A Vermont Sustainable Jobs Fund Project:
in Partnership with VCGI, Fountains Spatial & overit media

Vermont Sustainable Jobs Fund

VCGI INC.

Mike Brouillette
Sr. GIS Prj. Manager

RENEWABLE ENERGY ATLAS OF VERMONT

fountains spatial

overitmedia

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- U.S. Department of Energy via U.S. Senator Patrick Leahy
- Green Mountain Coffee Roasters
- Vermont Clean Energy Development Fund
- Vermont Community Foundation

Project Team

Vermont Sustainable Jobs Fund
Accelerating the Development of Vermont's Green Economy

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fountains spatial

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Outline

Presentation ~30 min. (25 min. present + ~5 min. Q & A)

- VSJF Project Overview
- VCGI Technical Overview
- Approach/Modeling Environment
- Demo
- FS Overview
- Wrap up/Questions

Technical Contributors

Primary:

USDA NRCS; Green Mountain Power/ESRI and Renewable Energy Vermont

Academic : Bill Hegman - Middlebury College; Dr. Heather Darby - University of VT Extension; Dr. John Kidder - VT Technical College; Dr. Sid Bosworth - University of VT; University of VT Spatial Analysis Lab.

Federal: Carolyn Alves & Reed Simms - USDA Natural Resources Conservation Service; National Renewable Energy Laboratory.

Non-Profit - Adam Sherman & Sarah Galbraith - Biomass Energy Resource Center; Andy Perchlik & Anne Margolis - VT Clean Energy Development Fund; Bethany Deyo - Efficiency VT; Brian Shupe, Johanna Miller & Jamey Fidel - VT Natural Resources Council; Carole Hakstian - Efficiency VT; Central VT Public Service; Jeremy McMullen, -VT Emergency 9-1-1 Board; Netaka White – VSJF: Scott Merriam - Renewable Energy VT.

Private - Barbara Patterson, Katie Budreski & David Healy - Stone Environmental, Inc.; Carl Nylen, Mansour Raad & Lisa Andrews – ESRI; David Blittersdorf - NRG Systems and All Earth Renewables; Greg Strong - Springhill Solutions; James Ashley - Green Mountain Geothermal; John Hanning, Josh Castonguay - Green Mountain Power; Nils Behn, Dave Anderson & John Budreski - Alteris Renewables; Stan Ward; VT Electric Coop - Washington Electric Coop

State - Dan Scruton - VT Agency of Agriculture, Farms and Markets; Brian Fitzgerald, Lawrence Becker, Peter Telep , Rob Achilles , Ryan Knox - VT Agency of Natural Resources; Vermont Department of Forests, Parks, and Recreation; Vermont Department of Public Service (Clean Energy Development Fund); Vermont Geological Survey and Vermont's 25 by '25 Initiative

Project Overview

The Client: Vermont Sustainable Jobs Fund

VSJF is a 501(c)(3) nonprofit in Montpelier, Vermont. VSJF's mission is to '**accelerate the development of Vermont's green economy**.'

VSJF provides early stage **grant funding** and **technical assistance** to entrepreneurs, businesses, farmers, networks and others interested in developing sustainably produced goods and services.

The Problem: Fossil fuel dependency, peak oil, climate change, and ripples in the global economy pose unprecedented risks to Vermont.

The key to accomplishing our mission is **transitioning away from fossil fuels & non-renewable energy** as quickly as possible, & **re-localizing production**- food production, energy production, etc.

Hence...

Cover All Renewables…

RENEWABLE ENERGY ATLAS OF VERMONT

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RENEWABLE ENERGY ATLAS OF VERMONT

www.vtenergyatlas.com

Renewable Energy Categories	Energy Selection Options	Atlas Energy Layers
Efficiency	Efficiency	Efficiency
Solar	Solar	Photovoltaic, Thermal
Wind	Wind	Small & Commercial
Hydro	Hydro	Dams
Biomass	Biodiesel	3 Oilseed Crops, Algae, WVO
	Perennial Grasses	2 Grasses
	Manure / Methane	Methane Digester
	Waste	Landfill Methane
	Woody Biomass	Woody Biomass
Geothermal	Geothermal	Open Loop, Closed Loop

Appears on Map When User Selects Energy Layer: Points	Polygons	Analysis Results Panel: Tables
Efficiency case studies (from Efficiency Vermont); efficiency consultants.	None yet. Phase 2: Thematic maps for total consumption, total savings, & avg. residential consumption & savings.	Total consumption & savings by town; average residential kW consumption & savings per household by town.
Existing solar PV & Thermal sites, solar installers, potential annual output (kWh) by E911 point.	None yet. Phase 2: Thematic maps for total sites and installed capacity by town.	Background info by area selected; potential annual output (kWh) by e911 point.
Existing wind sites, wind installers.	Predicted mean wind speed across VT at heights of 30 meters, 50 meters, and 70 meters. Phase 2: Thematic maps for total sites and installed capacity by town.	Background info by area selected; wind classes by hub height.
Existing hydroelectric dams; hydro consultants.	None. Phase 2: Thematic maps for total sites and installed capacity by town.	Background info by area selected; Installed capacity, production (MWh)
Existing oilseed producers, existing biodiesel producers, existing fuel dealers carrying biodiesel or bioheat.	Suitable acres of agricultural soils that meet canola, sunflower, and soybean growing conditions.	Background info by area selected; suitable acres by area / average bushel per acre / gallons of biodiesel / BTU
Existing algae R&D facilities, existing methane digester and landfill locations, possible future locations of digesters (and therefore algal facilities).	None.	Background info by area selected; can only identify possible locations for co-locating algae.
Existing WVO biodiesel producers, food establishments, existing fuel dealers carrying biodiesel or bioheat.	None.	Background info by area selected; can only identify possible WVO locations & businesses to contact.
Crop trial locations.	Suitable acres of agricultural soils that meet switchgrass and big bluestem growing conditions.	Background info by area selected; suitable acres in boundaries / average tons per acre / tons of grass pellets / BTU
Existing methane digester locations (e.g., Cow Power); potential digesters (i.e., large & medium dairy farms).	None. Phase 2: Thematic maps for total sites and installed capacity by town.	Background info by area selected; farm size / kWh / kW
Landfill methane sites; existing & potential digesters; potential WVO sites.	None.	Background info by area selected; annual production; potential sites.
Existing wood chip / pellet suppliers, wood energy systems manufacturers / suppliers / consultants, existing thermal & electric sites.	Estimate of available aboveground biomass in dry tons/acre produced each year on a renewable basis. Phase 2: Thematic maps for total sites and installed capacity by town.	Background info by area selected; NALG in green tons per acre by area / tons of chips, pellets / MWh, MMBH
Geothermal installers, existing wells by yield (GPM), existing geothermal locations	None.	Background info by area selected; can only identify possible open loop locations & businesses to contact.
Geothermal installers, existing geothermal locations.	Depth to Bedrock > 60" (5 ft) (closed loop horizontal and vertical systems are buried underground).	Background info by area selected; can only identify possible closed loop locations & businesses to contact.
Geothermal installers, existing geothermal locations.	Ponds at least 1/2 acre in size in (closed loop pond systems are meant to be at least ½ acre in size and ≥ to 8'-10' in depth. Pond depth data is limited in VT).	Background info by area selected; can only identify possible closed loop pond locations & businesses to contact.

Renewable Energy Uses: Saved / Negawatts; Electricity; Liquid Fuel; Thermal

Not Depicted: [Conservation]

…Enable Town Level Focus

Illustration of Atlas Concept

Data Layers → Composite Image for each Area

- *NOAA-CSC: 2006 Land Cover Data*
- *VAOT Road Line Features*
- *Existing Sites*
- *9-1-1 Building Point Features*
- *Rare, Threatened and Endangered Species*
- *Deer Wintering Areas*

Montpelier

Database Development

- Discovery Process (What's been done?)
  - Existing Data Availability: Quality, Publication Date & Usability (Public vs. Private)
- Database Development
  - Organization (define layers)
  - Naming Conventions (consistency – ISO 19115)
  - Layer Schema definitions
    - "Master" FC
    - Domain Tables

Inventory of Vermont Geographic Information System (VGIS) Source Data

Data Layer	Description	Source Scale	Last Update	Accuracy (m)
ANR private wells database*	Available private wells from ANR to date	Various	2009	NA
BoundaryOther_BNDHASH	Vllage, town, county, state and RPC boundaries	1:1250; 1:2500; 1:5k & 1:24k	12/31/2007	up to 100m +
BoundaryOther_NFLBND	Northern Forest Land Boundaries	1:250k		
CadastralPublands_CONSPUB; -CONSPRI	Public And Private Lands from the VT Conserved Lands dBase; some data is propietary		8/2009	
ClimateOther_WINDSPD30M	Residential; Predicted wind speed at 30 meter "hub height"	1:725k	6/2/2003	
ClimateOther_WINDSPD50M*	Small Commrcl; Predicted wind speed at 50 meter "hub height"	1:725k	6/2/2003	
ClimateOther_WINDSPD70M	Lrg Commrcl; Predicted wind speed at 70 meter "hub height"	1:725k	6/2/2003	
EcologicHabitat_DEERWN	Deer Wintering Areas	1:24k, 1:25k	5/1/2006	
EcologicOther_RTENATCOM	Rare, Threatened and Endangered Species & Significant Comm. Boundaries	1:5k, 1:24k	3/10/2010	
EmergencyE911_Esite	9-1-1 Building point features	GPS, 1:5k	9/15/2008	
GeologicSoils_SO (SSURGO)	Best avail soils data	~ 1:20k	2/18/2008	
ImageryPhotos_*	VT Mapping Program Imagery	1:1250; 1:5k; various	Various	
LC2006_CCAP	NOAA-CSC: 2006 LC data; 30m res (60m accuracy); 20 class raster	NA	2006	60
Tourism_RECSITES_point	VT Forest & Parks: VT outdoor rec sites inventory (points); Some features represented in conserved lands data.	1:5k; 1:24k; 1:100k	6/1/1999	
TourismTrails_TRAILS	State Trails	1:24k; 1:25k	4/30/1993	
TransRoad_RDS	VAOT Road line features	1:5k; GPS	9/30/2009	
UtilityTransmit_ELTRN	Electric Transmission data; some data propietary and used only internally.	1:5k, various	2009	
VTHYDRODEM	Vermont "Hydrologically Corrected" Digital Elevation Model	~ 1:5k	4/18/2005	
VTHYDRODEMSLP	Slope raster (units of percent slope)	~ 1:5k	4/19/2005	
WaterHydro_VHD	Streams, rivers and lakes and ponds of the National Hydrography Dataset	1:5k	8/6/2008	
WaterOther_CLASSA	VT Wtr Qual Stnd’s Class A watersheds	Various	7/16/2008	
WaterOther_DAMS	Vermont Dam Inventory (VDI)	Various	11/6/2009	
WaterWetlands_VSWI	VT Significant Wetlands Inventory	1:80k	2/8/2006	

RENEWABLE ENERGY ATLAS OF VERMONT

The Renewable Energy Atlas of Vermont is a new website that identifies, analyzes and visualizes existing and promising locations for renewable energy projects. The Atlas also depicts installers, consultants, and manufacturers that can help Vermonters implement projects.

6 Energy Categories	17 Options (to-date)
Biomass	Biodiesel (3 Oilseed Crops, Possible Algae Locations, Waste Vegetable Oil Locations)
	Grass Energy (2 Grasses)
	Methane (anaerobic) Digesters
	Waste to Energy: Landfill Methane, Digesters, WVO
	Woody Biomass
Efficiency	Efficiency Case Studies
Geothermal	Potential Open Loop Systems
	Pot. Closed Loop Systems (Horizontal, Vertical, Pond Systems)
Hydroelectric	Existing Sites
Solar	PV / Thermal Sites; PV potential for E9-1-1 points.
Wind	30, 50, 70 meter hub heights

Renewable Energy Layers Overview

Geodatabase	Feature Class
EnvironOther_Biomass.gdb	Environ_Biomass_poly_Cropland
EnvironOther_Biomass.gdb	Environ_Biomass_poly_Woody
EnvironOther_GeoThermal.gdb	Environ_GeoThermal_point_Wells
EnvironOther_GeoThermal.gdb	Environ_GeoThermal_poly_Soils
EnvironOther_GeoThermal.gdb	Environ_GeoThermal_poly_Wtr
EnvironOther_Hydro.gdb	Environ_Hydro_point_DamCmrcl
EnvironOther_RE_sites.gdb	Environ_RE_sites_point_Algal
EnvironOther_RE_sites.gdb	Environ_RE_sites_point_Biodiesel
EnvironOther_RE_sites.gdb	Environ_RE_sites_point_Digesters
`EnvironOther_RE_sites.gdb	Environ_RE_sites_point_Efficiency
EnvironOther_RE_sites.gdb	Environ_RE_sites_point_Geothermal
EnvironOther_RE_sites.gdb	Environ_RE_sites_point_HydroElectric
EnvironOther_RE_sites.gdb	Environ_RE_sites_point_Industry
EnvironOther_RE_sites.gdb	Environ_RE_sites_point_Lanfill
EnvironOther_RE_sites.gdb	Environ_RE_sites_point_Solar
EnvironOther_RE_sites.gdb	Environ_RE_sites_point_Wind
EnvironOther_RE_sites.gdb	Environ_RE_sites_point_Woody
EnvironOther_RE_sites.gdb	Environ_RE_sites_point_WVO
EnvironOther_Solar.gdb	Environ_Solar_point_FixedPV
EnvironOther_Wind.gdb	Environ_Wind_poly_LrgCmrcl70m
EnvironOther_Wind.gdb	Environ_Wind_poly_Residential30m
EnvironOther_Wind.gdb	Environ_Wind_poly_SmlCmrcl50m

Applicable Scales

RENEWABLE LAYERS						
SCALES	Bio fuels	Geo thermal	Hydro power	Solar	Waste to Energy	Wind
Residential		X		X		X
Community/Town		X	X	X	X	X
Commercial	X	X	X	X	X	X

Suitability Framework

A basic conceptual structure for weighting metrics, in a GIS based model, to address the complex issue of identifying the more suitable renewable energy resources amongst numerous choices. Selections are qualified on input from all sectors and the existing legal and regulatory environment.

MASK: Areas where a resource is not available due to physical constraints, highly valued natural resources, regulatory statutes etc.

METRIC: A quantitative measure (rank) based on procedures detailing the measure and the interpretation against comparable assessments. "Metrics are usually specialized by the subject area, in which case they are valid only within a certain domain and cannot be directly benchmarked or interpreted outside it.[1]"

Suitability Rankings	
Value	**Description**
Mask	No Development Areas
0	NoData – Temporary (Modeling Purposes)
1	Not Suitable
2	Poorly Suitable
3	Somewhat Suitable
4	Suitable
5	Very Suitable
6	Highly Suitable

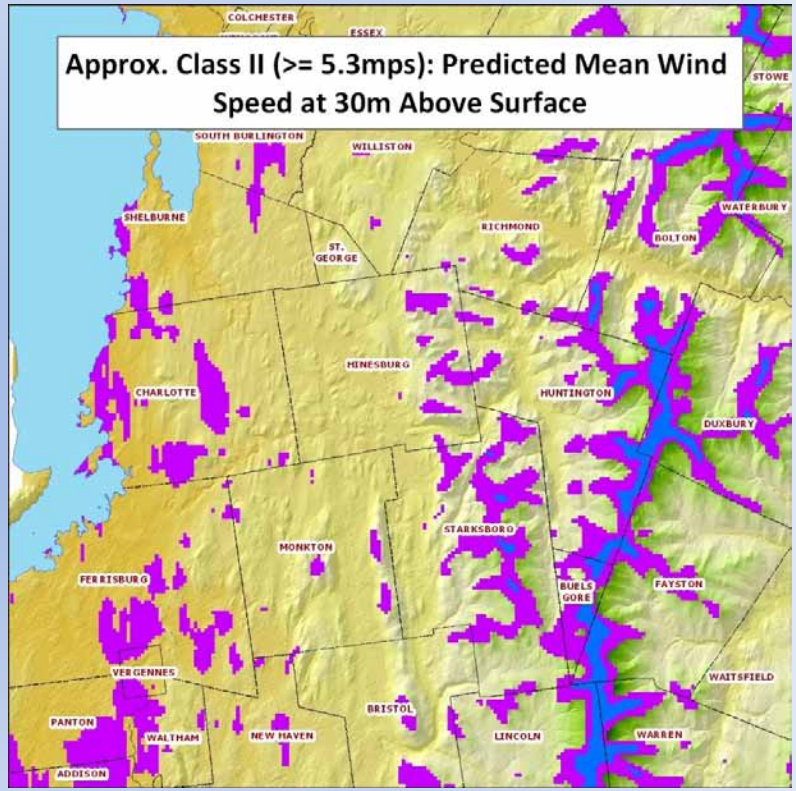
[1] WIKIPEDIA

Framework Applicability

RENEWABLE LAYERS						
Analysis	Bio fuels	Geo thermal	Hydro power	Solar	Waste to Energy	Wind
Masks	X	X				X
Metrics	X	X		X	X	Phase II

Modeling Approach

- Economics not considered due to technology dynamics, e.g., Wind now viable at lower average wind speeds.
- Predominately a raster based analysis. “Raster is faster”
- Phase I effort (don’t try to do it all at once).
- Individual metrics treated as building blocks for various combinations required with respective RE layers.



Modeling Environment

Why Automate?

- Aids in the visualization of the process being modeled;
- Built-in Quality Control & documentation
- Can be shared and easily rerun when things change, e.g., variables, data.

Model Builder (MB)

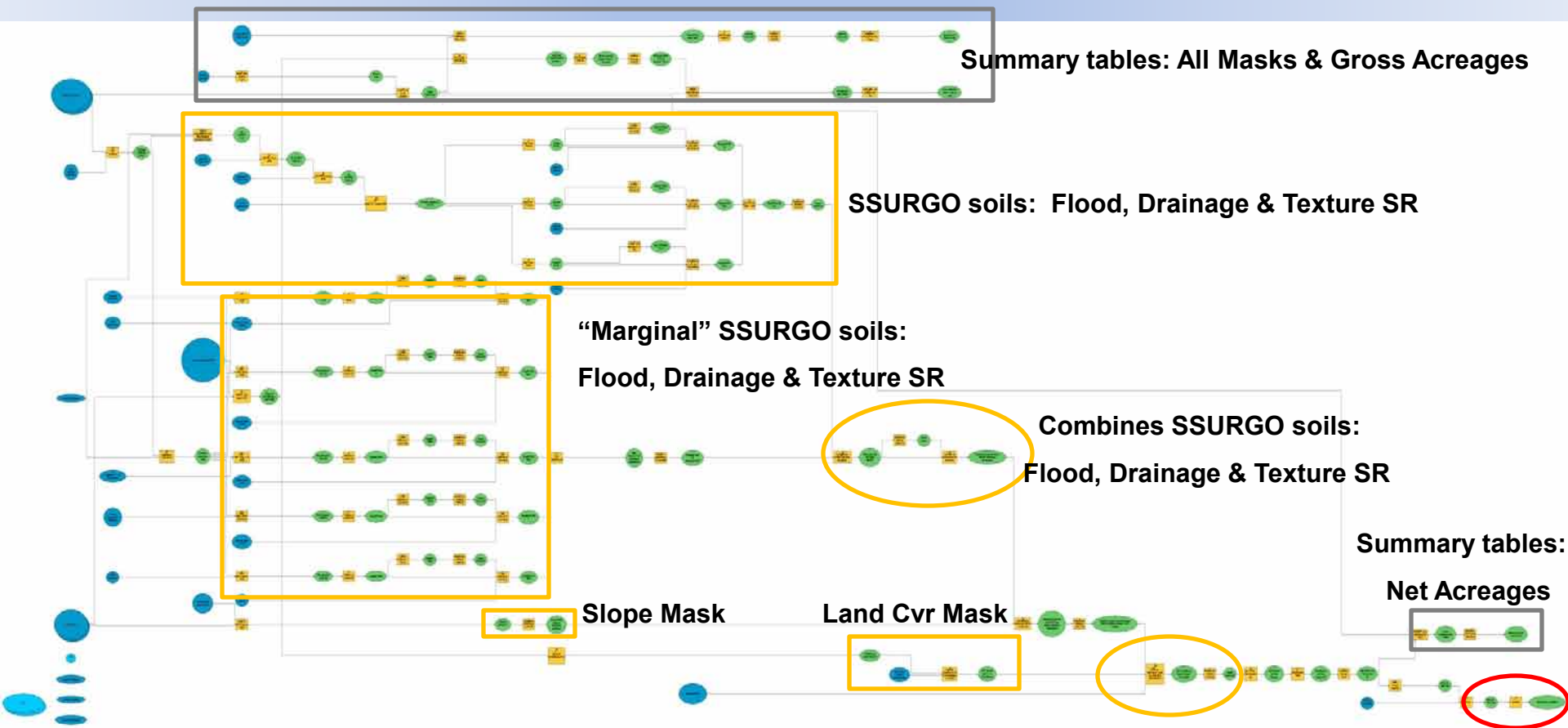
- A GUI w/a series of process wizards and diagramming tools that aid in the construction of spatial models represented as process flow diagrams.
  - **Pro's**:
    - Object oriented. Graphical environment very useful in flushing out an approach
    - Easy source for "starter Python code" to build from.
  - **Con's**:
    - Not as stable, more art than science with complex models . Slow interaction cycle.
    - Creates redundant variables when exported to Python.

Python (v.2.5)

- A well established scripting language with a large code library that can access GIS functionality through the "geo processor" (gp) object.
  - **Pro's**:
    - BULLET PROOF stability.
  - **Con's**:

Biofuel Model Example

- Query Soils suitable for Biodiesel crops & assign “Suitability Ranks”
- Query Marginal soils
- Mask unsuitable Land Cover, e.g., developed & orested etc.
- Mask steeps slopes
- Aggregate individual suitability ranks and assign qualitative values, e.g., “Marginal”, “Suitable”, “Prime”



Maintenance: Change IS Inevitable

The “Master” – where’d it go?

- Clarify roles of data partners
  - Who gets to wear Merlin’s hat?
- Some layers are more transactional than others
  - ID dynamic nature of layer(s) and plan accordingly.
  - Change threshold – attribute updates vs. adding/deleting/moving features
- Time interval of updates: 1month, 3 month’s?
- Develop supporting documents
  - Overall maintenance plan
  - Protocols/check-lists

Website Development

Fountains Spatial - Larry Spraker, President

"… In addition to energy-specific map services, ESRI ArcGIS Online basemap services (Street Map and World Imagery) were consumed and displayed for geographic reference. The Atlas web application and user-interface were designed and developed using Adobe Flex Builder 3 along with the ESRI ArcGIS Server Flex API (version 1.3) components for mapping functionality."

For More Information

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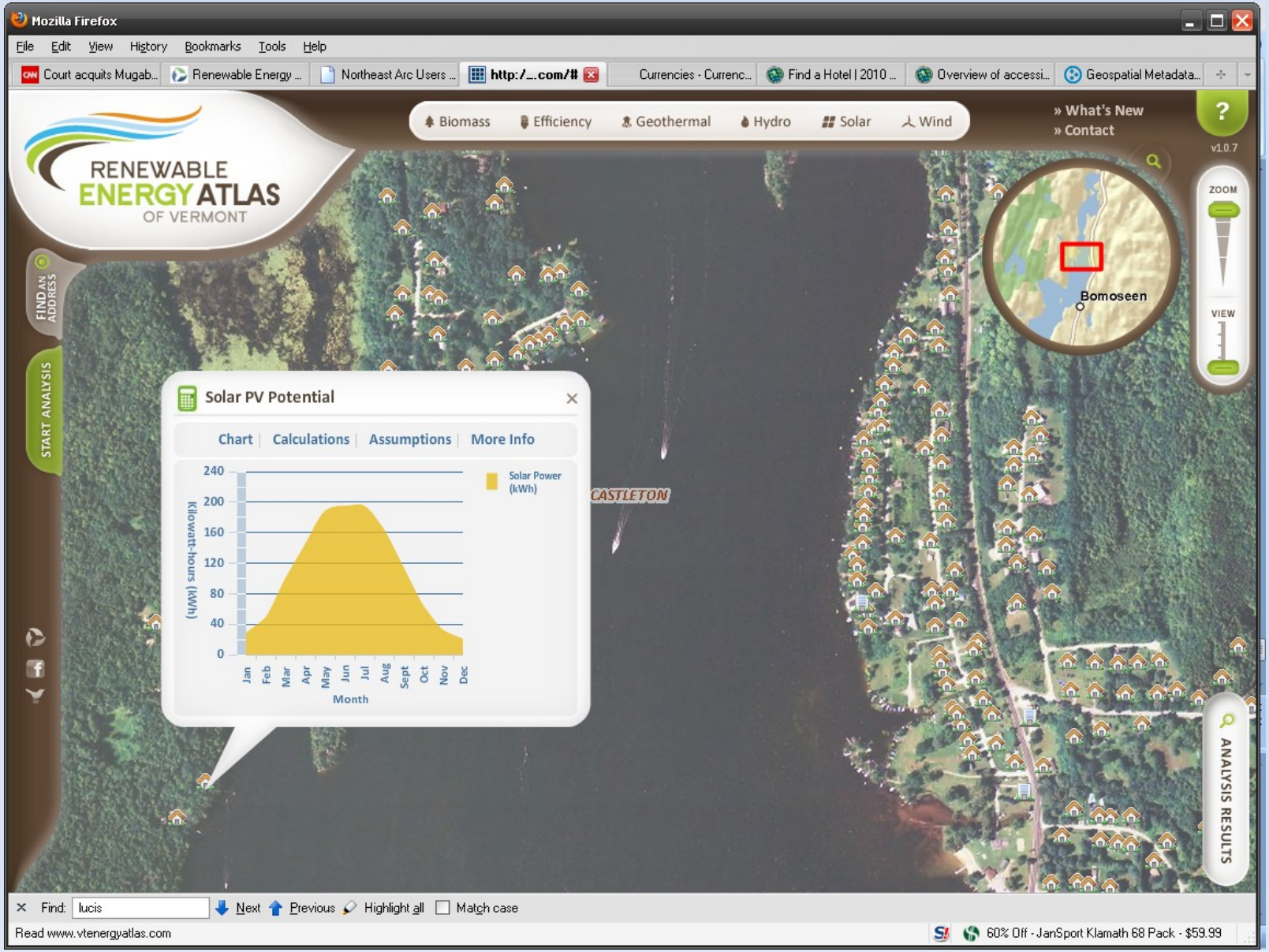
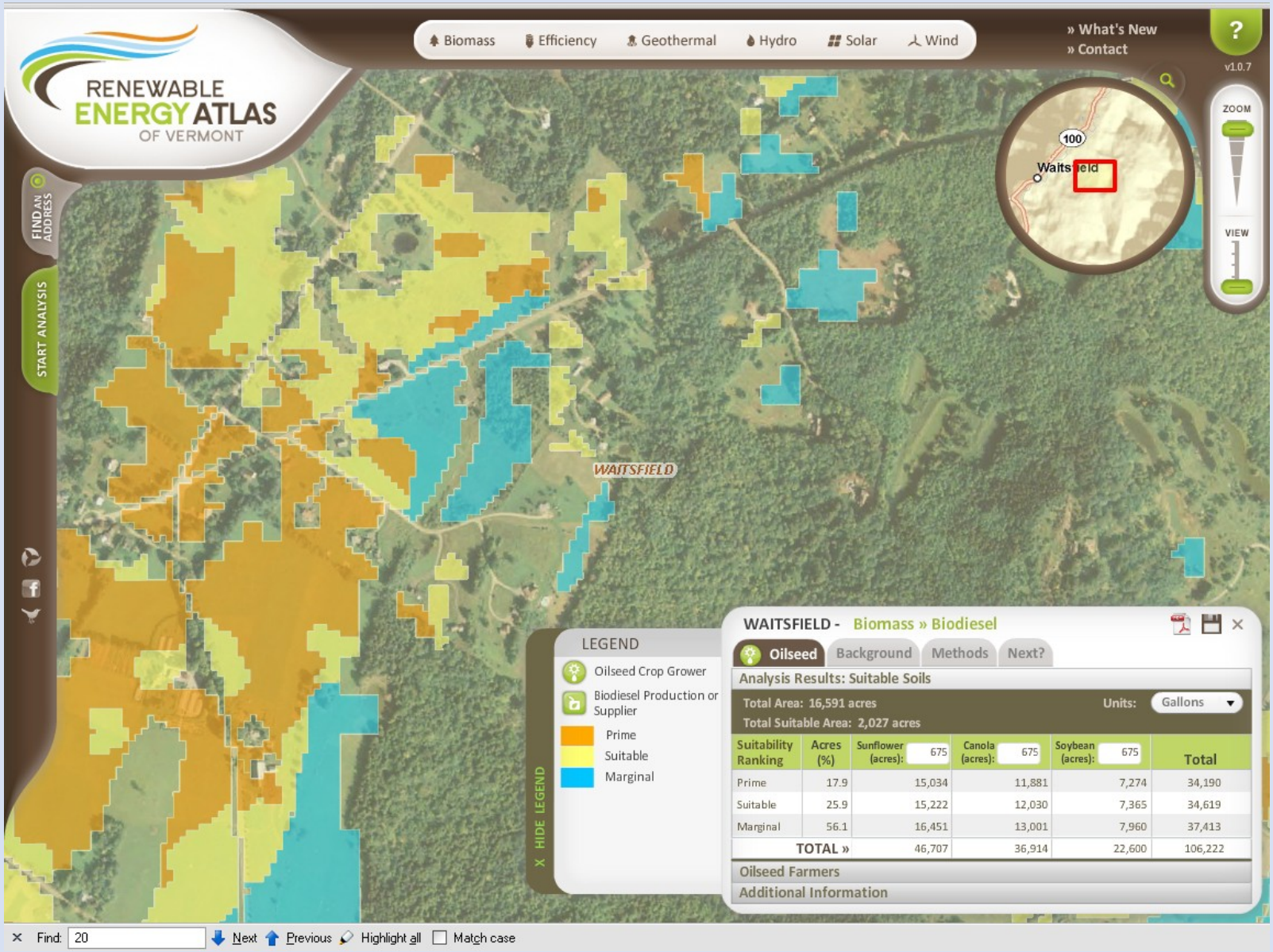
Demo – www.vtenergyatlas.com



Questions?



Suitability Ranking	Acres (%)	Sunflower (acres): 675	Canola (acres): 675	Soybean (acres): 675	Total
Prime	17.9	15,034	11,881	7,274	34,190
Suitable	25.9	15,222	12,030	7,365	34,619
Marginal	56.1	16,451	13,001	7,960	37,413
TOTAL »		46,707	36,914	22,600	106,222