the site (DeForge, 2016b).

Groundwater Concern and Habitat Displacement

Some waste-sites around Massachusetts are landfills, in the town of Amherst, Massachusetts, two capped landfills have the potential for 2.8 and 3.3 MW solar fields, respectively. One landfill was capped in 1985, and the other in the 1990s (Serreze, 2016). Concern from the town originated from groundwater monitoring at the 1990s capped landfill, which showed the presence of the carcinogen 1, 4-dioxane down-gradient, a chemical compound that makes the water unaccepted by Massachusetts drinking water standards. But the water was retested and there was no evidence of below-standard water found in this second test. This potential solar array on the 3.3MW site could save the town $47,500 in net-metering credits and $41,500 in tax revenues (Serreze, 2016). The older of the two landfills was capped in 1985, which concerns residents that the landfill was not capped to regulation. Development on the landfill could break the cap, strengthening their argument against a solar array. Most recently, plans have been suspended to install a solar field on the old landfill due to an endangered species of birds (grasshopper sparrows) that live in the habitat (Merzbach, 2016). The opposition and habitat restriction stopped all development plans, because evidence showed the capped landfill was not suitable for a solar field and the population of grasshopper sparrows would be put in danger.

3.0 Methods for Identifying Potentially Viable and Sustainable Waste-Sites

The goal of this project was to find sites on contaminated land on which developers will be attracted to build PV systems. Determining if a site is attractive to developers was based on its viability and sustainability. The **viability** of a waste-site depends on the immediate obstacles a developer faces when looking to begin a solar development project on a site, such as taxes and site contamination. The **sustainability** of a waste-site depends on the long-term impact the development of a PV system would have on developers, the community, and the site itself. Following are the three methods used to determine if a waste-site was viable and sustainable for PV development:

1. Used RE-Powering America's Land Decision Tree Tool, Google Earth Pro, ArcGIS, and MassDEP and EPA spreadsheets and databases to determine environmental viability and sustainability.
2. Estimated power output and income using the National Renewable Energy Laboratory's (NREL) PVWatts economic tool.
3. Conducted interviews and discussions with developers and town officials to determine if they encountered community opposition. Also, these interviews helped determine what kind of community opinion has been experienced in past projects, as well as the process developers go through when constructing a PV system.

3.1 Analyzing Environmental Sustainability of Waste-Sites

The sites that our group studied were given to us by our sponsor, MassDEP. They provided our group with spreadsheets and databases containing information about each site, and we used this information to determine the environmental characteristics. Sites we studied were sorted by the zoning class of the site, and the specific sites we analyzed were categorized as Tier1D. These are sites with known environmental contamination, however the owner of the site does not have the financial ability to remediate them, and as a result, proper remediation would require outside funding to complete.

Much of the information that MassDEP provided about the sites is found on a database of waste-site reports. Using a unique Release Tracking Number (RTN), all references and reports concerning that particular site can be accessed and used to find detailed information about the site. Examples of such references are communication and correspondences with property owners, legal proceedings, and on-site reports about contamination and remediation efforts (see Appendix A for further information about MassDEP and EPA databases and spreadsheets). This information was vital when determining the environmental viability and sustainability of each site.

Beyond the spreadsheets provided by MassDEP, the EPA has developed GIS software, such as Google Earth Pro and ArcGIS layers, that helped determine site characteristics such as estimated distance to transmission lines and graded roads, as well as the proximity of the site to wetlands. This means that the software is able to examine details such as terrain sloping of the site, shading, land size, and other characteristics to determine an estimate on the usable acreage for PV development on the site, as well as potential barriers to construction due to the location of sites relative to local utilities and infrastructure such as transmission lines and graded roads (see Appendix B for information regarding the use of GIS tools).

The information gathered from MassDEP and EPA databases, Google Earth Pro, and ArcGIS was used when completing the RE-Powering America's Land Decision Tree Tool. This tool took into account a variety of site characteristics and determined if the waste-site was viable for PV development (see Appendix C and D for information regarding Decision Tree Tool questions and results). Used in conjunction with detailed reports from MassDEP and EPA databases about the history and remediation that occurred on sites, we determined for each site if it was viable and sustainable based on the characteristics of the site and the result of the Decision Tree Tool.

3.2 Assessing Economic Sustainability for Solar Development

Determining if a waste site is viable for PV development partially requires evaluating economic viability. We used MassDEP's model and guidelines for assessing different factors that go into deciding if a specific site was likely to be economically viable. From the NREL, we used the PVWatts tool to determine economic viability. PVWatts is a tool that estimates the performance of potential PV installations. It calculates an estimate of the energy production and the cost of energy for PV systems (See Appendix E for a full list of what PVWatts calculates). To use this tool, we first entered a site's location and selected a nearby major city in order for the tool to use that city's weather data. We then mapped the region where the potential PV system would be installed on a satellite map. The tool then outputs predicted revenue.

Using this results summary, a developer can compare their costs of construction and development with the predicted revenue from the PVWatts tool. Because each site has a different cost of development, we cannot compare sites in terms of best return on investment. Although, we can provide the developers with the information they need to see if the site is worth the investment.

3.3 Social Sustainability of Previous Sites to Set Up Guidelines for Developers

The social sustainability of previous sites was researched to determine the types of community opinions that exist during and after the development of PV systems because it is difficult to assess social sustainability of potential sites. Analyzing the social sustainability of waste-sites that have previously been developed is important when determining the actions developers must take to maximize social sustainability when developing future waste-sites.

3.3.1 Visiting Developers

MassDEP and developers both understand there is local support and opposition when developing new PV systems on waste-sites. The team visited two developers with an employee of our sponsor, MassDEP, and conducted interviews to understand the obstacles they face from the local government, residents, and other opposition. Data gathered from the developers along with our research helped the team confidently decide factors that make a site socially sustainable (see Appendix J for interview questions).

3.3.2 Community Opinion

The goal of obtaining the community opinions was to find out what could have been done better and why, regarding previous PV developments. Interviewing town officials in locations of prior PV system development attempts, both successful and unsuccessful, helped the team gain an understanding of the social sustainability of future sites (see Appendix J for interview questions). Following community research, the data helped the team formulate a set of guidelines, white papers, that MassDEP provides to new developers to aid them in maximizing support from a community.

4.0 Waste-Site Environmental, Economic, and Social Viability and Sustainability Findings

Of the 83 sites analyzed for PV development, 43 were determined to be viable and sustainable. Figure 5 displays the Commonwealth of Massachusetts along with the location of the 43 waste-sites determined to be viable and sustainable for PV development. Once developers begin to do an in-depth analysis of the sites that we determined were viable and sustainable, they may find that there are other sites that cannot be developed for reasons that could not be determined through the preliminary screening conducted by our group.

When analyzing the characteristics of each site we used the following resources:

- RTN database
- Google Earth Pro
- ArcGIS
- RE-Powering America's Land Decision Tree Tool
- NREL's PVWatts tool
- Conservation Commission
- Town/City officials, MassDEP
- Interactions within communities

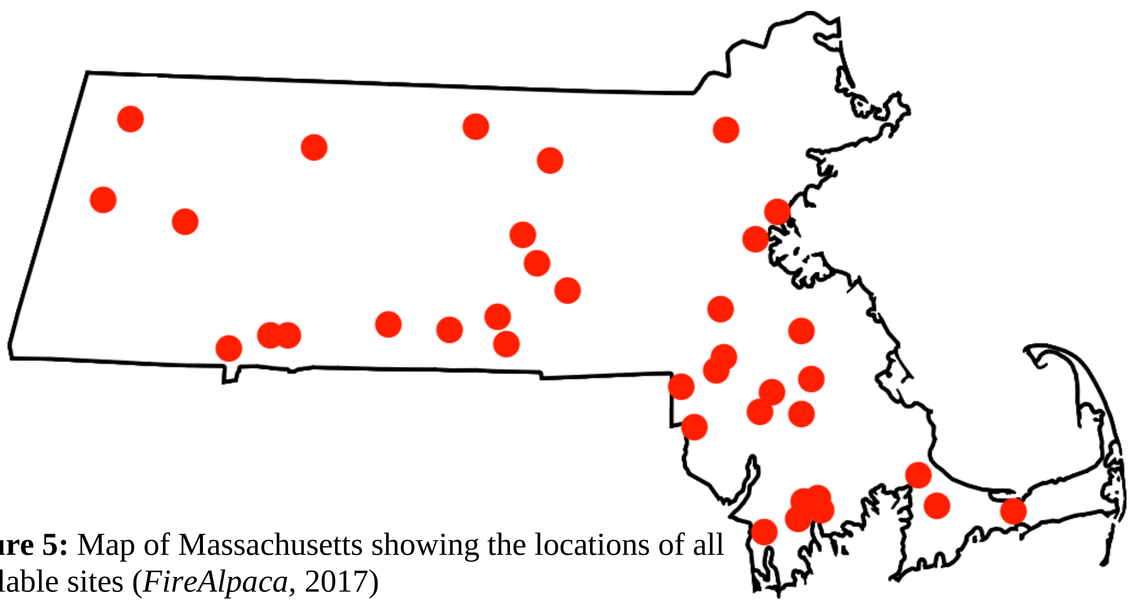

Figure 5: Map of Massachusetts showing the locations of all available sites (*FireAlpaca*, 2017)

The findings discuss the most influential and common characteristics such as how sites were identified, what they impacted, and how their impact can be altered. The findings that have the biggest impact on the viability and sustainability of a waste-site for PV development are:

- Size of useable land on the site
- Size of wetlands or areas of environmental concern on the site
- Profitability of a PV development on the site as determined by the PVWatts tool
- Distance to and condition of the local grid and transmission lines
- Access of waste-site to graded roads
- Previous redevelopment of waste-site or current use of waste-site

- Conservation Commission contingencies
- Local tax variations and Payment in Lieu of Taxes (PILOT) programs
- International Trade Commission (ITC) tariffs
- Community relationships and interactions with PV development

4.1 Usable Land

One factor that prevents MassDEP in finding sites for potential PV development is the usable acreage of the site. We found that the amount of usable land dictates the amount of power expected to generate energy. MassDEP knows that developers are attracted to sites that are five acres or greater in total useable land. A site that is under 5 acres will produce less than 1MW and therefore not be profitable. We used Using Google Earth Pro and ArcGIS layers to determine the total usable land for each site. **Wetlands** and **shading** impact the total usable land of a site. Eighteen of the sites that were determined to not be viable or sustainable did not have suitable useable land size, meaning they were less than five acres. Massachusetts law dictates that no solar installations can be developed within 100 feet of an existing wetland (310 CMR 10.00 wetlands protection act regulations, 2014). As a result of this land use ordinance, smaller waste-sites analyzed are not viable sites for PV development because the wetlands in and around the site reduce useable land to a point where a PV development would not be profitable.

Shading has a similar impact on sites. Sites that are in deep valleys or surrounded by tall buildings or trees have usable land size reduced, therefore developing in these shaded regions would not produce substantial amounts of energy or profit. In certain cases, this shading can be mitigated through building demolition or tree clearing; however, these actions are often impractical or impossible due to land ownership, land protection laws, and local regulations and permitting requirements.

In other cases, a waste-site is so large that even if there are wetlands or other characteristics that reduce the total available land, the site is still potentially viable and sustainable for PV development. Sites such as old farms or large demolished factories that have a large geographical footprint can still be good candidates for PV development simply due to the fact that their immense size allows them to produce large amounts of power, often greater than three or four megawatts. The General Latex/DOW PV development in Billerica, for example, has major wetlands throughout the site. Due to the large area of the site; however, the developer still found the site to be a viable PV location, even though there were areas that could not be developed due to the existence of wetlands. The developer still managed to fit 3.78 megawatts of solar power on the site, simply due to how large it was and how the size of the site overcame any wetlands area that could not be developed (Zensky, 2017).

Figure 6: Waste-site with a large presence of wetland (*Webster Fish and Game Associates*, 2015)

The economic profitability is directly related to the useable size of the site. When analyzing the economic viability of PV development on waste-sites using NREL's PVWatts economic tool, an estimated projected revenue and energy output is obtained. Due to costs of PV system installation differentiating from site to site, we cannot determine which sites are more economically viable than others. Factors such as the Engineering Procurement Company (EPC) labor and procurement costs, solar panel cost, and PILOT can influence the total cost of development. We are able to provide MassDEP with the predicted earnings from the site once it is installed. MassDEP uses the usable acreage and predicted earnings when attracting developers for PV projects. They can then decide if a site is economically viable and worth the investment, determined through the use of in-house economic tools that balance potential profit as well as costs of development.

Figure 7: Google Earth Pro image of the Former Curtis Paper Mill that has an abandoned building on site (*Former Curtis Paper Mill*, 2017)

4.2 Transmission Lines

Transmission line location and condition often determine the viability of a PV development more than any other characteristic of a waste-site. Sites located in areas with heavy duty and upgraded grid systems are usually capable of supporting the load of a PV system. Waste-sites located in secluded or residential areas often lack grids capable of handling the load of a PV development. Our group focused on estimating the proximity and condition of transmission lines around waste-sites. When notifying developers of viable waste-sites for PV development, MassDEP uses the condition of the local grid and its proximity to the waste-site as an important incentive to attract developers.

Waste-sites located in large industrial areas are often very close to transmission lines that are both in proper condition and capable of supporting the additional load of a PV system. This is due to the nature of the location. If the site is in an industrial area, such as bordering an operational manufacturing or storage facility, the local grid has usually been upgraded previously to accommodate this large facility. As a result, the developer of a PV site rarely has to incur large costs when connecting to the existing transmission system. Analyzing a site using Google Earth Pro helps determine the proximity of a waste-site to local industries and infrastructure, and if so, it is likely that the existing grid needs minimal financial investment to be able to support a PV system installed on the site.

In contrast, sites in a secluded or residential area generally lack adequate electrical grid systems for a PV installation. Site developers are often responsible for upgrading and constructing the infrastructure required to connect a PV installation to the grid, and utilities often make these developers upgrade the infrastructure owned by the utility to be able to support a PV installation. The cost of this construction alone can be in the millions of dollars, depending on the condition of the local grid and the distance that a developer must construct transmission lines to connect a PV system to the local utility.

In many cases, these costs result in a site not being a viable location for a PV system. For many developers, knowing the condition of a local grid requires in-depth conversations with local utilities. MassDEP has some preliminary information regarding transmission line location; however, this does not take into account the capabilities and condition of those lines. As a result, the analysis done by this group is only preliminary, and only determined the distance of a potential site to transmission lines. Using ArcGIS layers developed by MassDEP, as well as Google Earth Pro Street View, an estimated distance between a potential site and transmission lines is calculated. Distances of over a half mile often result in a site not being viable for PV development due to the cost a developer would incur when constructing a connecting transmission line to the existing grid. This analysis does not take into account the capabilities and condition of the grid as this is information that a developer acquires when completing an in-depth analysis of a site for PV development.

4.3 Distance to Graded Roads

Proximity and access to graded roads is a key for developers when installing a PV system on a waste-site. The construction vehicles necessary for the installation require well-maintained roads for travel and easy access. MassDEP uses the proximity of waste-sites to graded roads when attempting to attract developers. For many rural waste-sites, large distances exist between where the site is and where the nearest graded road capable of supporting traffic necessary for the construction of a PV system is located. This distance is determined by analyzing a Google Earth Pro image and looking at the distance between the edge of a waste-site and the nearest graded road. If this distance is greater than a half mile, the cost of constructing an interconnection is often prohibitive to developing a PV system on that particular waste-site.

4.4 Redeveloped or In-Use Land

While all the 83 sites analyzed are contaminated, nine are still in use and ten have been redeveloped. Identifying sites that are still in use or have been redeveloped is important, as MassDEP can communicate to developers the current use of the site and promote sites that are no longer in use or are under-developed when attracting developers.

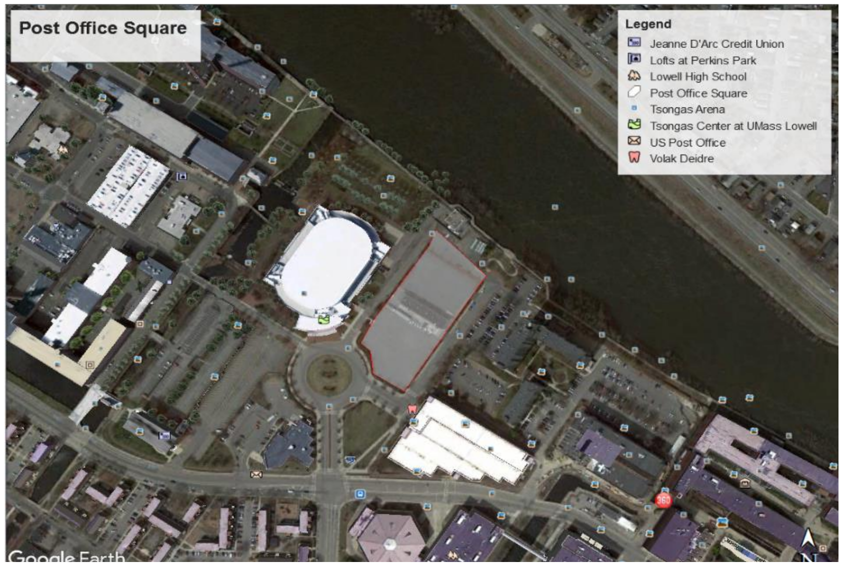

Figure 8: Google Earth Pro image of Post Office Square, a site that has been remediated and redeveloped (*Post Office Square*, 2015)

In nine cases, the waste-site is currently in use by the owner, be it in the form of housing or as a business. If the site is still in use by the owner, it is usually not a viable site for PV development due to the unlikelihood that the owner is willing to relinquish the land and its current use for a PV installation. Examples of land still in use by the owner are junkyards and manufacturing facilities.

Ten waste-sites analyzed are unviable for PV development due to the site having already been remediated and redeveloped. This situation is common for sites that have contamination dating back over 30 years. A Google Earth Pro satellite image can be studied to determine if a site is in use by the owner or has been remediated and redeveloped. This, along with the detailed history of the site contamination and use found in the RTN database, can show if there is either continued use of the site by the owner or if the site has been redeveloped. In both of these cases, the current land use is prohibitive to PV development. Figure 8 shows a Google Earth Pro image showing a waste-site, named Post Office Square, that has already been remediated and redeveloped.

4.5 Conservation Commission Contingencies

Through findings from conducting interviews with town officials, developers, our sponsor, and financial investors, we concluded that the influence of the Conservation Commission in every town is held by individuals within the board, who determine the local regulations regarding development in the town. Through discussions with our sponsor, Thomas Potter, and developers, we found that the types of environmental regulations vary from town-to-town. In some cases, MassDEP and developers have to work with the Conservation Commission to determine the best practices to benefit both the PV developer as well as the Conservation Commission and the local community, depending on the types of local regulations in place.

From visiting the Billerica developer, the Conservation Commission required the surrounding trees to stay standing by at least 12 feet in height, which meant the trees could be shortened to a fraction of its actual height and still be following the regulations imposed by the Commission. By doing so many trees surround the PV installation have the appearance of a large stick coming out of the ground, serving little to no purpose of what a tree is actually supposed to do. In cases like the Billerica site, the developer will meet local regulations; however, the regulation may not achieve the goal intended by the Conservation Commission and could be detrimental to the local community. In other cases, regulations prevent installations from becoming more beneficial to both the developer and the production capacity.

During the interview with the developer of the Emery Street Landfill site, Frank Sforza, he mentioned how they were unable to level the ground because they were building on a landfill and could not add fill to the site, even though it would flatten the terrain, allowing for more panels to be installed. Instead, the developer had to compromise installing panels on the slope due to the sloping of the site being unsuitable for development. Another power the Conservation Commission has is enforcing zoning regulations. Every town has solar permitting programs that are different; however, wetland regulations are strictly enforced, preventing installations from being within 100 feet of any wetlands. The Billerica solar installation is one of many sites where the installation is located next to small creeks and a pond. The Conservation Commission assessed the land the developer leased and determined new wetlands had formed since the previous wetland evaluation. This being the case, a new ordinance was issued forbidding development on a particular area of new wetlands and hurting the production capacity. The development continued because it was determined to still be economically viable.

4.6 Local Tax Variations and PILOT Programs

Local governments, while usually supportive of PV development due to the economic impact such an installation has on a local economy, can pose an obstacle toward PV development through the taxation laws regarding PV development. Local tax laws can vary widely from town-to-town, especially concerning PILOT programs. The waste-sites MassDEP presents to developers can change depending on the local tax laws and PILOT programs and how the costs associated with such obstacles affects the income of a PV installation for developers.

Unique revenue generating programs in every town will help determine the viability of new solar developments (Massachusetts Pilots, 2017). A common revenue generating program is the PILOT program, defined as a voluntary payment by a non-profit organization as a substitute for property taxes. PILOT revenues help offset cost of public services consumed by the PV development (Kenyon & Langley, 2010). Every town has their own variation of a PILOT program for paying taxes on the new solar development, which depends on the installation size and overall costs. These factors will determine the economic viability of the site. On average, developers pay $6,500 per MW of DC power annually (Massachusetts Pilots, 2017).

4.7 ITC Tariffs

Another factor that plays a role in a developer's decision is the ITC solar panel tariff. Currently, almost all solar cells are imported from overseas due to cheaper production costs resulting in American manufacturers struggling to compete with these lower-cost solar panels. This tariff aims to place a $0.40/watt tariff for cells and a floor price of $0.78/watt on modules (Hill, 2017). This tariff will force many developers to purchase more expensive solar panels made in the United States, raising development costs, and as a result an estimated 88,000 jobs will be lost in the US Solar Industry (approximately 1/3 of workers). In addition, this will put a stop to billions in private investments for solar development, causing 2/3 of expected installations in the next five years to completely cease (Hill, 2017). The ITC will make a recommendation to President Trump on November 13, 2017 for final approval after holding a hearing in October. Approval of this tariff will significantly slow the progress of renewable energy development in the United States and dramatically increase the cost of development of PV systems across the nation.

4.8 Developer-Community Relationships and Interactions

A favorable developer-community relationship will benefit both parties during the development process and reduce community opposition toward PV development, which is a common challenge faced by developers. Our group found that the most common cause of community opposition is the aesthetics of a PV installation. Knowing that aesthetics pose a major concern to many communities helps MassDEP provide tips to developers for working with communities in addressing concerns and creating healthy developer-community relationships.

Developing PV systems can often cause community kerfuffle if the PV development is visible from their homes, roads, or walkways. We learned that aesthetic concerns are not valid reasons for the prevention of a project, but if residents oppose a PV development, and have a means to disrupt a project, they have been known to do so (Martinage, 2016). An argument often brought up is how the large-scale renewable energy project will devalue property value. However, this argument is, in fact, false. An assessor in El Paso County tracked property sales in a 30,000-acre area near a wind farm and recorded that “property values are selling higher than what the current assessor’s value is. I’m seeing increase in the median sale price of the properties” providing evidence that large-scale renewable energy development was negligible towards the real estate market (National Association of Realtors, 2016). In the cases of developments built on private land, such as 79 of the 83 sites we analyzed, these community complaints do not impact the project because the land is privately owned.

A community’s relationship with the developer is critical in maintaining community support for a PV development. First impressions and accurate information are essential in these cases because residents who are against an installation will bring forth their concerns and fight the process of development, prolonging the project (Martinage, 2016).

4.9 Fact Sheet Information

In the interview with Frank Sforza, the developer of the Palmer Municipal Airport site, we found that developers are intrigued by the idea of having a fact sheet summarizing highlights of successful PV developments. Further research of previous PV sites found highlights and success stories, such as waste-site cleanup, greenhouse gas emission reductions, and financial benefits for local communities, such as lower electric bills.

5.0 Steps for Viable and Sustainable PV Development

Through the completion of our analysis of all the sites given to us, and points of views from developers, we have obtained a number of key points that will contribute to reducing the obstacles faced when attempting to install a PV system. Following the recommendations provided below facilitates the work the developer has to do when interacting with a community and dealing with opposition from the Conservation Commission in different towns.

5.1 Environmental Recommendations

Recommendation 1: Engage Conservation Commission

Due to the widely varying Conservation Commission regulations (as seen in section 4.5), we recommend that MassDEP suggest developers be proactive and engage with local Conservation Commissions early in the development process to determine if there are environmental permitting or other requirements for PV development. We recommended that MassDEP notify developers on how to contact local Conservation Commissions, through email, phone, or attendance at Commission meetings, enabling developers to learn the requirements and actions that must be taken to gain approval and permitting for a PV development. Contact information can be acquired through municipality websites.

5.2 Social Recommendations

Recommendation 2: Alerting residence to PV development

Through interviews with developers, we have determined that the most common opposition to PV development is the aesthetic of the installation itself (as discussed in section 4.8). The community members most likely to cite aesthetics as the primary reason to oppose a PV development are those neighboring the site. Therefore, we recommend the MassDEP encourages developers to notify residents within 500 feet of a potential PV installation of the details of the development, as well as the dates and times of local government discussions regarding the development. Such communication helps provide the community with factual and accurate information regarding the site, as well as giving residents an opportunity to voice their opinion on the development at a local government meeting, helping to create healthy developer-community relationships.

Recommendation 3: Improve aesthetics with tree buffer zone

While the community opposition surrounding the aesthetics of a PV installation usually does not prevent the development of a PV system (as discussed in section 4.8), creating a healthy developer-community relationship is still important. Addressing community concerns helps create this healthy relationship. As a result, we recommend the MassDEP encourage developers to include a buffer zone of trees in their development plans if the site is in a location where the PV installation has a major aesthetic impact on the area. The benefit of a healthy developer-community relationship outweighs the small amount of useable land lost due to the shading caused by planting trees around the perimeter of the site.

5.3 Economic Recommendations

Recommendation 4: Determining cost through in-house financial tool

Finding 4.1 explains how the PVWatts economic tool determines the potential profit generated by a PV development from the useable size of a waste-site. Determining the cost associated with developing PV on a waste-site varies depending on characteristics discussed in 4.1, 4.2, 4.3, and 4.4, such as choice of EPC, transmission line distance and condition, and distance to graded roads. We recommend MassDEP be transparent in the profit estimated by PVWatts so that developers can take such profit into consideration when doing an in-house financial analysis to determine the costs of development. With an in-house analysis, a developer can compare costs and projected profit to determine if the site is worth the investment.

Recommendation 5: Consult utility to assess transmission line status

Finding 4.2 displays the importance in determining the condition and distance of the nearest transmission line to the waste-site being analyzed for PV development. While the distance to transmission lines is relatively simple to determine, and the condition of such transmission line can be guessed by the local development, it is impossible to determine the specific capabilities of the local grid without engaging in discussions with the local utility. Therefore, we recommend that MassDEP encourage developers to contact local utilities immediately at the start of the PV development process, to determine the condition of the process, local grid as early in the development process as possible.

Recommendation 6: Highlight lessons learned from previous PV developments

We recommend using highlights of previous PV site development (finding 4.9) to promote PV development on future waste-sites in Massachusetts. Highlighting the benefits of PV development in communities across Massachusetts can show the communities of potential future PV sites the benefits they might also experience by developing PV systems in their local waste-site. MassDEP can highlight the success of waste-site redevelopment with PV, boosting community support for such redevelopment. These highlights can include greenhouse gas emission reduction, number of houses powered, and the number of equivalent vehicles taken off the road based on greenhouse gas emission reduction, and how targeting waste-sites for PV development helps clean up local contaminated land. Figure 9 shows an example fact sheet that contains these highlights.

MassDEP

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Project Fact Sheet

Brockton Brightfield

Brockton, MA

Site Information:	
Date completed:	October 26, 2006
Acreage:	3.7 acres
Power Output:	580 kWh
Green House Gas Emission Reduction:	677,000 pounds of CO_2 1,200 pounds of SO_2 315 pounds of NO_x.
Vehicles Taken off the road:	64.9 vehicles
Number of Houses powered in a year:	77 houses
Tree Seedling:	7,958 seedlings

Economic and Financial Benefits:

The construction of this Brightfield brought higher property values due to the increase in reinvestment, as well as jobs for local installers. The revenues of the field were given to Massachusetts-based renewable energy businesses. In the first 3 years of its completion the project exceeded its revenue expectation of $131,000 by making an average of $143,535. In addition, the project also brought a $3.00 per watt incentive for energy cost in the town.

About the project:

The Bay State Gas Company owns the land that is being used, and the project turned a polluted field in the middle of an industrial environment into a source of renewable energy. It uses 1,512 Schott ASE 300 modules facing south, angled at 42 degrees to maximize their total energy generation. This initiative for creating the biggest solar panel field of its time brought an improvement to the image of the city of Brockton, which the citizens are very proud about. The Brightfield received substantial amounts of local help, and became a source for education, teaching young children about programming and the importance of renewable energy.

Values for the power output and greenhouse gas emissions reduction were found online. This information was then put into the EPA Greenhouse Gas Equivalences Calculator to find the remaining values shown.

Figure 9: Example of a fact sheet

6.0 Conclusion

The Massachusetts government believes that climate change poses a major threat to the prosperity of the Commonwealth in the immediate as well as distant future. Through legislation such as the GWSA and CERP, Massachusetts is implementing efforts to combat climate change through the adaption of 1600MW of new renewable energy sources by 2020, aiming to reduce greenhouse gas emissions from fossil fuel use in the energy sector. Through CERP, MassDEP has been tasked with helping to reach this goal by finding waste-sites that can be developed with PV systems. Achieving this goal requires attracting developers to install PV systems and PV sustainable waste-sites in Massachusetts, as well as overcoming community opposition when encountered.

After analyzing the environmental, economic, and social viability and sustainability of 83 waste-sites, our group determined that 43 are viable and sustainable for potential PV development. We found that the biggest factors for viable sites were usable acreage, characteristics of local grid systems, and community opposition. By following our recommendations and utilizing and analyzing our deliverables, MassDEP can better work to attract developers to waste-sites for the purpose of installing PV systems, helping MassDEP and the Commonwealth of Massachusetts in meeting its goal of 1600MW of new renewable energy facilities in the state by 2020.

7.0 Deliverables

At the conclusion of our project, we gave the sponsor, MassDEP, a set of deliverables highlighting our findings and recommendations for the project. These deliverables include the following:

- Files of each site analyzed (Appendix G): These files include all the information and research conducted about each specific site. They also include a recommendation of the sustainability and viability of the site. Documents include a summary and data entry report for the RE-Powering America's Land Decision Tree Tool, a Google Earth Pro satellite image of the site with an outline of the waste-site property, relevant primary documents from the RTN database about the history and contamination of the site, and any notes made concerning the characteristics of the site. For waste-sites that are determined to be sustainable and viable, a PVWatts report has been included in the file detailing potential energy production and financial benefits of a PV development on the site.

- Fact sheets for specific sites already developed with PV installations (Appendix H): These fact sheets highlight the successes and benefits of previous PV developments around Massachusetts. They can be used by developers and MassDEP in showcasing positive experiences with PV development on waste-sites to the prospective site's residents and how PV development can benefit local communities. They can be used to garner support within communities of potential future PV development.

- White Pages (Appendix I): A summary of interviews conducted with developers and town officials that provide information about how community engagement has resulted in successful and expedited PV development. These can then be used by developers of future PV installations to determine methods to best gain community support and expedite the development of these future installations.

- Map of sustainable and viable waste-site locations (Appendix K): This map shows the Commonwealth of Massachusetts, with points placed over the locations of waste-sites determined to be viable and sustainable. It can be used by MassDEP and developers in determining where best to pursue PV development based off utilities, net metering availability, and energy pricing.

These deliverables can be given to developers, providing them insight and a preliminary report on the suitability of a site for PV development.

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Appendices

Appendix A: MassDEP and EPA Databases and Spreadsheet Information

The spreadsheets and databases provided by MassDEP have information such as:

- **Lot size**: determines the potential power output from a photovoltaic system that is developed on the site.
- **Zoning**: determines if the site is legally able to have solar development. A waste-site with improper zoning will immediately make it unsuitable for solar development.
- **Proximity to utilities**: important when calculating the cost of implementing a photovoltaic system on a site. MassDEP feels that whenever possible, sites within a quarter mile of power lines and graded roads be preferred to other sites, and any site over a mile from power lines be discarded as unsuitable for solar energy development.
- **Contamination**: determine the viability of a site due to the underlying contamination and how it is handled on the site. If developing solar would cause contamination to spread to other areas, then a site might not be environmentally sustainable.
- **History of Site**: The history of a site, including the contamination, ownership, and remediation, are important when determining if a site is viable for PV development. Sites that have already been remediated or developed, for example, is information that shows up in the history of the site.

The information found in these spreadsheets and databases was used when completing the RE-Powering America's Land Decision Tree Tool, which helps compile all of the environmental information of a site and drawing conclusions of if the site is environmentally viable and sustainable.

Appendix B: GIS Tools and How They Were Used When Determining Environmental Viability and Sustainability

Google Earth Pro and applicable GIS layers that have been created for use with Google Earth Pro by the EPA and MassDEP was be used by the group to analyze environmental characteristics of sites such as:

- **Proximity to wetlands**: By state law, no development can occur within 100 feet of wetlands. As a result, the group studied the proximity of any waste-site to wetlands to ensure that any potential solar development would not encroach on this 100-foot barrier. This information was found using Google Earth Pro to look at the area surrounding a waste-site, as well as information in EPA and MassDEP databases concerning the land surrounding each waste-site.
- **Shading**: The group looked to determine if the proposed waste-site has any natural or artificial shading from trees, buildings, or other obstacles that could decrease solar concentration on the site. This information was found using Google Earth Pro to look at the land around a waste-site and identifying where trees or other shadow-casting obstacles are. There are also GIS layers developed by the EPA that determines the potential solar energy production of each site. This takes into account the shading of the site and was used in determining the overall shading of the site.

In addition to Google Earth Pro, MassDEP also uses ArcGIS to create custom GIS layers that detail information that can be used when analyzing environmental characteristics of waste-sites. Examples of these layers are:

- **Distance to transmission lines**: This is one of the most important characteristics that a developer looks at when deciding if to develop a site with a PV system. A site that is far away from transmission lines that can handle the addition of a PV system is often unsuitable for PV development due to the cost and logistics of installing an appropriate transmission line system. ArcGIS has layers that show where such transmission lines are, and these layers can be analyzed to determine how far a potential PV system would be from transmission lines.
- **Parcel layout**: ArcGIS has a layer that shows the parcel layout of Massachusetts. When analyzing a site, knowing the total size of the waste-site depends on the parcel where the contamination took place. Using this layer, an accurate estimation of the total land that can be developed with a PV system is determined, which directly impacts the total potential power output of a site.

These characteristics, analyzed with both Google Earth Pro and ArcGIS, were used in conjunction with the RE-Powering America's Land Decision Tree Tool in determining the environmental sustainability of each waste-site analyzed by the group.

Appendix C: RE-Powering America's Land Decision Tree Tool Questions

The RE-Powering America's Land Decision Tree Tool from the EPA enables MassDEP and developers to determine the logistical viability of any given site. It takes into account the location, site characteristics, and regulatory obstacles that each site possesses.

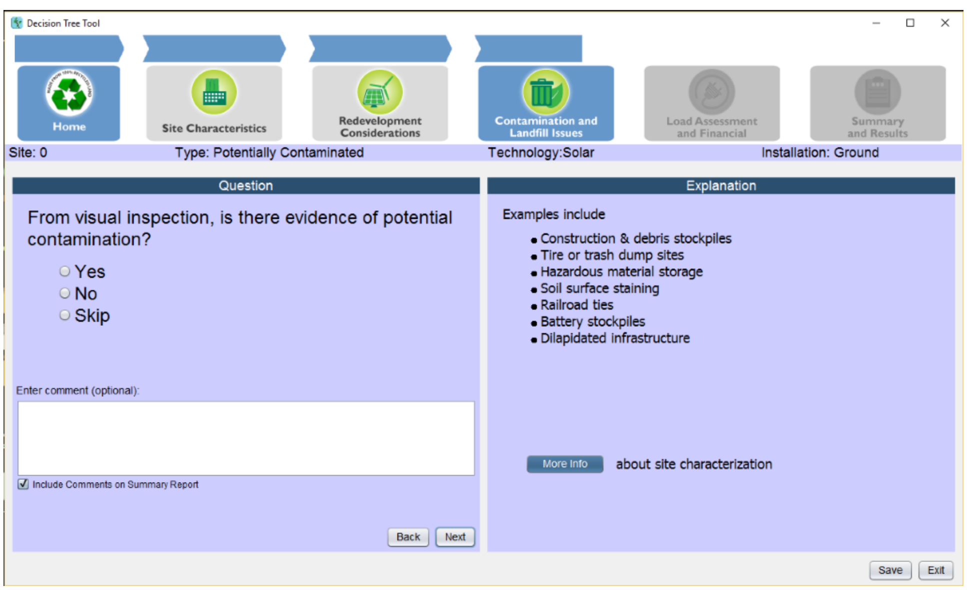

Figure 10: Screenshot of example question from the RE-Powering America's Land EPA Decision Tree Tool (RE-powering's electronic decision tree tool, 2017)

- As seen in the image above, the user inputs answers to yes or no questions concerning various site characteristics, as well as provides an explanation detailing the factors that go into each question. The above example concerns the contamination of a site, but other characteristics are inputted into the program, such as:

- **Type of site**: This can include sites such as landfills, Superfund Sites, brownfields, or parking lots. This information is important in determining cleanup activity that must occur in order to develop solar energy on the site. This information can be found on MassDEP spreadsheets about each waste-site that were given to the group.
- **Erosion control plans and vegetative cover**: This question concerns erosion control on the site. Ensuring that any solar development does not cause destructive erosion on the site is important when ensuring the structural stability of the site. The use of GIS layers developed by the EPA and Google Earth Pro answered this question.
- **Compatibility with operation and maintenance of leachate and gas collection infrastructure**: Ensuring that the site does not interfere with leachate and gas collection is important for preventing pollution on and around the site. This is especially important when looking at landfills as potential sites for solar development. Spreadsheets provided by MassDEP details the type of site that is being analyzed, and this is often dictated by the type of leachate and gas collection on the site.
- **Assessment for environmental contamination**: All of the sites that were studied by our team were assessed for environmental contamination. This is important due to the cleanup that would be required in order to develop the waste-sites being examined. This information was found on MassDEP spreadsheets in the form of the type of waste-site that is being analyzed, as well as by studying the activity that caused the site to become a waste-site. For instance, if a landfill is present on the site, then the type of contamination will be determined to be that associated with landfills.

Many of these questions required research before they can be answered, which can be as simple as a quick Google search to as in depth as research of databases and spreadsheets of information on each individual site, or the use of Google Earth Pro and GIS software. When our team analyzes a site, we compile as much data as we can from MassDEP and their resources, such as the databases and spreadsheets discussed earlier. We will then begin a new site analysis on the Decision Tree tool. If there are questions that we do not have information on, we do further research of the sites using tools such as GIS and the MassDEP waste-site databases, which can be used to determine characteristics such as contamination and remediation, tree shading and terrain sloping. Some questions may require a simple Google search or an analysis on Google Earth Pro, such as the proximity of three phase power lines to the site.

Appendix D: Re-Powering America's Land EPA Decision Tree Tool site categories (RE-powering's electronic decision tree tool, 2017)

1	Site assessed and remediation is not a barrier to a potential near-term solar PV or wind project
2	Site assessed and remediation must be completed prior to a potential solar PV or wind project
3	Site assessed but lacks an active remediation plan. Option to tailor remediation plan to a potential solar PV or wind project, if warranted
4	Site not yet assessed; contaminants may be present that need to be cleaned up, however, site conditions could pose few obstacles to a potential solar PV or wind project
5	Site not yet assessed; contaminant investigation and characterization is required as a next step prior to further scoping for a potential solar PV or wind project

Appendix E: PVWatts Information

NREL's PVWatts economic tool calculates:

- Monthly/Annually
    - Solar Radiation (kWh/m^2/day)
    - AC Energy (kWh)
    - Energy Value ($)
- PV System Specifications
    - DC System Size (kW)
    - Module Type
    - Array Type
    - Array Tilt (Degrees)
    - Array Azimuth (Degrees)
    - System Losses (%)
    - Inverter Efficiency (%)
    - DC to AC Size Ratio
- Economics
    - Average Cost of Electricity Purchased from Utility ($/kWh)
- Performance Metrics
    - Capacity Factor (%)

Appendix F: Incentives

1. Alternative Energy and Energy Conservation Patent Income Tax Deduction (Corporate) (Industry Recruitment/Support)
    a. 100% deduction incentive amount
    b. Income tax deduction for any royalty income, from sale or lease
    c. Deduction effective for up to 5 years

2. Business Energy Investment Tax Credit (ITC)
    a. Max incentive: 30% for solar until 2020
    b. Other renewable technology options available

3. Clean Renewable Energy Bonds (CREBs)
    a. From March 2015 close to $1.4 billion available for financial incentives and bonds
    b. Any federal sector can apply

4. Concord Municipal Light Plant - Solar Photovoltaic Rebate Program (residential/private)
    a. Any utility sector can apply
    b. Incentive amount = $625/kW AC with a maximum of $3,125
    c. This is more for residential customers

5. Energy Goals and Standards for Federal Government
    a. Energy standards for public buildings
    b. Required 30% reduction in energy consumption by 2015
    c. Not very relevant to our project

6. Energy Reduction Plan for State Buildings
    a. Energy targets for the state
    b. Not very relevant to our project
    c. Goal of 40% reduction by 2020 from 2002 baseline

7. Excise Tax Deduction for Solar or Wind Powered Systems (for companies)
    a. Following state guidance expenditures paid for the installation of solar or wind may be deducted from net income
    b. Only allowed in mass
    c. Incentive amount = 100%

8. Local Option - Energy Revolving Loan Fund
    a. PACE financing, though not offered to everyone, contact local gov. first
    b. Given to private property owners
    c. 20-year financing term

9. Model As-of Right Zoning Ordinance or Bylaw: Allowing Use of Large-Scale Solar Energy Facilities

a. "As-of-right" siting allows for locations that have been classified as designated locations to not require special permits, only standard building permits and compliance with local zoning bylaws.
b. Requires at least 50 ft of setbacks if the property will border residential and/or conservation-recreation districts.

10. Modified Accelerated Cost-Recovery System (MACRS)
    a. 40% first year bonus depreciation in 2018
    b. 30% first year bonus depreciation in 2019

11. Net Metering
    a. 7% utility peak load for private entities
    b. 8% of utility peak load for municipalities or gov. Entities
    c. <u>Class I Facilities:</u> any type of generating systems up to 60 kilowatts (kW) in capacity.
    d. <u>Class II Facilities:</u> systems greater than 60 kW and up to 1 megawatt (MW) in capacity that generate electricity from agricultural products, solar energy, or wind energy.
    e. <u>Class III Facilities:</u> systems greater than 1 MW and up to 2 MW in capacity that generate electricity from agricultural products, solar energy, or wind energy.

12. Renewable Energy Property Tax Exemption
    a. Systems that are primary source of energy are 'taxable property' however they are 100% exempt from local property tax for a 20 year period
    b. Anyone can apply in the state 70% of full rate set by the Treasury Department

13. Reading Municipal Light Department - Business Energy Efficiency Rebate Program
    a. Utility sector
    b. Up to $50,000 incentive amount
    c. Rebate program

14. Renewable Energy Trust Fund
    a. This fund can provide grants, contracts, loans, equity investments, energy production credits, bill credits, and rebates to customers.
    b. Total Fund: $150 million over a five-year period (1998-2002); $25 million per year from 2003 to 2010; and approximately $23 to $24 million starting in 2011

15. Residential & Small-Scale Solar Hot Water Program
    a. Maximum incentives:
        i. Residential: $5,000 per building or 40% of total installed costs
        ii. Residential (80% - 120% of SMI): $5,500 or 45% of eligible costs
        iii. Residential (less than 80% of SMI): $6,000 or 50% of eligible costs
        iv. Commercial: $20,500 or 40% of eligible costs
        v. Non-Profit/Public Entity: $30,500 or 65% of eligible costs
        vi. Affordable Housing: $40,500 or 80% of eligible costs

b. Non-Residential incentives rates are determined by using the following equations:
    i. Standard Rebate: *$100 X (# of collectors) X (Solar Rating and Certification Corporation (SRCC) rating)*
    ii. Non-Profit/Public Entity Rebate: *$150 X (# of collectors) X (Solar Rating and Certification Corporation (SRCC) rating)*
    iii. Affordable Housing Rebate Adder: *$200 X (# of collectors) X (Solar Rating and Certification Corporation (SRCC) rating)*
    iv. Customers can receive up to an additional $500 to cover the costs of a meter installation if the customer signs up for the MassCEC performance monitoring program. An additional $500 is also available for customers that have installed solar PV on the same facility by the time of application submission.
    v. Rebates are capped at $20,000 per building or 40% of the total installed costs (whichever is less), not including the $500 metering bonus. For non-profit and public entities, rebates are capped at $30,000 or 65% of eligible project costs. For affordable housing facilities, rebates are capped at $40,000 or 80% of eligible project costs.

16. Solar Easements & Rights Law
    a. Solar access provisions in Massachusetts allow for the creation of voluntary solar easements to protect solar exposure and authorizes zoning rules that prohibit unreasonable restrictions on solar access.
    b. Similar to solar easement provisions in many other states, solar easements in Massachusetts allow for the voluntary creation of solar access contracts, but do not make solar access an automatic right.
    c. In addition, the statutes allow for communities to authorize zoning boards to issue permits creating solar rights.

17. Solar Renewable Energy Certificates (SERC-II)
    a. Max Incentives: 2017 compliance year: Alternative Compliance Payment Rate is $350 per MWh (~$0.35 per kWh)
    b. Eligible system size: 6 MW (DC) or less
    c. Duration: 10 years

18. U.S. Department of Energy - Loan Guarantee Program
    a. Loan term: Full repayment is required over a period not to exceed the lesser of 30 years or 90% of the projected useful life of the physical asset to be financed.

19. USDA - High Energy Cost Grant Program
    a. Incentive amount: $50,000-$3,000,000
    b. Available for:
        i. Electric generation, transmission, and distribution facilities;
        ii. Natural gas or petroleum storage or distribution facilities;
        iii. Renewable energy facilities used for on-grid or off-grid electric power generation, water or space heating, or process heating and power;

iv. Backup up or emergency power generation or energy storage equipment; and
v. Weatherization of residential and community property, or other energy efficiency or conservation programs.

20. Holyoke Gas & Electric - Commercial Energy Conservation Loan Program
    a. Offers zero interest loans for the development of solar facilities on property of Holyoke Gas & Electric commercial customers. Loan period is up to 10 years.

21. Hudson Light & Power - Photovoltaic Incentive Program
    a. Offers financial payback of $1.00/watt for panels oriented between 170 and 220 degrees (Range 1) and $1.25/watt for panels oriented between 220 and 300 degrees (Range 2).
    b. Maximum incentive is $10,000 per installation per 12 month period for Range 1 and $12,000 per installation per 12 month period for Range 2.
    c. Incentive only available to installations connected to grid and to Hudson Light & Power customers.

22. Local Option - Commercial PACE Financing
    a. Massachusetts offers PACE Financing in Municipalities that approve joining the PACE program. Financing varies.

23. USDA - Rural Energy for America Program (REAP) Grants
    a. Offers grants of up to 25% of the total cost of solar installation for rural businesses or agricultural property. Total grant may not exceed $25 million.
    b. Incentive amount:
        i. Renewable Grants: $2,500-$500,000
        ii. Efficiency Grants: $1,500-$250,000
        iii. Loan and Grant Combination: Grant portion must exceed $1,500

24. Renewable Energy Trust Fund
    a. Offers grants, contracts, loans, equity investments, energy production credits, bill credits, and rebates to customers of renewable energy.
    b. Funding for Trust Fund comes from $0.0005 per kilowatt-hour surcharge on all customers of investor owned and competitive municipality utilities in Massachusetts.

Appendix G: Sample Waste-Site File

Site Screening Summary Report

Site Name	HURTUBISE RESIDENCE
Site Address	1433 GREEN ST GARDNER MASSACHUSETTS 01440
Evaluator Name	Carl Turnquist
Site Type	Potentially Contaminated
Technology	Solar
Installation Type	Ground

EPA is encouraging renewable energy development on current and formerly contaminated lands, landfills and mine sites when such development is aligned with the community's vision for the site. This report is from U.S. EPA's Electronic Decision Tree tool and its data is for informational purposes and reflects the data as inputted by the user.

Summary

Based on the responses provided, this site appears to be a good candidate for redevelopment with a Solar PV system.

General Site Characteristics

Quick Facts	
Solar Resource	> 3.5 kwh/m2/day based on location
Usable Space	11.5
Distance to Distribution/Transmission Lines	0.3
Distance to Road	0.3

- Project is located in an area of the country that receives more than the minimum solar resource (3.5 kwh/m2/day) to make a solar PV installation technically viable
- Usable acreage is sufficient/not likely to pose an obstacle
- Site has sufficient proximity to electrical grid to establish interconnection
    - Transmission lines are single phase. Would have to be upgraded to three phase.
- Site is sufficiently close to roads for purposes of installing and operating a renewable energy system

Redevelopment Considerations

- Site owner is interested in developing renewable energy at the site
  - Assumed to be yes. Site is partially developed with residence. Owner would have to be receptive to PV development in rear of property.
- Community has or is developing a redevelopment plan. (It may be possible to integrate solar PV into the reuse plan for the site, pending further exploration.)
  - Site is developed with residence.
- Site free of land-use exclusions or restrictions that would preclude solar PV on the usable acreage or rooftop
  - Assumed to be yes.
- Site does not have a landfill

Contamination and Landfill Issues

- Site has been assessed for environmental contamination
  - Contaminated with Petroleum Hydrocarbons.
- Remediation is not complete
  - Remediation is not complete.
- Remediation is in progress
  - Site has been assessed but cleanup has not begun.
- Remediation activities is or is expected to disturb the useable acreage for the solar PV installation
  - PV cannot be installed until remediation activities have been completed.
- Site is considered a Category 2 site on the tool's readiness scale. Such sites have been assessed, but remediation must be completed prior to a potential solar PV or wind project.

Load Assessment and Financing

Quick Facts	
Feasible Project Arrangements Identified	Sell Power to Utility, Sell Power to Off-Site Buyer or Collection of Buyers
Comparison Electricity Price	Price valid as of June 2017,

- Local utility or other energy provider is interested in buying power from a solar PV project at the site
  - Local utility is National Grid.
- The power supplied by a solar PV system could be credited towards multiple utility customers that purchase or subscribe to shares (Virtual Net Metering)
- Retail price of electricity is not likely to pose an obstacle for an economically viable project
  - Price valid as of June 2017
- There is a potential sponsor for a community solar project

General Site Characteristics	Satisfied criteria
Redevelopment Considerations	Satisfied criteria
Contamination and Landfill Issues	Satisfied criteria
Load Assessment and Financial	Satisfied criteria

These findings do not replace or substitute the need for a detailed site-specific assessment.

Next Steps

Congratulations!

- Engage a qualified developer to pursue a more in-depth feasibility study
    - If concerns were identified, be sure to highlight
- Begin / continue community engagement efforts to confirm that renewable energy is preferred and compatible with the community vision and/or redevelopment plan
- Consider who will buy or use the power from the planned renewable energy system and the mechanisms for such arrangements (e.g., a power purchase agreement)
- Pursue financing options and a more detailed economic analysis of the expected cost, payback and projected return from the new installation
- Begin drafting a Request for Information or a Request for Proposals
- Explore strategies to enhance your project that could include
    - Opportunities for collaborative procurement
    - Opportunities to also incorporate other energy saving and environmental technologies whether that be green remediation, energy efficiency, etc., depending on the type of site and installation
- Upon project completion, consider joining EPA's Green Power Partnership to communicate your organization's leadership in green power production

Additional Considerations

The following table highlights additional considerations and actions for select attributes of a renewable energy project on contaminated lands, landfills or mine sites for those sites that have successfully passed through the initial screening provided by this electronic decision tree. Many of the actions identified in the table below can be addressed in the next phase(s) of project development and typically involve a more in-depth feasibility analysis by a renewable energy developer as well as additional discussion with appropriate parties, such as government agencies that have approval authority over site redevelopment.

Site Characteristics	Additional Considerations / Next Steps
Usable Acreage	Amount of usable acreage may change as development conversations continue and as stakeholders better understand how the integration of a renewable energy installation on a contaminated land, landfill or mine site proceeds. Keep abreast of the implications of design, technology, land use, other site redevelopment plans, etc. will have on usable acreage. Explore project economics. System size will depend upon usable acreage among other factors and generally, the larger the installation, the lower the expected per kilowatt hour cost. In addition, available energy load and regulatory policies might lead to smaller systems, despite acreage available.
Interconnection, Transmission and Distribution	Keep in mind that there will be a process involving the local utility to interconnect a renewable energy system with the electricity infrastructure serving the site; this process is typically required even if the renewable energy system is intended to serve on-site energy load. Also, this screening has evaluated proximity of transmission and distribution to the site, but the type, capacity and other specification of these connections will be important. If a large renewable energy system is being considered, the utility may need to evaluate whether existing electrical capacity provided by transmission or distribution lines serving the site is sufficient or whether a capacity upgrade is needed.
Redevelopment Considerations	**Additional Considerations / Next Steps**
Land Use	Consider both the whole and parts of the land parcel for renewable energy development. Explore applicable zoning, permitting or other regulatory processes. Confirm whether a renewable energy project is compatible with existing land use designations or whether some kind of variance is needed.
Community Engagement	Begin / continue community engagement efforts to confirm that renewable energy is preferred and compatible with the community vision and/or redevelopment plan. Attend community meetings related to the site's redevelopment and discuss how the renewable energy installation can be considered in the context of the redevelopment plan or visioning process. Confirm community interest and direction, engage stakeholders and foster potential partnerships.

Contamination and Landfill Issues	Additional Considerations / Next Steps
Landfills	Consult with a developer and/or civil engineer familiar with the landfill to pursue a more detailed evaluation of how the technical criteria associated with renewable energy development at the landfill will be satisfied (e.g., settlement, weight bearing capacity, etc.). Consider how a renewable energy project will integrate with the landfill and its post-closure operations.
Environmental Assessment and Remediation	<u>Category 1: Site assessed and remediation is not a barrier to a potential near-term solar PV or wind project.</u> Inform appropriate parties (government oversight agency, site owner and/or operator) of interest in pursuing a renewable energy project at the site. Provide information on the site screening considerations addressed.
	<u>Category 2: Site assessed and remediation must be completed prior to a potential solar PV or wind project.</u> Check the remediation plan to determine when remediation activities will be complete in order to plan the project timeline for a potential solar PV installation. Talk to the project manager who is overseeing remediation and the site owner/operator about potential adjustments to the design of and/or post-remediation plan for the site remedy, e.g., capping of contaminated areas, that might be needed to best accommodate a solar PV installation.
	<u>Category 3: Site assessed but lacks an active remediation plan.</u> Check with the project manager who is overseeing remediation and the site owner/operator about the reason(s) behind the delay; consider whether the prospect of a solar PV installation at the site might help expedite the steps needed to begin remediation. If remediation activities are expected to disturb the surface of the usable acreage for solar PV, talk to the project manager and site owner/operator about the opportunity to design the site remedy, e.g., capping of contaminated areas, and post-remediation plan in a manner that can best accommodate a solar PV installation.
	<u>Category 4 and 5: Site not assessed.</u> Talk to the site owner/operator about what's needed to initiate a site assessment (i.e., investigation of contaminants); consider whether the prospect of a solar PV installation at the site might

	help expedite a site assessment. [Note that the site investigation and cleanup cost analysis can be structured to include a comparison of cleanup costs that would be necessary to repurpose the site to solar versus other potential redevelopment re-uses that may incur larger cleanup costs.] Following site assessment -- if remediation of contaminants is found to be necessary and would disturb the surface of the usable acreage for solar PV -- talk to the project manager and site owner/operator about the opportunity to design the site remedy, e.g., capping of contaminated areas, and post-remediation plan in a manner that can best accommodate a solar PV installation.
Liability	Check with site's project manager to ascertain the coverage and extent of applicable liability protections to the extent they exist for the site. Engage legal counsel as needed. Research both Federal and State liability provisions, as applicable.

Load Assessment and Financial	**Additional Considerations / Next Steps**
Financing	Project financing varies by project size, as well as local market conditions and available incentives. Renewable energy developers, once contracted, typically conduct site-specific project economic analyses that address procurement alternatives (e.g., direct purchase, power purchase agreement, or lease) and takes into account available tax credits and incentives. Site owners will weigh the preferable development structure for both financing and operations (for example, owning and operation the installations themselves, relying on third party developers through lease or easement arrangements or some other configuration). Explore brownfields, renewable energy and other related sources of funding, even if not expressly advertised for renewable energy development on contaminated lands.
Renewable Energy Project Arrangements	Further explore feasible renewable energy project arrangements. A renewable energy developer can help vet which project arrangement(s) will be the most feasible considering the technical potential of the site (looking at different options for system size and design), the electricity load to be served, policies and regulations that either enable or hinder on- and off-site sales arrangements and fundamentally, project economics.

	Evaluate investments needed to develop project in the context of acceptable returns for investors and payback periods. If considering a Community Solar project, gather information on any legislative or local initiatives that support Community Solar projects. Identify potential project sponsors and neighborhood or business districts that may be good candidates for purchasing or subscribing to the power generated by a renewable energy installation.

Data Entry Report

Site Name	HURTUBISE RESIDENCE
Site Address	1433 GREEN ST GARDNER MASSACHUSETTS 01440
Evaluator Name	Carl Turnquist
Site Type	Potentially Contaminated
Technology	Solar
Installation Type	Ground

EPA is encouraging renewable energy development on current and formerly contaminated lands, landfills and mine sites when such development is aligned with the community's vision for the site. This report is from U.S. EPA's Electronic Decision Tree tool and its data is for informational purposes and reflects the data as inputted by the user.

Question	User Response	Value Entry	User Comments
General Site Characteristics			
Is the site in the northwest corner of Washington state or Alaska?	No		
Is the usable acreage for a ground mounted system greater than 2 acres?	Yes	11.5	
Is the distance to transmission and/or distribution lines less than 1 mile?	Yes	0.3	Transmission lines are single phase. Would have to be upgraded to three phase.
Is the distance to graded road less than 1 mile?	Yes	0.3	
Redevelopment Considerations			
Is the site owner(s) interested in investing in and/or selling or leasing the site in order to enable development of solar PV?	Yes		Assumed to be yes. Site is partially developed with residence. Owner would have to be receptive to PV development in rear of property.
Is there an existing redevelopment plan for the site or is one being developed?	Yes		Site is developed with residence.
Is the site free of land use exclusions or restrictions that would preclude the use of solar	Yes		Assumed to be yes.

PV on the usable acreage or rooftop?			
Is there a landfill or similar unit on the site being considered as part of a solar PV installation?	No		
Contamination and Landfill Issues			
Has the site been assessed for environmental contamination?	Yes		Contaminated with Petroleum Hydrocarbons.
Is remediation complete or not required on the usable acreage?	No		Remediation is not complete.
Is remediation in progress?	Yes		Site has been assessed but cleanup has not begun.
Are remediation activities actively disturbing or going to disturb the usable acreage for solar PV?	Yes		PV cannot be installed until remediation activities have been completed.
Load Assessment and Financial			
Is the local utility or other energy provider interested in buying power from a renewable energy project at the site?	Yes		Local utility is National Grid.
Is Virtual Net Metering allowed by the local utility?	Yes		
Is the retail price of electricity greater than 8 cents/kWh?	Yes	19.95	Price valid as of June 2017
Is there a potential sponsor for a Community Solar project?	Yes		
Feasible project arrangements	Sell Power to Utility, Sell Power to Off-Site Buyer or Collection of Buyers		

Site Map


Hurtubise Residence
1433 Green Street
Legend
Click on the Google Earth Instructions layer in the navigation bar under "Renewable Energy Sites" for more information.
© 2017 Google
N
1000 ft

PVWatts Economic Tool Sheet Example

9/12/2017

PVWatts Calculator

NREL

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at http://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

Disclaimer: The PVWatts® Model ("Model") is provided by the National Renewable Energy Laboratory ("NREL"), which is operated by the Alliance for Sustainable Energy, LLC ("Alliance") for the U.S. Department Of Energy ("DOE") and may be used for any purpose whatsoever.

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The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

9,321,681 kWh/Year*

System output may range from 8,922,713 to 9,655,397kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Energy Value ($)
January	3.30	633,045	46,719
February	4.20	725,051	53,509
March	4.76	876,973	64,721
April	4.85	839,780	61,976
May	5.25	898,832	66,334
June	5.33	858,427	63,352
July	5.59	923,342	68,143
August	5.30	878,863	64,860
September	4.93	803,962	59,332
October	4.33	769,015	56,753
November	3.21	574,878	42,426
December	2.85	539,517	39,816
Annual	4.49	9,321,685	$ 687,941

Location and Station Identification

Requested Location	1433 green st, gardner, ma 01440
Weather Data Source	(TMY2) WORCESTER, MA 25 mi
Latitude	42.27° N
Longitude	71.87° W

PV System Specifications *(Commercial)*

DC System Size	6979.2 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	42.6°
Array Azimuth	180°
System Losses	14%
Inverter Efficiency	96%
DC to AC Size Ratio	1.1

Economics

Average Cost of Electricity Purchased from Utility	0.07 $/kWh

Performance Metrics

Capacity Factor	15.2%

RTN Database Information Example

Site Information			
Site Number:	2-0011092	Category:	120 DY
Site Name:	HURTUBISE RESIDENCE	Release Type:	TIER1D
Address:	1433 GREEN ST	Current date:	7/7/2008
Town:	GARDNER	Phase:	
Zipcode:	01440-0000	RAO Class:	
Official notification date:	2/2/1996	Locationtype:	RESIDNTIAL
Initial status date:	6/30/2008	Source:	

Click Here for Supporting Documents

Response Action Information	
Response Action Type:	RNF Release Notification Form Received
Status:	REPORT Reportable Release or Threat of Release
Submittal Date:	06/13/1996
RAO class:	
Activity & Use Limitation:	
Response Action Type:	REL Potential Release or Threat of Release
Status:	REPORT Reportable Release or Threat of Release
Submittal Date:	02/02/1996
RAO class:	
Activity & Use Limitation:	

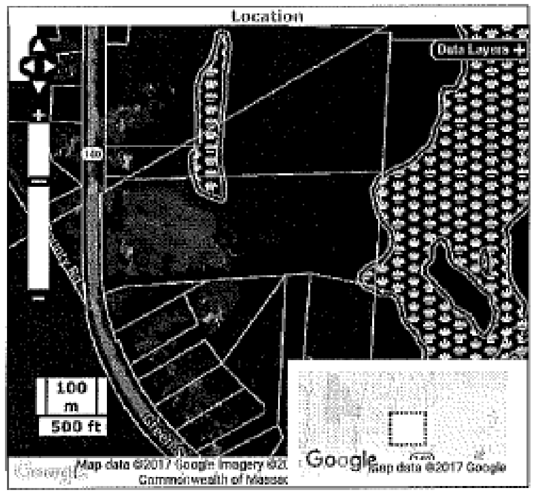
Chemicals

Chemical	Amount	Units
TOTAL PETROLEUM HYDROCARBONS (TPH)	49000	PPM

LSPs

LSP#	Name
N/A	PURINGTON, JAMES M

Location



●Open Sites ●Closed Sites ●Closed Sites with Use Limitation

Commonwealth of Massachusetts

Massachusetts Environmental Police

Headquarters Bureau (617) 727-3905
175 Portland Street, Boston, MA 02114 Fax: (617) 727-8551

Richard A. Murray, *Director*

1433 Green St
Gardner
RT #2-11092

MEMORANDUM

TO: Lt. Gail Larson, Environmental Police

FROM: Michael Moore, Environmental Police Officer

DATE: October 18, 1996

RE: 101 Septic Services; Summary of Investigation

On October 3, 1995, Craig Dunlop with the Worcester Regional Office of the Department of Environmental Protection (DEP) received a tip from a resident of the town of Gardner, Mr. Frank Dack. Mr. Dack informed Mr. Dunlop that a septic hauler had dumped the contents of his truck several times during the previous 2-3 months behind a house owned by Mr. Joseph Thibeault and Michael Thibeault at 1433 Green Street in Gardner, MA ("the site"). Mr. Dack was unsure of the specific dates.

Upon further investigation by Mr. Dunlop, he learned that the site consists of 18 acres and that there are drinking wells within 400 feet of the alleged dump site. Later that day, Mr. Dunlop drove past the site and observed a large tanker truck marked "101 Septic Services" backed into the driveway on the side of the house. Mr. Dunlop then went and met with Mr. Dack. Mr. Dack and Mr. Dunlop then went on to an adjacent property, to the rear of the site. From this location, Mr. Dunlop could observe a large area of dark sludge-like material on the surface of the ground approximately 50 yards from the back of Thibeault's house. Mr. Dunlop was also downwind of the material and could smell a strong septage odor. Mr. Dunlop took several photographs of the dark sludge, which appeared to be moist. Mr. Dunlop did not take any samples at this time.

On October 13, 1995, at approximately 3:30 p.m. this officer and Mr. Dunlop arrived at the site. Upon arriving at the site we first spoke to Ms. Theresa DesRoche. Ms. DesRoche informed us at that time that the owners of this property were not home, but they should be back soon. After waiting 10 minutes, at approximately 3:40 p.m., an unknown individual drove into the driveway. This individual identified himself as Mr. Michael Thibeault, who owns the site jointly with his father, Mr. Joseph Thibeault. This officer and Mr. Dunlop identified ourselves and explained to Mr. Thibeault that we had received a complaint regarding some excavation work going on at the site. This officer then showed Mr. Thibeault a form entitled "Consent to Inspection". Mr. Thibeault read and signed the form. (SEE ATTACHED)

After signing the consent to inspection form, I asked Mr. Thibeault some additional questions. During my conversation with Mr. Thibeault, Mr. Dunlop went to the rear of the site to the area where he had previously seen the dark sludge-like material. At this time, he observed a large area of discolored soil, which was now dry, and obtained two samples. He also observed that the discolored soil appeared to be 6-8 inches deep. Mr. Dunlop also observed, but did not sample, several piles of what appeared to be sand located closer to the house.

During my conversation with Mr. Thibeault, he stated that earlier that day, his friend, Mr. Robert Hurtubise had excavated a 20' x 40' area on the property where Mr. Thibeault intended to put a garden. Mr. Thibeault stated that Mr. Hurtubise moved the excavated fill to an area at the rear of the site and spread it around, together with some other fill that Mr. Hurtubise had previously brought onto the site during the previous three to four months. Mr. Thibeault estimated that Mr. Hurtubise had brought six to seven loads of fill onto the site since approximately April of 1995. Mr. Thibeault thought that each load was approximately 15-20 cubic yards of fill. He stated that Mr. Hurtubise transported the fill in a large box trailer with a canvas top. Mr. Thibeault said that he did not know where Mr. Hurtubise had obtained the material. This officer then directed Mr. Thibeault's attention to the area of discolored soil on the site where Mr. Dunlop had obtained the samples. Mr. Thibeault stated that he had noticed the discolored soil before. Mr. Thibeault told this officer that during 1991-1992 period, he had allowed the town of Gardner to dump leaves, brush and sand from street cleaning onto the site. Mr. Thibeault then went into the house to make a phone call.

Shortly thereafter, an individual arrived at the site. This individual approached this officer and Mr. Dunlop identifying himself as Mr. Robert Hurtubise (31 Regina Drive., Leominster, MA, D.O.B 03/10/35, SS# 014-26-5078). This officer and Mr. Dunlop identified ourselves and asked Mr. Hurtubise some questions.

Mr. Hurtubise stated that he had dumped approximately 30 loads of fill onto this site since April of 1995. He could not recall specific dates, however, Mr. Hurtubise did state that he had used a trailer truck to bring the fill onto the site. He estimated that each load was only 4-5 cubic yards, equivalent to that contained in a pick-up truck.

Mr. Hurtubise stated that the fill was sand from various carwashes with which his company, 101 Septic Services, did business. Mr. Hurtubise stated that he knew carwash sand was classified as industrial waste by DEP. He stated that since landfills could not accept it, he thought he could take it anywhere for disposal. He acknowledged that the Thibeault property was the only place he had taken carwash sand during 1995.

Mr. Hurtubise agreed to accompany this officer and Mr. Dunlop to his place of business in Gardner, MA, where he operates a carwash and 101 Septic Services, a septic hauling business. He stated that he has one employee. In his office, Mr. Hurtubise read and signed a "Consent to Inspection" form which authorized this officer and Mr. Dunlop to review records relating to hazardous or solid wastes, or pollutants. Mr. Hurtubise also agreed to answer some additional questions.

Mr. Hurtubise stated that he knew that the Thibeaults' had previously permitted the towns of Gardner and/or Winchendon to dump leaves and waste from street sweeping at the site. Mr. Hurtubise stated that the car wash sand was not supposed to be contaminated. He stated that most car washes test their sand periodically. Mr. Hurtubise stated that he was a member of the New England Car Wash Association, which, he knew, recommends that such material be tested. Mr. Hurtubise stated that he had not asked any of his customers whether they had tested the sand that he picked up from them, and further stated that he had not had his own sand tested for 3-4 years. He insisted that he only collected the car wash sand, not wastewater, for dumping at the Thibeault site. Mr. Hurtubise stated that he only owns one truck, a pump truck which he uses for his septic hauling business and as well as for collecting car wash sand. He said that his tanker truck is equipped with a 100 gallon water tank which he uses to rinse out the interior of the truck before picking up the sand. He denied ever dumping septic waste at the site. He stated that he takes all of his septic waste to the Templeton POTW. Mr. Hurtubise permitted this Officer and Mr. Dunlop to inspect and to remove the following original records from his files:

(a) invoices for car wash pumpouts during 1995;

(b) September 1, 1989 letter from Cornelius O'Leary of DEP to Mr. Robert Hurtubise stating in part: "**In response to your letter of July 31, 1989, please be advised that the effluent from a car wash, when free of hydrocarbons such as gasoline, oil or solvents, is to be considered to be industrial waste for the purposes of disposal...**"

(c) January 1992 DEP Penalty Assessment Notice (PAN) and Settlement; and

(d) several single page advisories to members of the car wash trade group re: Proper handling and disposal of car wash wastewater.

Mr. Hurtubise then signed an inventory form, prepared by this Officer regarding the documents taken by this Officer and Mr. Dunlop.

After reviewing the documents obtained from Mr. Hurtubise, it was learned that the DEP Penalty Assessment Notice (PAN) and the Settlement Agreement arose from a May 1991 incident in which Mr. Hurtubise was caught by the Acton Police Department discharging liquid car wash waste into a stream. By executing the Settlement, Mr. Hurtubise acknowledged that such waste is defined as a pollutant under G.L. c. 21 § 42, and that the discharge of any such material to the waters of the Commonwealth requires either a surface water or ground water discharge permit issued by DEP. Pursuant to the settlement agreement, Mr. Hurtubise agreed to pay a $3,000.00 administrative penalty and to prepare and distribute educational materials to professional car wash organizations for the purpose of familiarizing the membership with the Massachusetts Laws, Regulations and Procedures required for the proper storage and disposal of wastewater.

During the course of this investigation, this Officer and Mr. Dunlop spoke to all the various car washes that Mr. Hurtubise claimed to be doing business with. None of his customers had ever seen any educational materials from Mr. Hurtubise or from the New England Car Wash Association to which he belongs. Moreover, all of the car wash operators that were interviewed stated that 101 Septic pumped out the entire contents including liquid and sand from their waste tanks. Lastly, none of the invoices for car wash pumpouts specify whether sand or liquid was removed.

Laboratory analysis of the two samples taken from the site by Mr. Dunlop on October 13, 1995 revealed Total Petroleum Hydrocarbon (TPH) levels of 26,500 and 49,000 parts per million (ppm), which clearly meet the definition of a pollutant under Chapter 21 § 42.

A. Clean Water Act.

The Chapter 21E notification threshold is triggered for release of oil at concentrations greater than 500 ppm of TPH. Any person who, directly or indirectly, throws, drains, runs, discharges or allows the discharge of any pollutant into waters of the commonwealth, except in conformity with a permit issued under section 43; or who violates any provision of this chapter, any valid regulation, order or permit prescribed or issued by the director (of the Division of Water Pollution Control) thereunder. . .shall be punished. . . ."

314 CMR 5.03(1) provides, in pertinent part: "No person shall discharge pollutants to ground waters of the commonwealth without a currently valid permit . . . ." 314 CMR 5.03(2) provides, in pertinent part: "Activities which constitute discharges of pollutants requiring a permit under 314 CMR 5.03(1) include, but are not limited to: (a) any facility which discharges a liquid effluent onto or below the land surface. . . ." 314 CMR 5.04 provides, in pertinent part:

"No person shall engage in any other activity, other than these described in 314 CMR 5.03, which may reasonably result, directly or indirectly, in the discharge of pollutants into ground waters of the Commonwealth, without a currently valid permit. . . ."

A "pollutant" is ". . .any element or property of. . .industrial or commercial waste. . .or other matter, in whatever form. . .which is or may be discharged, drained or otherwise introduced into any. . .waters of the commonwealth." G.L. c. 21, sec. 26A.

"Waters of the commonwealth" are defined as ". . .all waters within jurisdiction of the commonwealth, including, without limitation, . . .groundwaters." G.L. c. 21, sec. 26A.

A "discharge or discharge of pollutants" is ". . .any addition of any pollutant or combination of pollutants to waters of the Commonwealth from any source. . . ." 314 CMR 5.02.

"Groundwater" is ". . .water below the land surface. . . ." 314 CMR 5.02.

"Effluent" is ". . . a discharge of pollutants into the environment, whether or not treated." Id. ...

The evidence in this case shows that Mr. Hurtubise discharged a petroleum contaminated mixture of water and sand onto the surface of the land without a groundwater discharge permit. We have evidence that, despite Mr. Hurtubise's statements to the contrary, the car wash "sand" was not completely dry and contained liquid that was capable of reaching groundwater. Mr. Dunlop's observations on October 3, 1995 confirm that the material discharged from the septic tank truck (as observed by Dack, the neighbor) was partially liquid. Indeed, Dunlop can testify that a tank truck of the type used by Hurtubise can only pick up and discharge material that is or contains liquid.

Pursuant to 314 CMR 5.03(2), the discharge of liquid effluent onto land is an activity which constitutes a "discharge of pollutants requiring a permit under 314 CMR 5.03(1)." In the alternative, Hurtubise was engaged in an activity which, pursuant to 314 CMR 5.04, could "reasonably result, directly or indirectly, in the discharge of pollutants" to the groundwater. Under either regulation, Mr. Hurtubise lacked the necessary groundwater discharge permit. Accordingly, Hurtubise violated a regulation promulgated pursuant to G.L. c. 21 sec. 42, and this violated the statute itself.

In this case, we have evidence that Hurtubise previously violated G.L. c. 21 § 42 in 1991 and that he signed a Settlement Agreement in 1992 acknowledging that liquid car was waste is a "pollutant" and may be disposed of only pursuant to permit. Moreover, as a condition of settlement, Hurtubise was required to prepare educational materials of car washes, altering them to the proper methods for handling and disposing of liquid car wash wastes. Several copies o a single page advisory containing such advice were found in the records that Hurtubise made available to the investigators. Based on the foregoing, as well as Hurtubise's misrepresentation that he only collected "sand" from his car was customers, we can show that Hurtubise knew what he was dealing with and the proper methods of its disposal.

Hurtubise Residence Notes

- Current owners do not feel they are responsible for contamination. May be unreceptive to PV development

Appendix H: Site Fact Sheet Example

MassDEP

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Project Fact Sheet

Brockton Brightfield

Brockton, MA

Site Information:	
Date completed:	October 26, 2006
Acreage:	3.7 acres
Power Output:	580 kWh
Green House Gas Emission Reduction:	677,000 pounds of CO_2 1,200 pounds of SO_2 315 pounds of NO_x.
Vehicles Taken off the road:	64.9 vehicles
Number of Houses powered in a year:	77 houses
Tree Seedling:	7,958 seedlings

Economic and Financial Benefits:

The construction of this Brightfield brought higher property values due to the increase in reinvestment, as well as jobs for local installers. The revenues of the field were given to Massachusetts-based renewable energy businesses. In the first 3 years of its completion the project exceeded its revenue expectation of $131,000 by making an average of $143,535. In addition, the project also brought a $3.00 per watt incentive for energy cost in the town.

About the project:

The Bay State Gas Company owns the land that is being used, and the project turned a polluted field in the middle of an industrial environment into a source of renewable energy. It uses 1,512 Schott ASE 300 modules facing south, angled at 42 degrees to maximize their total energy generation. This initiative for creating the biggest solar panel field of its time brought an improvement to the image of the city of Brockton, which the citizens are very proud about. The Brightfield received substantial amounts of local help, and became a source for education, teaching young children about programming and the importance of renewable energy.

Values for the power output and greenhouse gas emissions reduction were found online. This information was then put into the EPA Greenhouse Gas Equivalences Calculator to find the remaining values shown.

Appendix I: White Papers

Best Practices for Community Support with New PV Development

Lambert, Nathaniel
Turnquist, Carl
Cano-Ventura, Abraham
Medjahed, Anis
WORCESTER POLYTECHNIC INSTITUTE

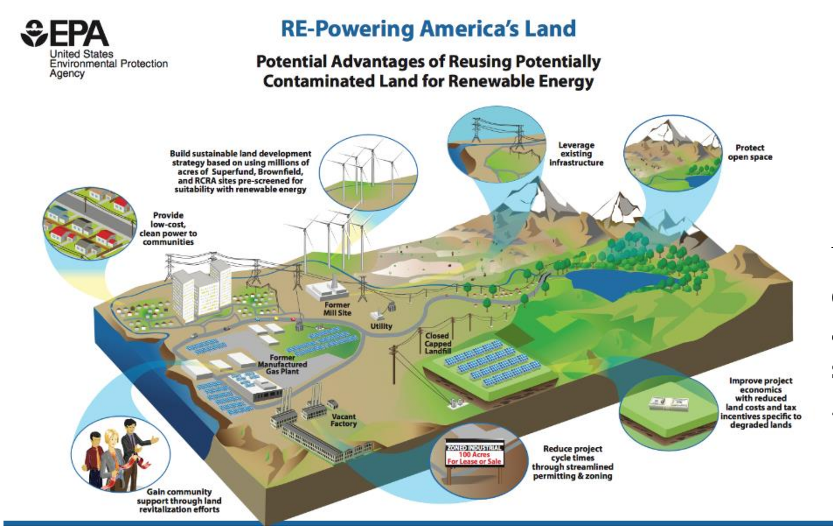
Social sustainability is a factor for all PV redevelopment in local communities. In order for a development to be successful for the duration of its existence, the developers should make it a priority to satisfy the local community regarding any aesthetics or concerns. After talking to developers and town officials, good communication on both sides will benefit both parties by expediting development and satisfying residents’ concerns.

Residents have been known to have the following concerns regarding PV installations:

- Aesthetically unappealing i.e.
    - The fence is unpleasant
    - The view is dominant from their house
    - There were trees cut down and none to replace them
- The substation is a loud humming noise
- Traffic concerns while construction was taking place

After conducting interviews with two developers and six town officials, the team learned some of their views about how to best work with potential host communities.

- Work with Pro-Solar communities; “Green Communities” are the best municipals to target for new solar installation - “they know what benefits [solar] offers” - Mr. Sforza
- Coaching and educating the public is a big point in the success of social acceptance: Generally, interviewees felt that will support new solar development but don’t understand the whole process of what it takes to complete a big project.
- When developing on waste-sites, it is important to explain: “We’re taking these different projects that are essentially useless and revitalizing them.” -Mr. Zensky
- Always welcome any concerns from the public because it is an opportunity to educate and let them know what’s going on. Peoples’ pre-conceived notions are often because of the lack of education about solar projects. It is your opportunity to get these people information that is information as possible.



Visual representation with descriptions of what potential advantages of redeveloping waste-sites provide for society. (EPA, 2012)

Appendix J: Interview Questions

Developer Interview:

- How many projects like this have you worked on?
  - How long do you work at one site/how long are projects like this usually? Would you be moved to another project or do you stay on one project at a time?
- What appeals most to the developers when you are in the preliminary part of project?
  - Do towns seek you out, or do you offer your service to them?
  - Is there more involvement with entities such as MassDEP or the municipal themselves?
  - Have you been encountered by a "sustainability committee" in towns of developments? Before or after your work?
- Did you notify residents that there was a solar installation coming to town, or residents that live in close proximity of the development?
  - (if so) how were they informed? A letter? A plan? A map?
- What steps (if any) did you take to involve the community with the solar development?
  - There's been some instances where community involvement resulted in huge positive community support. (Brockton)
- How big is the team (If you know) of engineers, surveyors, workers, etc. does it take from the developer's company to make this successful?
- What makes a site successful in your point of view?
  - Was this site a success?
    - Are there other sites you've worked on that were less successful?
    - Do you (or anyone in your company) rank each site?
- Would you consider this site sustainable?
  - Economically, Environmentally, Socially Sustainable? (can elaborate)
- Where does the developer get their panels from? What company?
- How many hours of work total would you say this project lasted?
- How many construction vehicles were on site operating at this site?
- Is there something you would have changed in the process?
- Do you have any questions for us?
- Were there any questions we might have forgot to ask?

Appendix K: Authorship Table

Section	Primary Author	Primary Editor
Abstract	Carl Turnquist	Abraham Cano
Executive Summary	Abraham, Carl, Anis, Nathaniel	Anis Medjahed
Acknowledgments	Abraham Cano	Carl Turnquist
Authorship	Nathaniel & Carl	Nathaniel Lambert
Table of Contents	Abraham Cano	Carl Turnquist
Table of Figures	Anis Medjahed	Abraham Cano
List of Acronyms	Carl Turnquist	Carl Turnquist
1. Introduction	Abraham Cano	Anis Medjahed
2.0 Background 2.1 Climate Change in Massachusetts 2.2 Current Efforts to Address Climate Change Through Renewable Energy Development in Massachusetts 2.3 What has Been Done Before 2.4 Challenges of PV Development	Nathaniel Lambert Anis Medjahed Nathaniel Lambert Carl Turnquist Abraham Cano	Carl Turnquist Nathaniel Lambert Anis Medjahed Anis Medjahed Nathaniel Lambert
Methods 3.0 Methods for Identifying Potentially Viable and Sustainable Waste-Sites 3.1 Analyzing Environmental Sustainability of Waste-Sites 3.2 Assessing Economic Sustainability for Solar Development 3.3 Social Sustainability of Previous Sites to Set Up Guidelines for Developers	Carl Turnquist Carl Turnquist Anis Medjahed Nathaniel Lambert	Abraham Cano Abraham Cano Nathaniel Lambert Anis Medjahed
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4.7 Local Tax Variations and PILOT Programs 4.8 ITC Tariffs 4.9 Community Relationships and Interactions	Nathaniel Lambert Anis Medjahed Abraham Cano	Carl Turnquist Carl Turnquist Nathaniel Lambert
Recommendations 5.0 Next Step for Developers 5.1 Environmental Recommendations 5.2 Economic Recommendations 5.3 Social Recommendations 5.4 Fact Sheets	 Nathaniel Lambert Carl Turnquist Anis Medjahed Nathaniel Lambert Abraham Cano	 Abraham Cano Anis Medjahed Abraham Cano Abraham Cano Nathaniel Lambert
6.0 Conclusions	Carl, Nathaniel, Abraham, Anis	Carl Turnquist
7.0 Deliverables	Anis Medjahed	Nathaniel Lambert
Appendices	Nathaniel Lambert	Abraham Cano
Bibliography	Abraham Cano	Carl Turnquist