RENEWABLE ENERGY EVALUATION: LANDFILL IN SUDBURY, MA

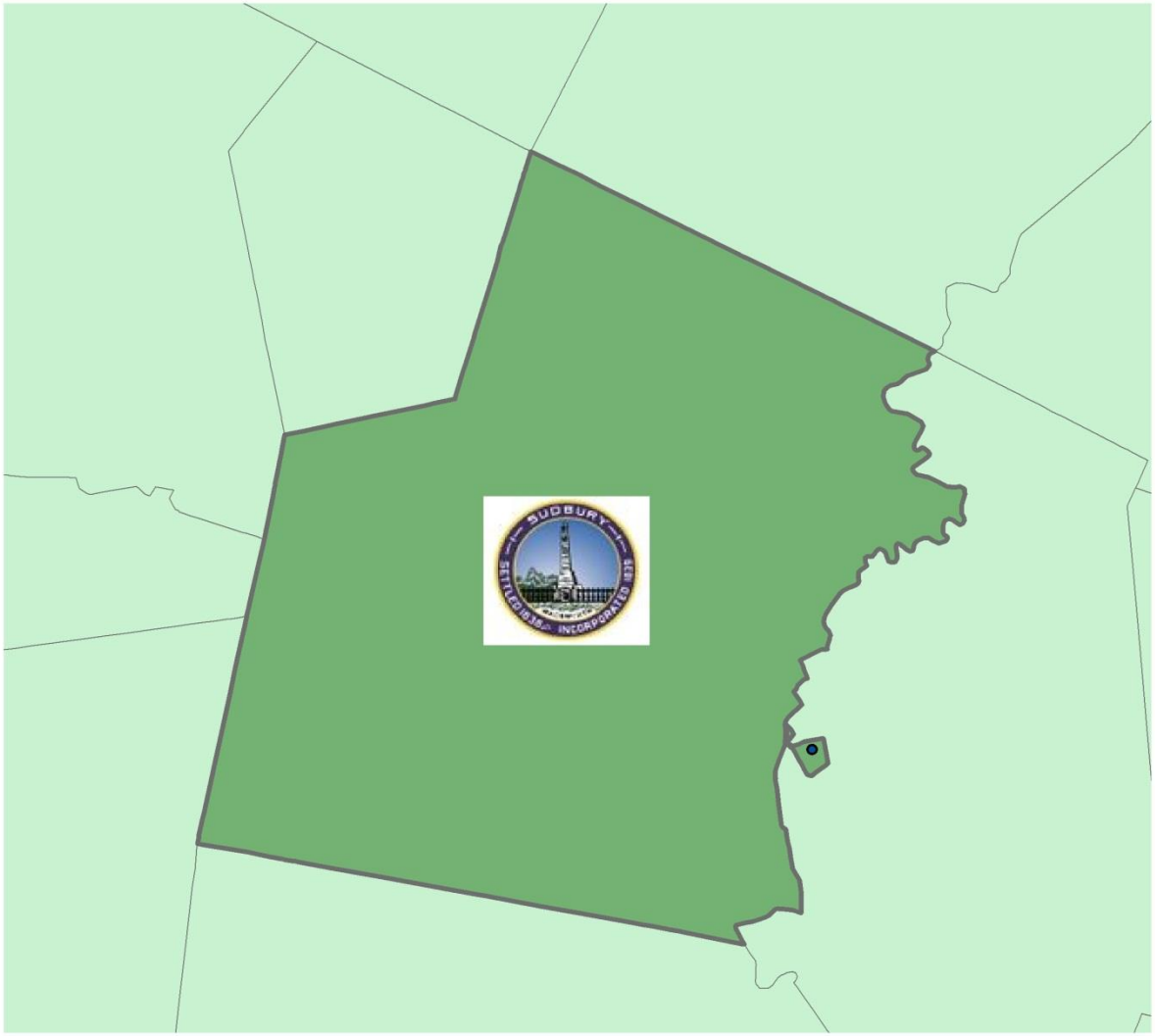
Ashley Hebert

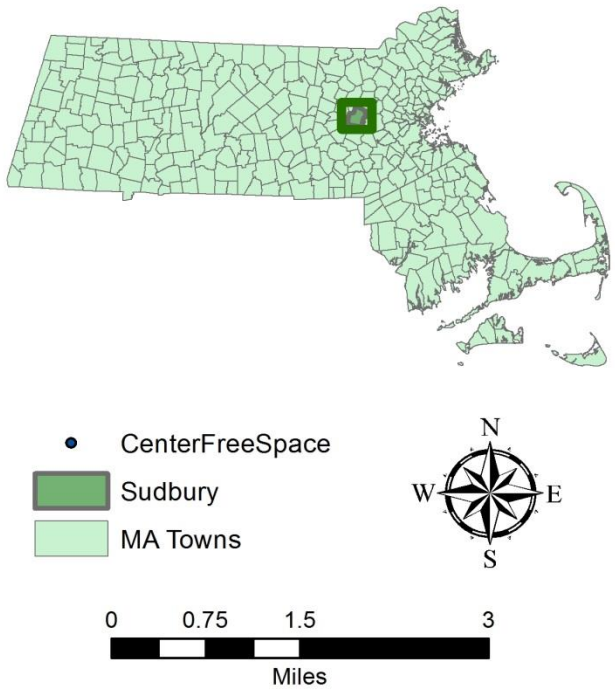
GPH904: GIS for Research and Analysis

April 28, 2014

The purpose of this presentation is to evaluate the potential for solar and wind electricity generation on a landfill in Sudbury, Massachusetts.

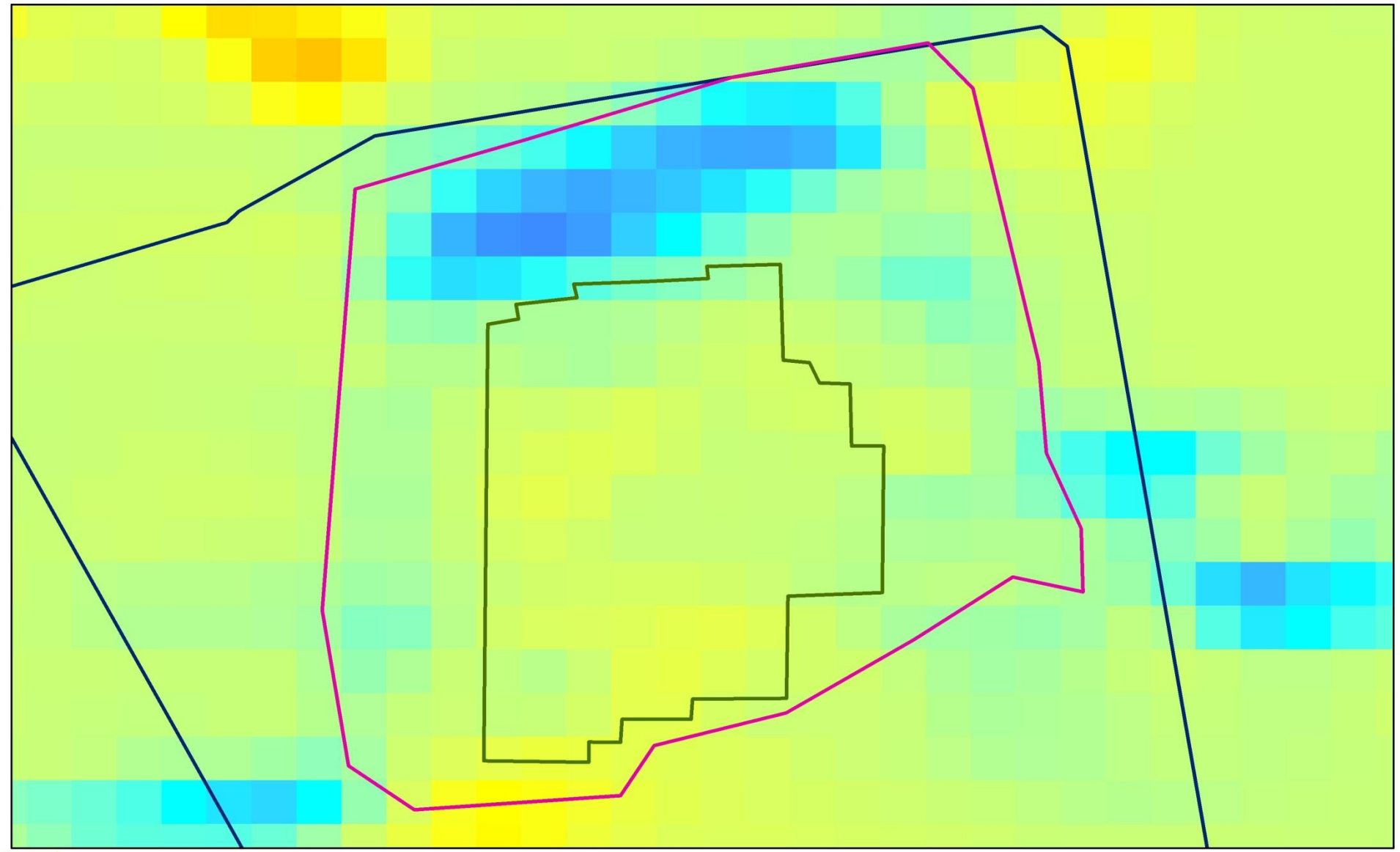
Sudbury, MA






Minuteman Dr
© 2014 Google
Google earth
1995
Boston Post Rd
Imagery Date: 8/24/2013 42°21'51.69" N 71°23'07.27" W elev 178 ft eye alt 1682 ft

Solar Insolation Raster for Landfill



Current Solar Array
Total Landfill Area
MA Towns

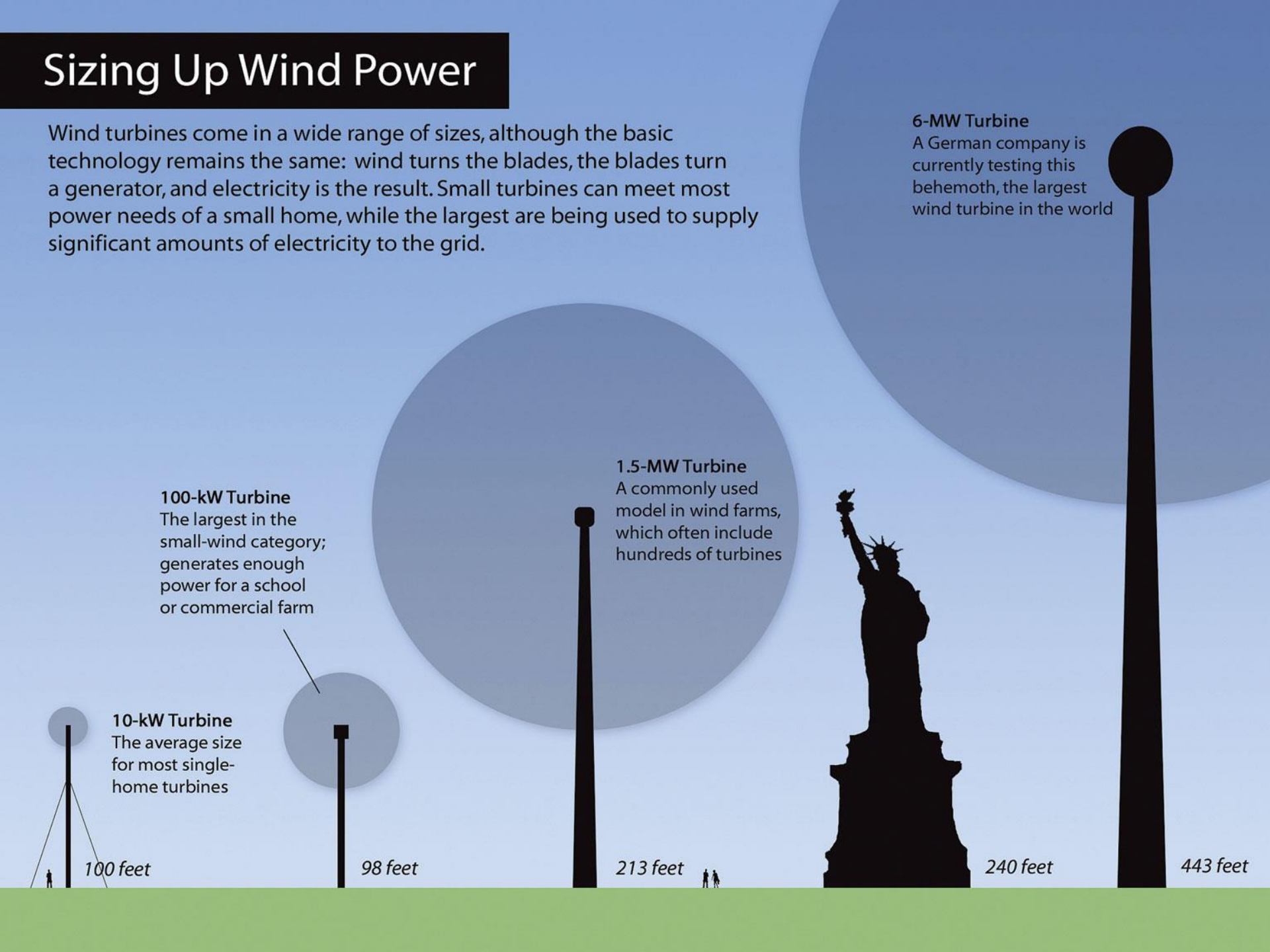
Solar Radiation
Avg Wh per Year
High : 40903.8
Low : 8434.83

0 0.0125 0.025 0.05 0.075 0.1 Miles

N

Sizing Up Wind Power

Wind turbines come in a wide range of sizes, although the basic technology remains the same: wind turns the blades, the blades turn a generator, and electricity is the result. Small turbines can meet most power needs of a small home, while the largest are being used to supply significant amounts of electricity to the grid.

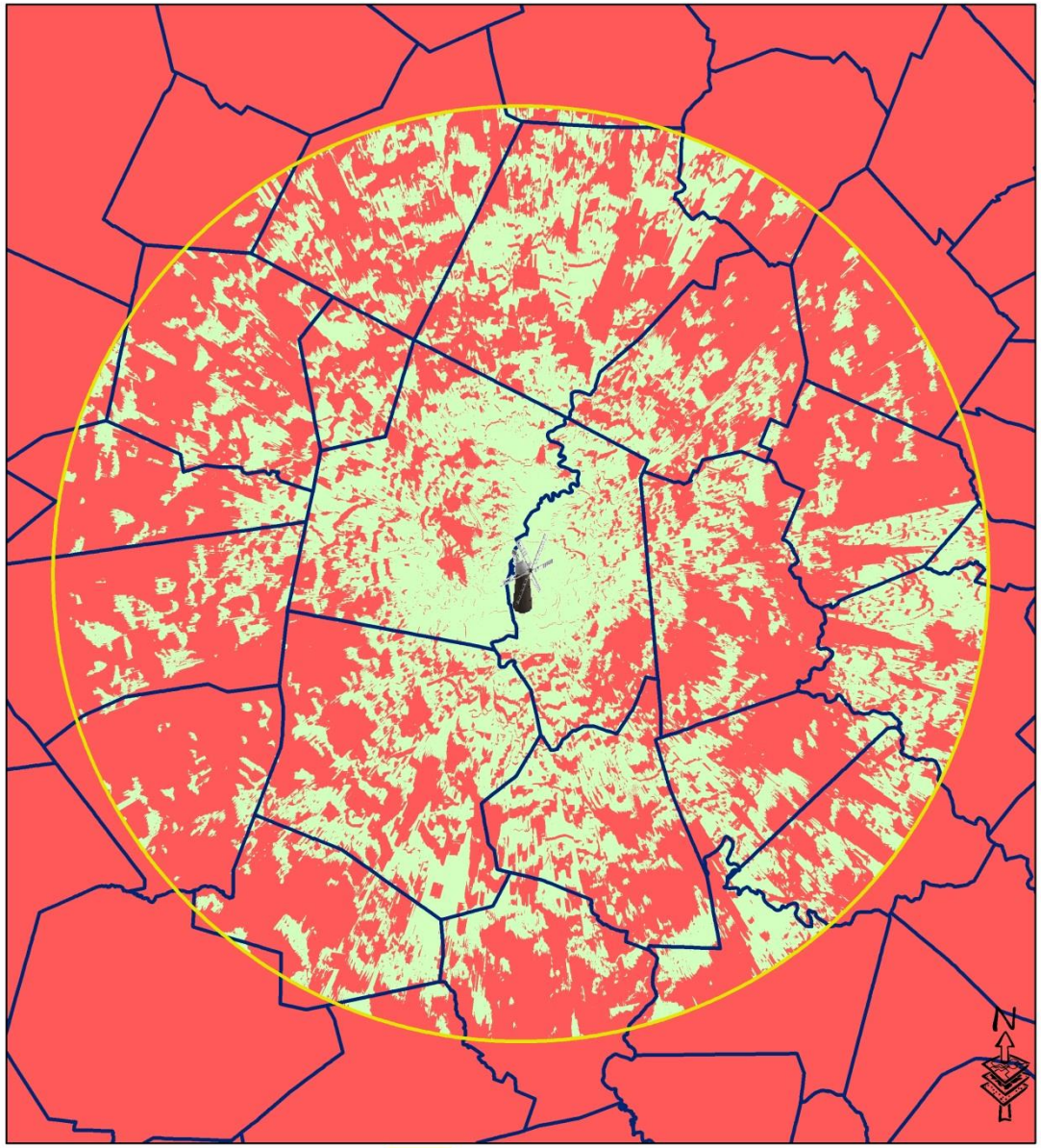


Equation used to determine wind energy

$$number\ of\ MW\ generator\ is\ able\ to\ produce * number\ of\ days\ running * number\ of\ hours\ running\ each\ day * capacity\ factor = MWh * 1000 = kWh$$

$$1.5MW * 365days * 24hours * .125 = 1642.5MWh * 1000 = 1642500kWh\ /10000 = about\ 164\ residential\ homes$$

Viewshed for 100m Windmill



Windmill Location on Landfill

10 mile radius from Windmill Location

MA Towns

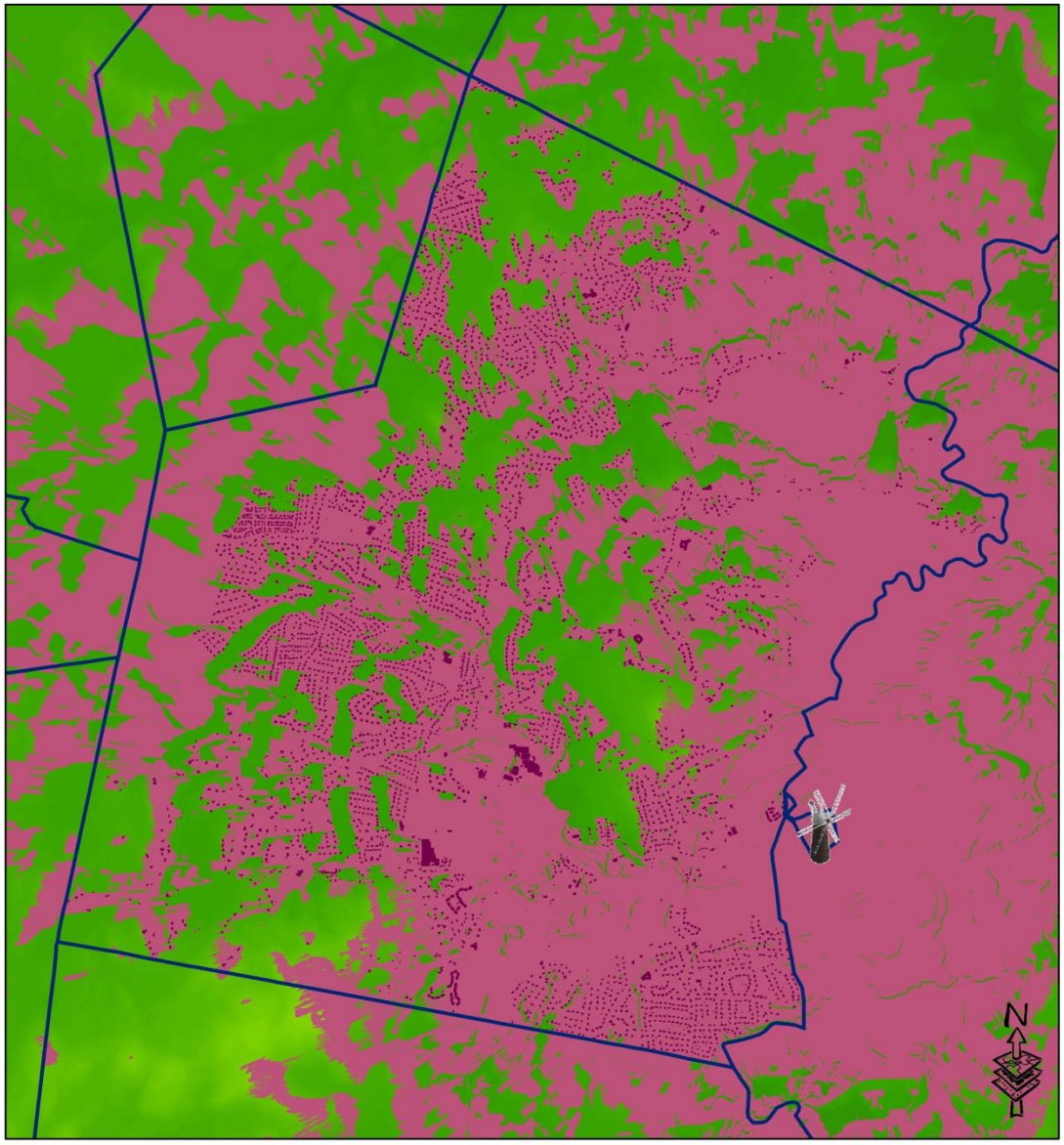
0 0.751.5 3 4.5 6 Miles

Viewshed

Not Visible

Visible

Sudbury Houses with View of Windmill



Solar

- The current 1.5MW solar array can produce enough energy for about 57 homes at 13% capacity if available for 8 hours each day for one year.
- According to the area solar analyst tool in ArcGIS, a more realistic analysis of solar electricity generation because it considers elevation, atmospheric conditions, and changes in sunlight throughout the year, the current solar panels can produce enough electricity for about 7.5 residential homes each year.

Wind

- If a 1.5 MW wind turbine was placed at the center of the landfill, is available for 24 hours each day for one year at wind speeds of about 5.5m/s, it could produce enough energy for about 164 residential homes.
- It would be highly visible to 128.65 square miles of land within 10miles of the windmill.
- In the town of Sudbury, about 93% of the residential housing units and 94% of the residents would have a clear view.

References 1

- MassGIS. (2012, April). *MassGIS Data - Datalayers from the 2010 U.S. Census*. Mass.gov Administration and Finance: http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/census2010.html (Accessed April 8, 2014)
- US Census Bureau. (n.d.). *Summary File 1 Table H12 Average Household Size of Occupied Housing Units by Tenure*. *2010 Census.* American Fact Finder: http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_SF1_H12&prodType=table (Accessed May 6, 2014)
- US Census Bureau. (n.d.). *5 Year Estimates Table S1903: Median Income in the past 12 Months*. 2012 American Community Survey. American Fact Finder: http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml (Accessed April 8, 2014)
- Total electricity consumed in 2005 was provided by N*Star.
- O'Connell, S. (2013, November 14). Sudbury turns on 1.5MW solar array at former landifll. *Metrowest Daily News:* http://www.metrowestdailynews.com/article/20131114/News/311149870 (Accessed May 6, 2014)
- Google earth Imagery: August 24, 2013, just after installation of array
- MassGIS. (2007, August). *MassGIS Data - Zoning*. Mass.gov Administration and Finance: http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/massgis-data-zoning.html (Accessed May 6, 2014)
- MassGIS. (2003, April). *MassGIS Data - Digital Terrain Model (DTM) Files.* Mass.gov Administration and Finance: http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/dtm.html (Accessed May 6, 2014)
- MassGIS. (2014, April). *MassGIS Data - Building Structures (2D from 2011-2013 Ortho Imagery)*. Mass.gov Adminstration and Finance: http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/structures.html (Accessed May 6, 2014)
- National Wind Watch, Inc. (n.d.). *FAQ - Output*. National Wind Watch : https://www.wind-watch.org/faq-output.php (Accessed May 6, 2014)

References 2

- National Wind Watch, Inc. (n.d.). *FAQ - Size.* National Wind Watch: https://www.wind-watch.org/faq-size.php (Accessed May 6, 2014)
- ESRI. (2012, November 8). *ArcGIS Help 10.1 Area Solar Radiation (Spatial Analyst)*. ArcGIS Resources: http://resources.arcgis.com/en/help/main/10.1/index.html#//009z0000001t000000 (Accessed May 6, 2014)
- ESRI. (2007, May 2). *Performing a Viewshed Analysis*. ArcGIS 9.2 Desktop Help: http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=Performing_a_viewshed_analysis (Accessed May 6, 2014)
- NOAA.gov. (n.d.). *CanVis Distance Calculations.* http://www.csc.noaa.gov/digitalcoast/_/pdf/Height_and_Horizon_Calculations_in_CanVis.pdf (Accessed May 6, 2014)
- Merigan, S. (2012, September 27). *Windfall: 0, Wind: 1 - Kending Wind Turbines*. Solvent Green: http://www.solventgreen.net/2012/09/windfall-0-wind-1-kending-wind-turbines.html (Accessed May 6, 2014
- Iowa Energy Center. (2014). *Operating Characteristics*. Iowa Energy Center: http://www.iowaenergycenter.org/wind-energy-manual/wind-energy-systems/operating-characteristics/ (Accessed May 6, 2014)
- Iowa Energy Center. (n.d.). *Geography and Wind*. Iowa Energy Center: http://www.iowaenergycenter.org/wind-energy-manual/wind-and-wind-power/geography-and-wind/ (Accessed May 6, 2014)
- Robert G. Sullivan, Kirchler, L. B., Lahti, T., Roche, S., Beckman, K., Cantwell, B., & Richmond, P. (n.d.). *Wind Turbine Visibility and Visual Impact Threshold Distances in Western Landscapes.* Argonne: UChicago Argonne, LLC, Operator of Argonne National Laboratory. http://visualimpact.anl.gov/windvitd/docs/WindVITD.pdf (Accessed May 6, 2014)
- MassGIS. (2005, April). *OLIVER: MassGIS's Online Mapping Tool/MassGIS Data - Elevation (Topographic) Data (2005)*. Oliver/ Mass.gov Adminstration and Finance: http://maps.massgis.state.ma.us/map_ol/oliver.php and http://www.mass.gov/anf/research-and-tech/it-serv-and-support/application-serv/office-of-geographic-information-massgis/datalayers/elev2005.html (Accessed May 6, 2014)