Assessing the Feasibility of New Transmission Lines in Vermont for Prospective Wind Farms

Silas A. Bauer, December 12, 2008
Introduction to GIS—Final Project

Purpose:

The purpose of this project is to assess wind power potential in the state of Vermont and calculate the least-cost paths for new transmission lines to four proposed wind farms.

Background:

As a member of the Regional Greenhouse Gas Initiative, or RGGI, Vermont has set lofty goals for itself in terms of greenhouse gas reductions and adoption of renewable energy generation technology. RGGI is a carbon dioxide (CO_2) trading program, the purpose of which is to reduce carbon emissions in the power sector by 10 percent by 2018. RGGI provides oversight for the measure of emissions from power plants and by issuing the tradable allowances to the power plants. The proceeds from the sale of these allowances between power producers will go to the development of new renewable and alternative energy solutions.[1] In addition, the renewables portfolio standard (RPS) in Vermont calls for a state goal of assuring that 20% of total statewide electric retail sales before July 1, 2017 are generated by qualifying renewables.[2] Given these goals, it should be evident that Vermont will need to build new renewable energy plants in order to reduce their emissions appropriately.

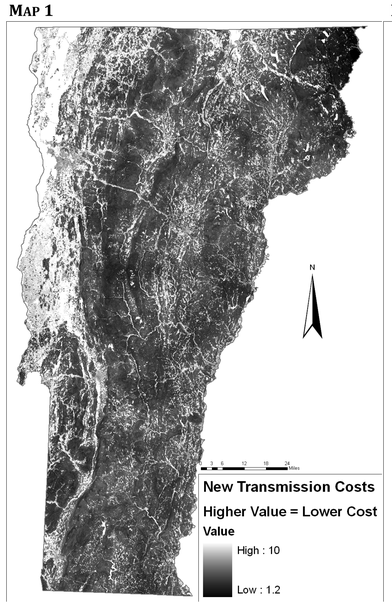
Analysis:

In my analysis, which is represented in Map 3, I chose to focus on wind power and the difficulty of interconnection into the state's existing electrical transmission grid. The best wind resources in Vermont are located on the mountains and create a difficult construction landscape for new transmission lines. Additionally, the forests, natural habitats and developed plots of land, as well as the proximity of the electrical substations where the electricity can be converted to the proper voltage for transmission or distribution, create obstacles for new transmission. In ArcMap I selected all electrical substations within 6 miles of my four prospective wind farm sites and used the spatial analyst tools to construct a cost calculation (see map 1) that assessed the various land uses in Vermont and the severity of the land's slope, to generate least-cost paths for interconnection. The calculation gives priority to the least populated areas of land (excluding water and wetlands) and the least amount of slope. My selected wind farm sites are very large, encompassing in the neighborhood of 60+ square kilometers, and are not meant to be suggestions of actual farms – though an actual large wind farm on one or all of these sites would produce a great deal of electricity and generate large CO_2 emission reductions – but rather areas in which a small farm or multiple smaller farms could be built. In reality, NIMBY (Not in my backyard) concerns would hinder the approval of wind farms of this size, but I feel the analysis is important regardless. I have calculated least-cost paths to all substations within 6 miles of the four wind power sites and the purpose is to give suggestions of the routes for electrical substation interconnection along any point of the selected wind power area. I chose my wind power sites by acquiring Wind Power Class (WPC) data from the National Renewable Energy Lab (NREL) (see map 2) and choosing only the three highest wind power class measures, 5, 6, and 7, to determine my wind power source locations.

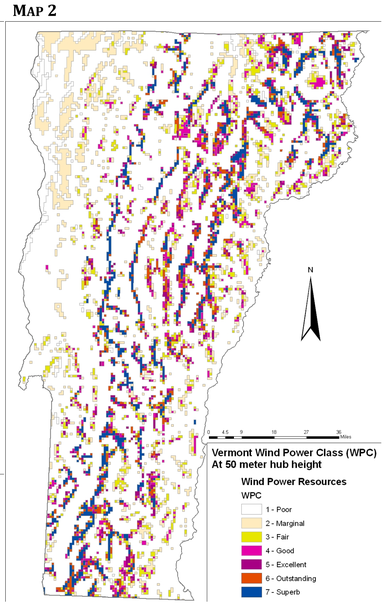
In map 1 below the cost calculation described above is displayed. By ranking the land use layer and slope layers on a scale from 1 to 10 with 10 being the most favorable conditions for transmission line construction, and 1 the least, I was able to add the values of the two layers together and give a higher priority to the land use conditions and a slightly lower value to the slope. The result is this map which shows high value to low value areas for transmission construction corresponding to low to high cost respectively.

In map 2 the Wind Power Class (WPC) measurements from NREL are displayed, correspondent to an expected wind turbine hub height of 50 meters or Approximately 164 feet. It was based on this information that I chose my prospective wind sites in map 3.

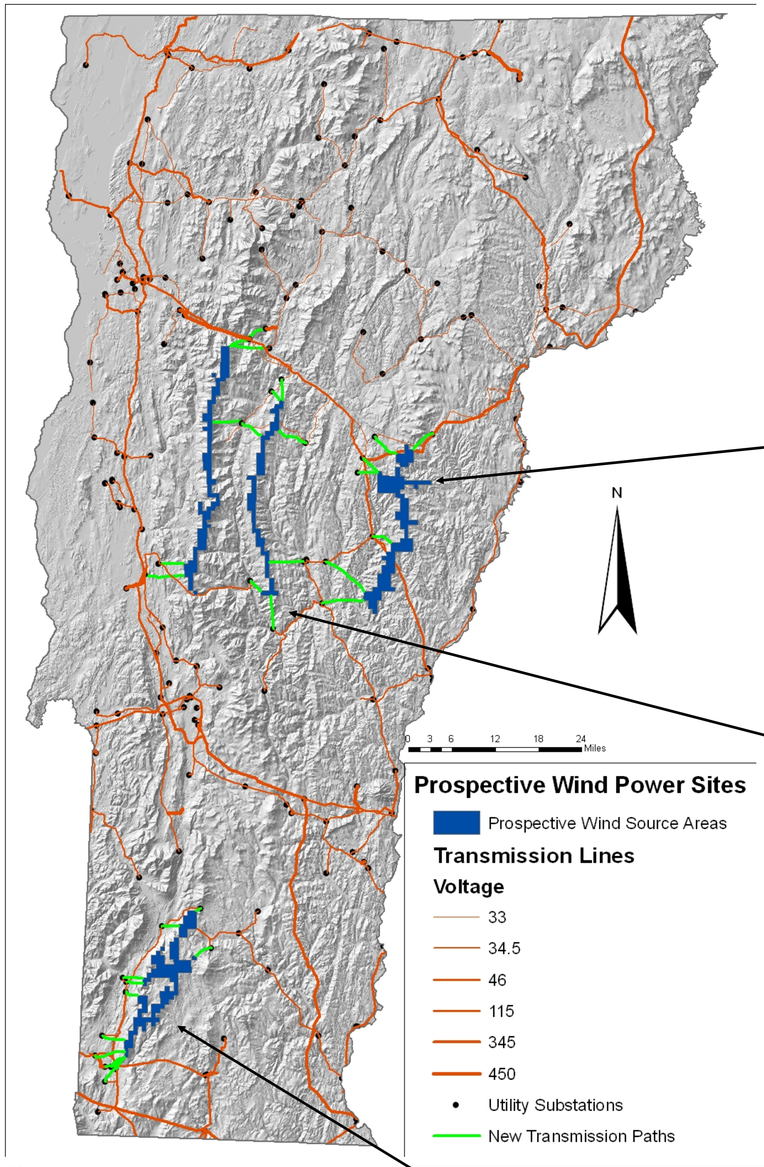
Map 1



Map 2

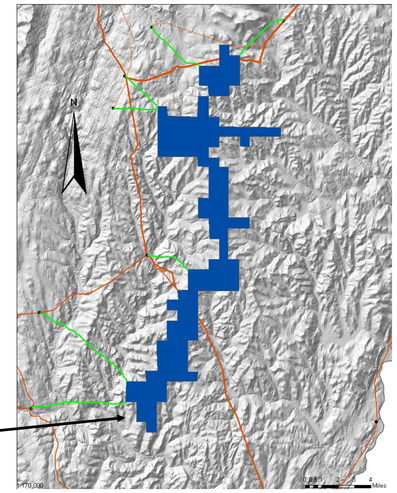


Map 3:
This map shows the proposed wind farm sites and the new transmission line routes calculated with the least-cost path parameters. The resultant green lines represent the various options for electric line interconnection into the existing transmission grid through the existing substations.

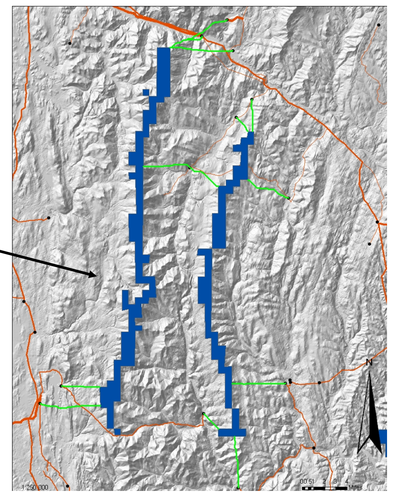


Wind Site 1

This close up of the terrain in northeastern Vermont shows the prospective transmission line routes (in green) from the area of prime wind to the existing substations. In this case you can even see existing transmission lines that run through the prospective wind farm area in two separate places. With this site, the interconnection may make more sense on those existing lines, rather than running a new line or multiple new lines over new ground.



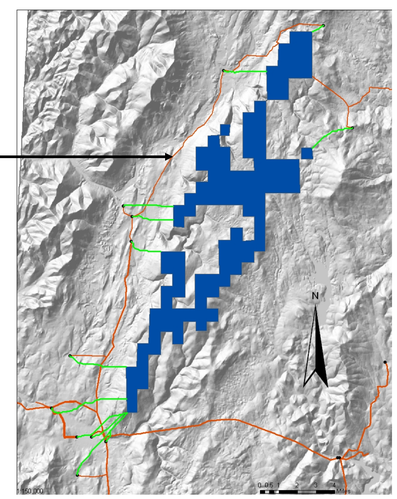
Wind Sites 2 & 3



These two sites are a bit more remote and have long sections in the middle that aren't close to any substations or existing transmission lines. New transmission line construction would be necessary here, and the green sections are my calculations of the best routes. The site that is further to the west is not a likely candidate for a wind farm given that Vermont's Long Trail, a popular recreational hiking trail, runs along its ridge. While it's unlikely that a wind farm and new transmission lines would win the favor of local politicians and conservationists, it's hard to ignore the quality of the wind source.

Wind Site 4

This final site in southern Vermont abuts a valley where large, high voltage transmission lines already run within a short distance of the site. The substations are also a short distance away over terrain, which you can see in map 1, is high value and therefore low cost. Of the four sites, I believe that this one holds the most potential to be a successful wind farm.



Sources:

1. Regional Greenhouse Gas Initiative: http://www.rggi.org/home (Accessed on 12/1/2008)

2. Database of State Incentives for Renewables and Efficiency, Vermont Rules, Regulations & Policies; Renewables Portfolio Standard: http://www.dsireusa.org/ (Accessed on 12/1/2008)

All Data Layers except the Wind Power Class Measures:
Vermont Center for Geographic Information Data Warehouse: http://www.vcgi.org/dataware/ (Accessed on 11/10/2008)

Wind Power Class Data Layer Acquired from:
The National Renewable Energy Laboratory: http://www.nrel.gov/gis/ (Accessed on 11/10/2008)