



VERMONT SUSTAINABLE JOBS FUND

Vermont Bioenergy Initiative

How can Vermont farmers reduce input costs? How can Vermont increase its capacity for producing bioenergy? What are key on-farm energy production infrastructure needs?

The Vermont Bioenergy Initiative (VBI) of the Vermont Sustainable Jobs Fund (VSJF) has successfully demonstrated a farm-focused, community scale biofuel production model that is relevant to many other rural communities across the nation.

At the heart of this model is sustainable oilseed production on Vermont farms, which is integrated with existing and future food production systems via shared equipment, crop rotation, local distribution channels and on-farm use of the products produced. The economical production of crops, seed processing, pressing, and fuel production have all been demonstrated at farm facilities. Furthermore, when farms produce their own fuel from these oilseed operations, they are saving money on their operating costs while avoiding the need for imported, petroleum-based fuels and the price volatility associated with them. This increases the long-term sustainability, stability and economic feasibility of these food systems.

Where can entrepreneurs enter the food system who are not necessarily producers? We have this whole food system here, so how do people identify the opportunities? —Netaka White

The VBI model depends, not on advanced technology or capitally intense systems, but rather on sound land use, smart integration of existing equipment and technologies, and intimate process control by the farmers and businesses involved in production. This has been supplemented by technical assistance and grant funding as needed during design, construction, and operation phases.

VBI GOALS

The purpose of the Vermont Bioenergy Initiative (VBI) is to foster the development of a viable biomass-to-biofuels industry in Vermont that uses local resources to supply a portion of the state's energy needs. It is a component of sustainable, diversified agriculture with demonstrated progress against the following objectives;

- 1. Expand local production of biofuels,**
- 2. Reduce dependency on petroleum,**
- 3. Promote entrepreneurial activity in the biofuels sector,**
- 4. Stimulate farm-based biofuels production efforts, and**
- 5. Educate the public about sustainably and locally produced biofuels.**

Regionally specific economic, energy and greenhouse gas analysis tools have been developed through the VBI to enable the measurement of program performance. On all performance metrics, the VBI model is excelling even at currently limited production volumes compared to installed capacity:

- ▶ Present installed capacity to fuel 47% of VT agriculture on 10% of cropland (with rotation) at a capital cost of \$0.93/gallon/yr
- ▶ Average fuel production cost of \$2.81/gal (from field to tank)
- ▶ Meal production costs of \$200/ton
- ▶ Energy return on investment (EROI) of 4:1 (net positive)
- ▶ CO₂ avoidance of 2 tonnes / yr / ha (net negative)

As more of the installed capacity is utilized, these measures of performance will improve due to economies of scale.

A key result of this integrated, farm-focused approach is that a path to truly sustainable fuel production has been identified and is summarized below. There are, however, challenges that remain. The key challenges identified by VBI partners are:

- ▶ Increasing acreage to maximize utilization of existing production facilities
- ▶ Improving yields through continued crop research and adaptation to the Northeast
- ▶ Increasing oilseed crushing capacity by adding more presses
- ▶ Developing sustainable substitutes to chemical reagents (i.e., lye and alcohol) by producing alternatives from local feedstocks
- ▶ Improving marketing for co-products of oil, biodiesel, meal, and glycerin
- ▶ Expanding the deployment of the VBI model through regional collaboration and outreach

Vermont's community-scale bioenergy systems have demonstrated their feasibility at the pilot scale. Additional resources and complementary policies are needed to:

- ▶ Accelerate commercial capacity build out,
- ▶ Convey the prospects to other rural communities in the US,
- ▶ Increase technical assistance through public/private collaboration (i.e., State agencies, NGOs, the Land Grant University system and the private sector)
- ▶ Extend the VBI and similar programs to other parts of the country as a means of meeting broader renewable energy, food system and rural economic development goals.

We urge Congress to create regionally appropriate objectives and "set asides" in federal energy and agriculture programs that will help drive smaller scale and distributed regional bioenergy and rural economic development projects. National renewable energy policies and incentives need to be updated to recognize and prioritize regional needs and resources so that the Northeast and other similar rural regions are able to compete for limited federal dollars for the types of projects and fuels outlined here.

BACKGROUND

VSJF is a 501(c)(3) nonprofit organization based in Montpelier, Vermont. We were created by the Vermont Legislature to accelerate the development of markets for sustainably produced goods and services. We do this by providing grants, loans, and technical assistance to entrepreneurs, businesses, farmers, networks and others interested in sustainable development in Vermont.

VSJF believes that energy is the crucial variable for understanding and solving our most pressing environmental problems. The energy systems we choose to use impact our air, water, land, wildlife habitats, and overall quality of life. In the 200 years since the Industrial Revolution, virtually every society on the planet has become dependent on nonrenewable fossil fuels for everything from electricity and fuel to agricultural production and plastics. The harnessing of fossil energy power, especially oil, radically changed the trajectories of human societies and, of course, peak oil and global climate change both have their roots in fossil fuel dependency and energy consumption. Our grant-making, loan, and technical assistance efforts are consequently geared toward:

1. transitioning away from non-renewable sources of energy;
2. relocalizing energy production, food production, and other forms of manufacturing;
3. building resilience against challenges such as peak oil and climate change.

On the ground, the VBI has taken the form of farm-based oilseed operations and crop research (for liquid fuels, vegetable oil and livestock feed), regional biofuel distribution system enhancement (biodiesel storage and commercial blending of heating oil and transport fuel), algal oil-to-biofuels research and development and pilot project support (collocated with on farm anaerobic digesters and landfill gas to energy systems), grass energy crop research and densification (for thermal conversion), and education and outreach.

What distinguishes the VBI from other advanced liquid biofuels initiatives is the model of local production for local use with farms at the center of a sustainably minded commercial network (see Figures 1 and 2). Partner farms are motivated primarily by the desire to fuel their own operations from their own fuel crops, with an added benefit being an inventory of co-products (such as oil, meal, and glycerin) and surplus fuel for external sales. Another unique feature of the VBI model is the craft nature of the systems and equipment which has been merged with appropriate technical assistance and engineering review to ensure safety, quality and reliability. This approach has leveraged Vermont's Yankee ingenuity resulting in cost effective, efficient, and effective small-scale fuel production systems, which are integrated with existing and future food systems.

Figure 1: Conversion of Oilseed Crops to Oil, Biodiesel, Meal and Glycerin

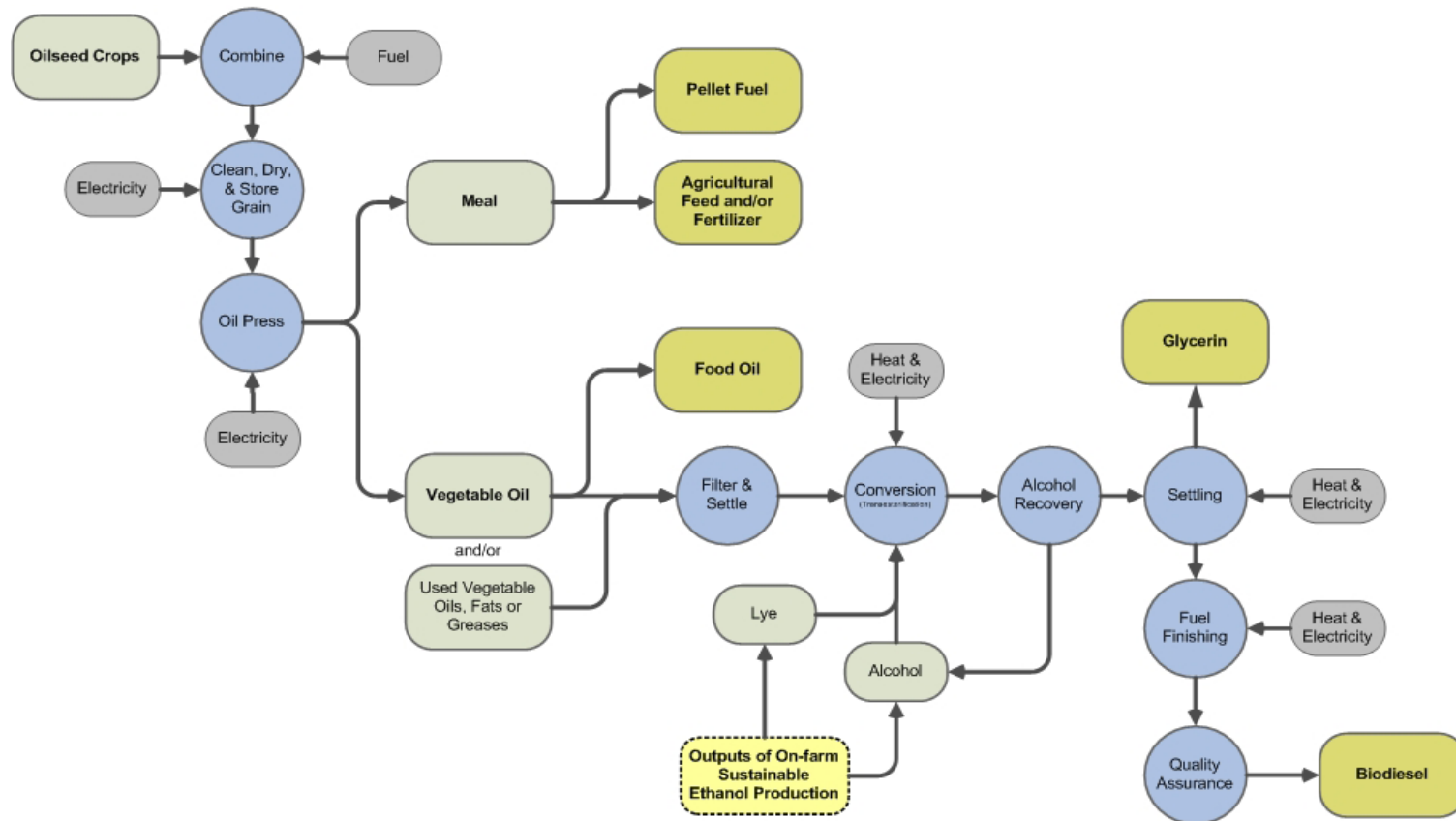
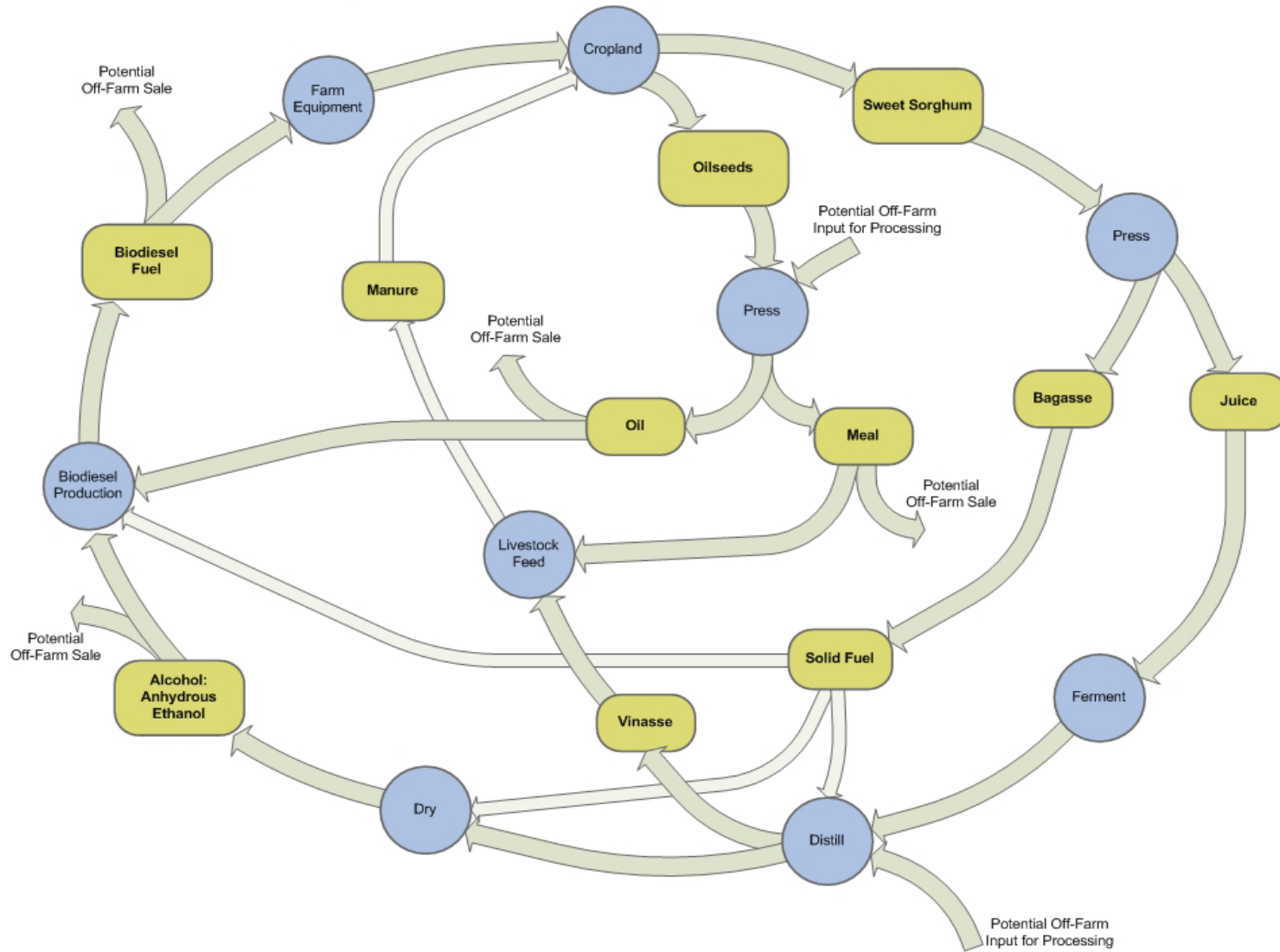


Figure 2: Integrated Farm-focused Liquid Biofuel Production Using Sustainable Feedstocks Grown Locally



ACCOMPLISHMENTS

The VBI has stimulated the development of 2.8 million gallons per year of biodiesel production capacity among seven Vermont farms since 2005. This is the result of \$5.4 million total and on-going investment (\$3.9 million VBI funded primarily through U.S. Department of Energy grants secured through the Office of U.S. Senator Patrick Leahy and \$1.4 million cost share by owners). The installed cost of the facility equipment was \$2.6 million. Therefore, the average cost of installed capacity is \$0.93 per gal/yr which is competitive with the national average for biodiesel plants of these capacities. It should be noted that these capacities assume less than 24x365 operation since the operations are integrated into other farm operations.

In addition to the development of biodiesel production capacity, the VBI has also teamed with University of Vermont Extension to assist farmers with oilseed production in Vermont (e.g., sunflower, canola, and soy.) Total acreage has grown from 5 acres in 2005 to 338 acres 2010. Seed crushing equipment has also been installed and is in operation with a total capacity of 5,240 ton/year (403,000 gallon/yr equivalent). Similar initiatives are underway in Pennsylvania, New Hampshire, New York, Maine, and Massachusetts.

The primary goal is on-farm, distributed fuel production to displace a portion of the region's fossil fuel use. The approach is to build a local supply of renewable bioenergy in order to reduce costs associated with the import of fuel and feed. By substituting biodiesel for petrodiesel and decreasing imported feed on Vermont farms, they become more environmentally and economically sustainable. Vermont agriculture uses approximately 6 million gallons of distillate per year. Therefore, the installed biodiesel production capacity (2.8 million gallon/year) could displace 47% of the current agricultural fuel use processing 40,000 acres of oilseed production per year. To displace 100% of the Vermont agricultural distillate use would require an estimated 85,700 acres annually. This allows for a 5-year rotation of oilseeds with other Vermont crops.

An easy to use cost calculator has been developed to allow oilseed entrepreneurs to quickly assess their costs of production. Economic analysis of the Vermont operations using this tool indicates average seed production costs between \$230 and \$300 / ton (sunflower). Meal production costs are generally \$190-220 / ton and oil costs are

\$0.45-0.50 / gallon. At these on-farm fuel sites biodiesel is produced at an average cost of \$2.09 / gallon (fixed and recurring) resulting in an average biodiesel cost of \$2.81 / gallon (a \$0.75 / gallon savings at current market rates for off-road diesel).

The VBI has commissioned both greenhouse gas analysis and energy return on energy investment (EROI) analysis tools for these operations. In both cases, our model of distributed production leads to reduced lifecycle GHG emissions and high EROI. For example, the EROI study indicates a mean second order average return of 4:1 in these operations. The greenhouse gas study concludes that VBI facilities are carbon negative even at present, limited production volumes relative to installed capacity. The study estimates that VBI grantees avoid up to 2 tonnes CO₂e/ha/yr, which is 100% better than the national average oilseed production. This equates to roughly 5,000 auto passenger miles/yr/ha of production.

CHALLENGES and NEXT STEPS

Along with accomplishment and progress comes learning. The six-year history of the VBI has produced the following findings:

- 1. Low Production Costs with Potential for Improvement:** Crop production costs are below national averages in most cases. However, relatively high equipment costs and associated production capacity can be further leveraged with increased acreage. More oilseed acres can and should be pursued.
- 2. Crop Yields Variable:** Yields are more variable than those achieved in other areas of the nation with longer production histories and larger acreage fields. The primary yield losses are attributed to pest damage.
- 3. High Crushing Capacity:** Installed oilseed crushing / pressing equipment is also underutilized. Similar to #1, an increase in acreage can be accommodated by installed capacity.
- 4. Benefit of Farm Scale:** The frugality and craftsmanship of farmers combined with specialized technical assistance has resulted in safe, economical, and appropriately sized biodiesel facilities that offer economic advantage over larger scale operations in our region.

- 5. Chemical Reagent Costs:** The greatest cost component of biodiesel conversion in Vermont is the cost of reagents (methanol and lye). Local, sustainable and economic alternatives are required and feasible.
- 6. Co-product Development:** Most participants are growing oilseeds to provide fuel for the farm. The co-products have not yet been fully marketed and to do so will require specialized marketing support.
- 7. Regional Collaboration:** The regional potential for the Vermont model has not yet been fully explored. Although there has been cooperation and communication with individuals, organizations and academic institutions throughout the target region since the inception of the VBI, there has not been a concerted effort to formalize a regional problem solving team.

We believe that through continuation and expansion of our efforts these gaps will be closed and the result will be a significant increase in sustainable biofuels production and agricultural economic feasibility in the region. At the heart of the VBI are the farmers and entrepreneurs who are pursuing these enterprises as going concerns. But there is a need for complementary support mechanisms.

CONCLUSION

The VBI model depends on sound land use, smart integration of existing equipment and technologies, and intimate process control by the farmers and businesses involved in production. This has been supplemented by technical assistance and grant funding as needed during design, construction and operation phases.

Biomass/bioenergy business and development leaders in the Northeast have been appealing to their Congressional delegations to create regionally appropriate objectives and "set asides" in federal energy and agriculture programs that will help drive smaller scale and distributed regional bioenergy & rural economic development projects.

National renewable energy policies and incentives need to be updated to recognize and prioritize regional needs and resources, i.e., with the RFS2, USDA and DOE programs heavily favoring cellulosic ethanol development, help 'leveling the playing field' is needed from Congress so that the Northeast states are better able to compete for limited federal dollars for the types of projects and fuels outlined here.

LINKS

Additional General Information is available on the VSJF Website – www.vsjf.org

Specific Partner Case Studies

<http://www.vsjf.org/case-studies/15/grantees-vermonts-oilseed-producers>

Homegrown Food, Feed and Fuel Project

<http://www.vsjf.org/projects/homegrown-feed-food-and-fuel-project>

Oilseed Production Cost and Profit Calculator

<http://www.vsjf.org/resources/reports-tools/oilseed-calculator>

Renewable Energy Atlas of Vermont

<http://www.vtenergyatlas.com>

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