

POTENTIAL RENEWABLE ENERGY SOURCES

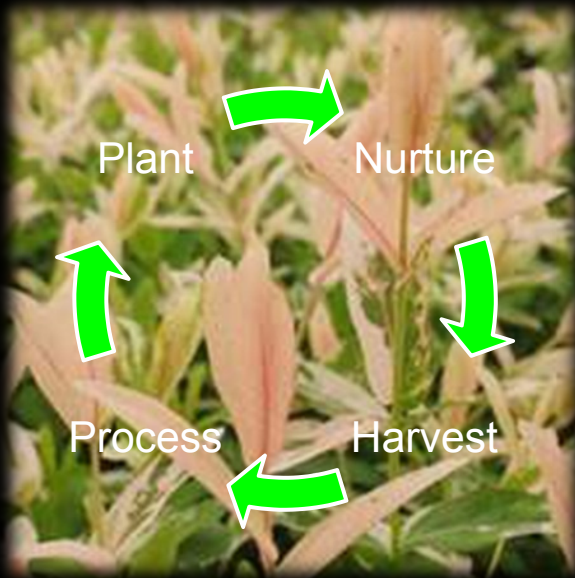
A Preliminary Assessment for Ipswich, Massachusetts

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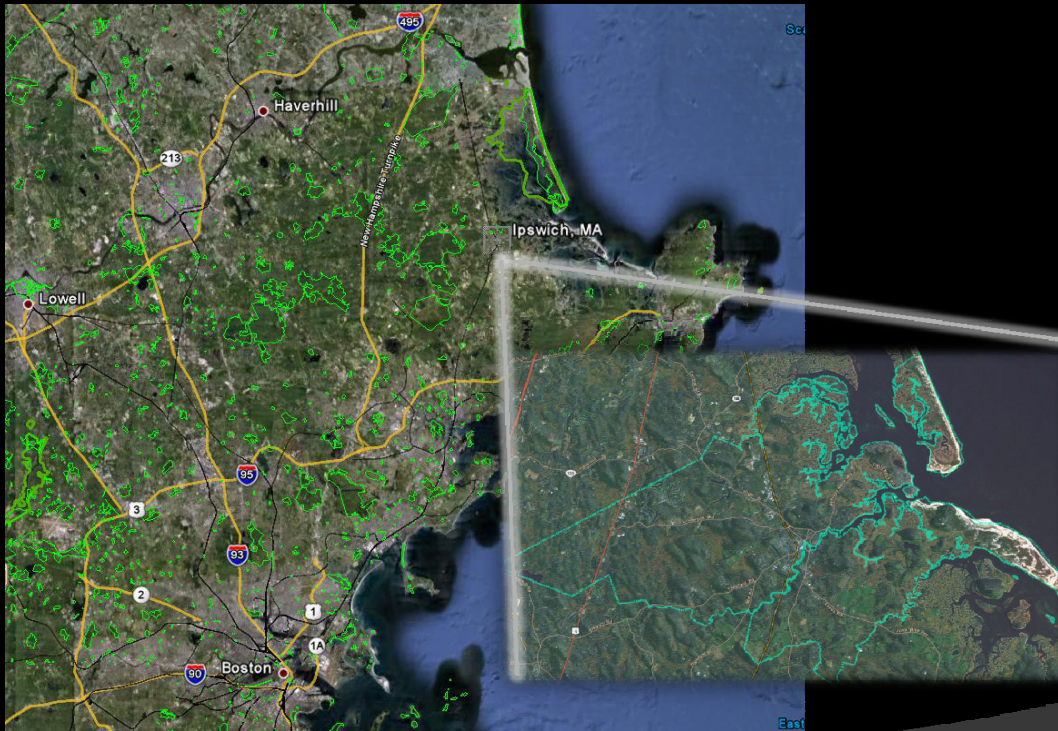
Objective:

- Suitable agricultural lands for biomass harvesting
- Suitable lands for Wind Turbine Generator (WTG) sites
- Suggest recommendations for further study



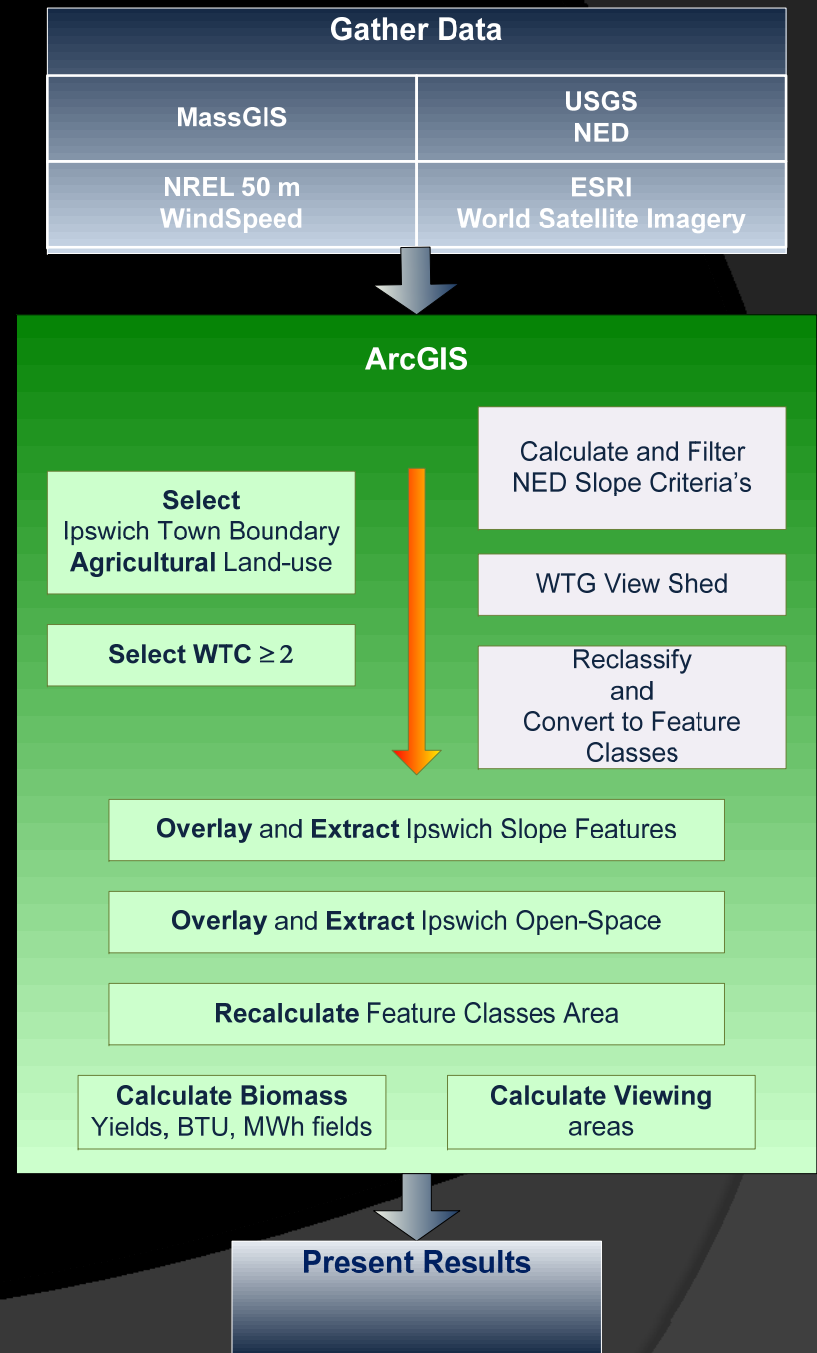
Ipswich:

- Colonized by John Winthrop in 1633 from the native Agawam tribes
- Traditionally rich Farming, Fishing, and Textile community
- Remains a rural town with 70% covered by forest and wetlands

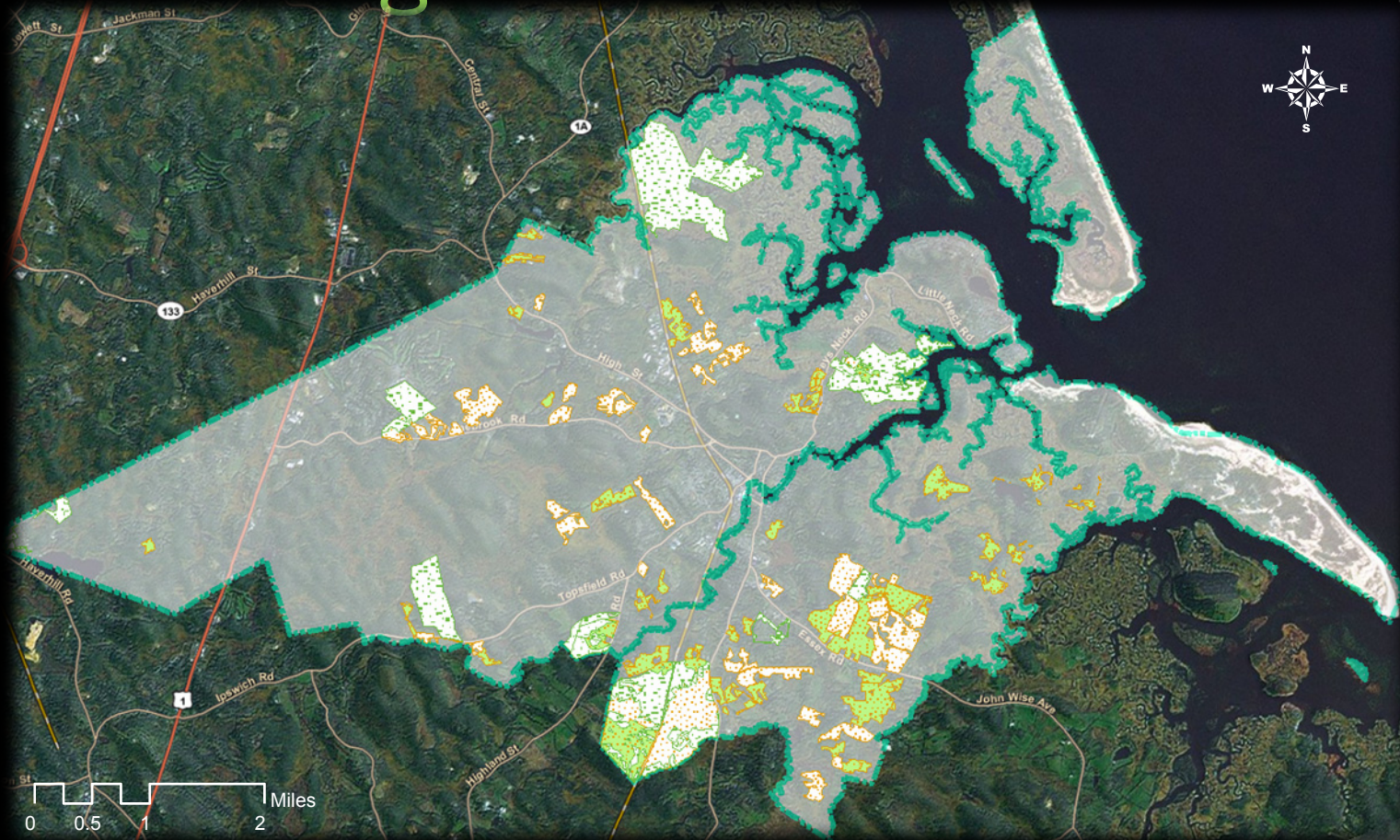


Methodology:

- Leverage Castellano's land criteria:
 - Crop, Pasture, Brush lands
 - Slope $\leq 8\%$
 - Area ≥ 2 ha
 - No protected, wetlands, water
 - High, Average, Low ODT yields
 - High, Average, Low land usage
 - All available agricultural lands
- Wind Turbine Sites
 - Lands whose WTC ≥ 2
 - No protected lands or water
 - Slope $\leq 10\%$
 - Area ≥ 0.1 Ha (0.25 acres)
 - Minimum Visual Impact
- Assumptions:
 - Harvesting Shrub-Willow
 - Lands have suitable soil
 - GE 1.5 MW 77m diameter Turbine



Suitable Agricultural Lands:



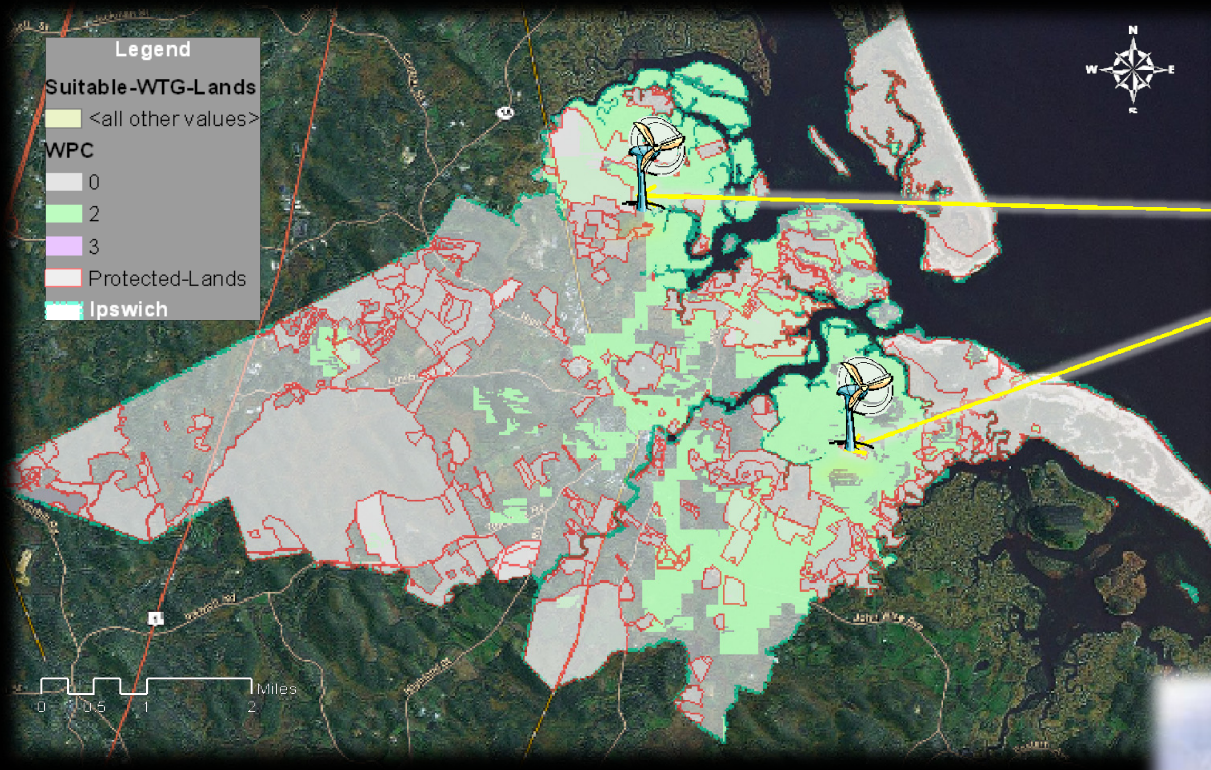
Total Area (Ha)	1, 006.888
Pasture (Ha)	272.27
Crop (Ha)	322.68
Other (Ha)	411.93

Biomass Energy Yields:

Yields (odt·ha ⁻¹ ·yr ⁻¹)				BTU (10 ⁸)			Electricity (MWh)		
Yields (odt)	Low (1%)	Med (10%)	High (20%)	Low (1%)	Med (10%)	High (20%)	Low (1%)	Med (10%)	High (20%)
6.75	6.7965	67.965	135.929	1.02	1.31	20.36	29.88	298.79	597.58
11.25	11.3275	113.275	226.549	1.69	16.99	33.98	49.80	995.97	995.97
15.75	15.858	158.584	317.169	2.38	23.79	47.58	69.72	697.17	1, 394.35

Fuel	Low BTU Yield	High BTU Yield
Heating oil (gal)	735.45	34, 306.73
Gasoline (gal)	821.00	38, 267.46
Natural Gas (ft ³)	99, 318.40	4, 632, 911.392
Propane (gal)	1, 120.47	52, 226.76

Suitable Wind Sites:



Total Area: 2,184.36 Ha

Two Potential Sites

- Town Farm Road
- Labor-in-Vain Road

GE 1.5 MW Wind Turbine Specifications

Rotor Diameter	77 m
Hub Height,	80 m
Frequency	60 Hz
Cut-in Velocity	3.5 m/s
Cut-Out Velocity	25 m/s
Average Annual Energy *	2, 999.148 – 4, 211.716 MWh



Town Farm Road:



Visible Area	514.73 Ha
Not-Visible	8038.71 Ha
Total Area	8564.15 Ha
% Seen	6.01
% Not Seen	93.86

Labor-in-Vain Road:



Visible Area	448.42 Ha
Not-Visible	8105.13 Ha
Total Area	8564.15 Ha
% Seen	5.24
% Not Seen	94.64

*2010 Ipswich Energy Consumption:

What percentage would potential biomass and Wind Turbine replace ?

Ipswich Sector	Consumption (MWh)	Low % Biomass	High % Biomass	GE 1.5 MW %
Residential	49, 797.63	0.14	2.80	6.24
Small Commercial	5, 303.14	1.31	26.29	58.62
Large Scale Commercial	49, 495.89	0.14	2.82	6.28
Municipal	6, 055.31	1.15	23.03	51.34

Summary:

- Agricultural lands suitable for biomass production
 - May provide Farmers an independent, energy source
- Suitable lands for Wind Turbine installation sites
 - Two additional sites with minimum visual impact
- Recommendations:
 - Is it worth harvesting crops?
 - Yes:
 - In-depth study for each farm
 - Assess each farms consumption and energy needs
 - Find best crop to harvest.
 - Annual wind analysis of WTG sites and full cost-benefit analysis
 - Further research solar potential, leveraging off Town Hall project.

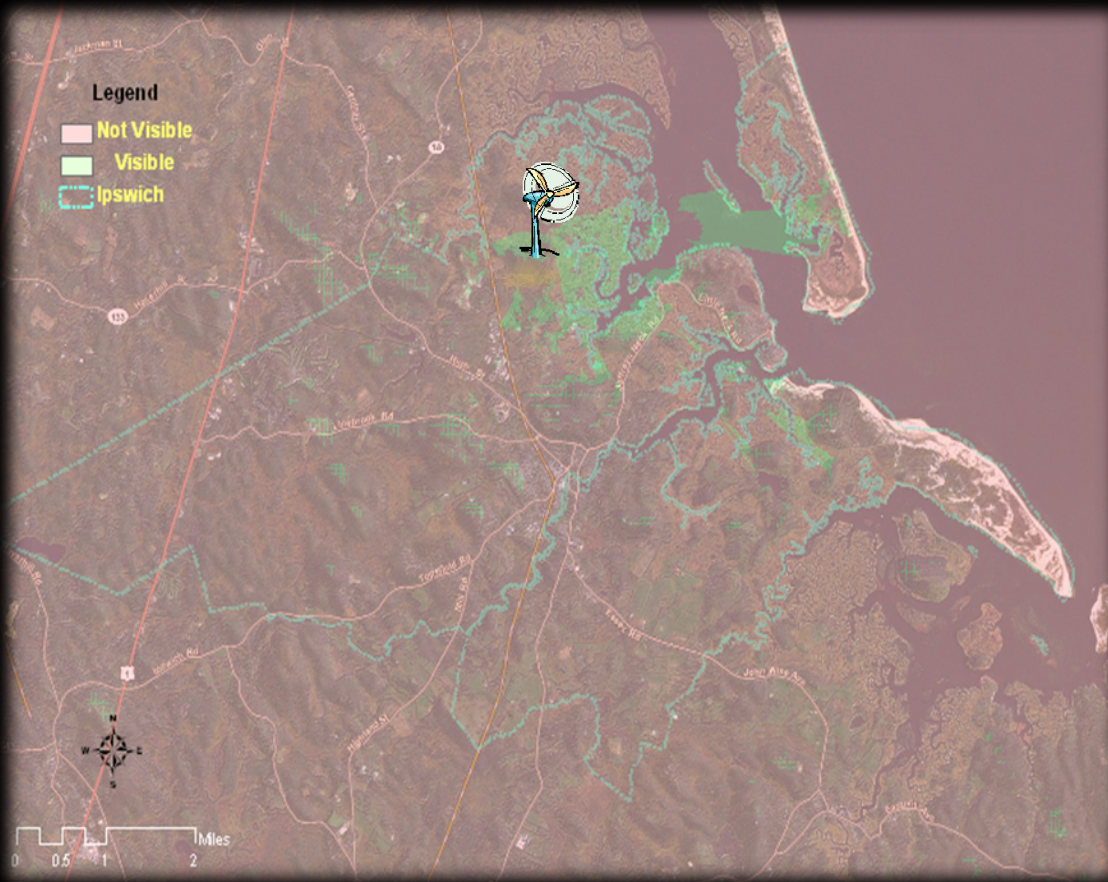
References:

- Bowen, Donald. et. al. 2005. Wind Turbine Feasibility Study. *Meridian Associates, Inc.*
- Castellano, P.J. and T. Volk, L. Herrington. 2009. Estimates of technically available woody biomass feedstock from natural forest and willow biomass crops for two locations in New York State. *Biomass and Bioenergy*. Vol. 33 393-406
- Commission On Energy Use and Climate Protection. 2009. Energy Use and Greenhouse Gas Inventory: Ipswich, Massachusetts.
- Cudnohufsky, Walter. 2000. Ipswich Farms and Agricultural Lands. *Ipswich Agricultural Commission*. Walter Associates, Inc.
- DOE Environmental Information Agency <http://www.eia.gov>
- DOE National Renewable Energy Laboratory <http://www.nrel.gov>
- ESRI World Imagery Layer http://downloads2.esri.com/resources/arcgisdesktop/layers/World_Imagery.lyr
- Ipswich Municipal Light and Utilities Department. Home Energy Loss Prevention Service (HELPS) http://www.munihelps.org/ipswich_Solar_PV_Rebate_Program.html
- Henry, Tim. 2011. 2010 Town Energy consumption statistics. Director of Utilities Department. Ipswich, Massachusetts. (Personal correspondence)
- Lovett, Andrew A., Richter, G., Riche, A. 2009. Land Use Implications of Increased Biomass Production Identified by GIS-Based Suitability and Yield Mapping for Miscanthus in England. *Bioenergy Resources*. 2:17-28
- Luna, Marcos. 2011. Identifying Wind Turbine Sites and Estimating Visual Impact. *GPH-904 Exercise 2*
- Manwell, James. Ellis, A. and Dua, M. 2004. Preliminary Site Feasibility Report Draft Copy. *Renewable Energy Research Laboratory*. University of Massachusetts, Amherst MA 01003
- Mass GIS depot <http://www.mass.gov/mgis/laylist.htm/>
- Town of Ipswich, Massachusetts. Protective Zoning Bylaw. October 2010
- USGS NED data <http://seamless.usgs.gov>
- Vachon, William A. 2008. Estimated Energy Production and Economics for a Wind Turbine Generator installed at The Ipswich Light Department site in Ipswich, Massachusetts.

**Thank You
for
your time ;-)**

Backup Slides

Town Farm Road : Ipswich Viewshed



Labor-in-Vain Road: Ipswich Viewshed

