

WSU Bioenergy Advances

Washington State University Supports Bioenergy Development

Bioenergy is a growth industry. Washington State is laying the groundwork for statewide bioenergy industries by investing in research, legislation, incentives and public-private partnerships. With our vast supply of renewable biomass, Washington is well positioned to help offset fossil energy use by converting these resources into bioenergy.

Several efforts underway to develop bioenergy have at least one thing in common: a partnership with the Washington State University (WSU).

WSU Extension Energy Program has a staff of energy engineers, energy specialists, technical experts, software developers, and energy research librarians who provide unmatched energy services, products, education and information – all with a focus on advancing the environmental and economic well-being of our customers.

The WSU Center for Sustaining Agriculture and Natural Resources (CSANR) is leading research and educational efforts to promote agriculture, food and natural resources systems that are economically viable, environmentally sound and socially responsible. One area that WSU CSANR researchers continue to examine is using anaerobic digestion at our state's dairies to produce bioenergy from waste. This technology shows great promise to help dairy farmers reduce environmental impacts, be more energy independent and make other profitable products.

Anaerobic Digestion – A Solution That Leads to More Solutions

Anaerobic digestion of dairy wastes is receiving a lot of attention in Washington. Approximately 450 dairy farms operate in the state; together, these dairies manage 275,000 cows. Managing their waste so it does not create odor, water quality, pathogen transfer, nutrient management and air

quality problems – including greenhouse gas emissions – becomes much easier with anaerobic digesters.

Many dairies that use digesters to manage waste find that they also provide new sources of revenue. Cow manure can be processed into electricity, heat, fuel, potted plant substrate, fertilizers and other products that can replace products made from fossil fuels. Digester technology is nudging Washington toward a more sustainable energy future.

Washington Farm Energy Program Looks at All Energy Costs

The WSU Extension Energy Program is working with the U.S. Department of Agriculture's Natural Resources Conservation Service and Rural Development Program, plus Washington State's Department of Agriculture, Conservation Commission and Dairy Federation to support the Washington Farm Energy Program. This program is designed to help



Washington's agricultural producers reduce on-farm electricity use, fuel use and other farm energy costs.

Note in the chart in Table 1 that electricity is a small part of overall energy use, especially in Washington.

The WSU Extension Energy Program role includes getting the word out about the program, recruiting support from utilities and developing software tools to help farmers assess their energy efficiency and evaluate opportunities to use and produce renewable energy.

Washington is leading the way

Homegrown companies that design and install digester systems are doing their part to make anaerobic digestion the industry norm for managing animal wastes.



Washington's newest anaerobic digester at the Van Dyk Dairy Farm in Lynden.

Andgar Corporation of Ferndale, Washington, has teamed with GHD Inc. of Chilton, Wisconsin, to build customized biogas systems.

DariTech, Inc. of Lynden, Washington, designs anaerobic digesters that minimize maintenance and oversight requirements so dairy farmers can focus on the cows while still seeing savings and revenue from the digester.

Farm Power of Skagit County, Washington, builds partnerships with small dairies to process their manure in a digester. They sell the energy that is produced to Puget Sound Energy and pass the revenues on to the contributing dairies.

J-U-B Engineering Inc., Kennewick, Washington, is doing active work in digestion of manure and organics with their patented technology.

Anaerobic digestion technology is also creating jobs.

Bellingham (WA) Technical College was awarded almost \$300,000 by the U.S. Department of Agriculture's National Institute of Food and Agriculture to develop a training program for technicians to operate, repair and maintain anaerobic digesters. This program is being designed in partnership with WSU and Andgar.

Table 1.

Total Energy Directly and Indirectly Consumed on U.S. Farms in 2002 was 1.7 Quadrillion Btu

(Source: Miranowski, 2004)

Energy Source	Percentage
Fertilizers	29.0
Diesel	27.3
Electricity	20.7
Gasoline	8.5
Pesticides	6.3
LP Gas	4.5
Natural Gas	3.6

Getting the word out

Agriculture Matters is a database of energy information useful to the Northwest agricultural community. www.energy.wsu.edu/EnergyLibrary/AgricultureMatters.aspx

EnergyAg Newsbriefs is a free monthly email newsletter about topics of interest to agricultural producers and service providers, focusing on energy efficiencies and the generation of renewable energy and bioproducts. www.energy.wsu.edu/EnergyLibrary/Newsbriefs.aspx#EnergyAg

Recruiting utility support

In 2006, Washington voters passed the renewable energy initiative, I-937. It includes a renewable portfolio standard requiring that certain electric utilities obtain 15 percent of their electricity from new renewable resources by 2020. This includes electricity produced from animal waste.

WSU staff members are also working to bring utility companies and dairies into partnerships so bioenergy produced on farms can be sold for a fair price.

Developing software tools

Software products developed by the WSU Extension Energy Program can help farmers evaluate their energy use and define specific cost/benefit relationships as they consider capital investments to produce or use renewable energy.

The **RELCOST Financial model** provides three methods to judge the financial viability of an energy project: life cycle cost analysis, the use of projected financials, and the use of accounting ratios to analyze financial statements. This tool was developed because lenders want a detailed analysis of future financial expectations before funding a project.

Farm Energy is the working title of another software tool the WSU Extension Energy Program is developing. It will be used to perform energy audits of Washington dairy farms, with the goal of helping farmers secure funding for specific energy projects. The program will expand to other farms soon.

WSU Improves Digester Efficiencies

WSU researchers have found that anaerobic digestion is the best available technology for capturing and recovering methane from organic wastes and generating renewable energy. Through CSANR's Climate Friendly Farming Project, WSU is investing in research, technology development, demonstration and educational activities to advance the use of anaerobic digestion for dairy operations in Washington.

To better understand the strengths and weaknesses of existing digester technology, WSU researchers collaborated in the design and



WSU tested Multiform Harvest nutrient recovery technology at the Qualco Energy biogas facility in Snohomish County, Washington.

construction of the first commercial-scale digester on a dairy farm in Washington, where they tested engineering innovations, nitrogen and phosphorous recovery, co-digestion of food processing waste with manure, and purification of biogas so it could be used as a vehicle fuel. By demonstrating this technology to dairy farmers, researchers also hope to spur interest in – and widespread adoption of – anaerobic digester technology.

These innovations aim to optimize manure treatment, energy production, greenhouse gas mitigation, and by-product quality. For example, by adding additional enzymatic hydrolysis steps, researchers hope to promote high efficiency fiber digestion, which will allow digesters to work using additional animal waste streams.

WSU Works to Enhance Nutrient Recovery

While WSU researchers work to improve digester efficiencies, they are also evaluating the fiber and

liquid effluent that is produced. These nutrient-rich co-products could provide key benefits for dairy farms. Nutrient overloading on Washington croplands – especially from nitrogen and phosphorous – has emerged as a water quality concern for regulators and some communities. By transporting these excess nutrients off farms in solid or liquid form, farmers can solve the problem of nutrient overloading while creating a marketable product.

WSU's Climate Friendly Farming researchers are working with partners in agriculture and industry to test and develop technologies to recover, purify and concentrate nutrients from digester effluents. Transporting these valuable nutrients from dairies to croplands in other parts of the state that can use them creates another marketable product from the digester and provides a recycled biofertilizer to reduce reliance on fossil-fuel based fertilizers.

Puget Sound Clean Cities Coalition Supports Biomethane as Vehicle Fuel

Most owners of anaerobic digesters burn the biogas they produce to generate electricity, which they either use themselves or sell to utilities. But groups like the Puget Sound Clean Cities Coalition encourage use of scrubbed biomethane to replace fuels in vehicles – you could say they want to turn cow power into horsepower.

But the biogas created by anaerobic digesters contains carbon dioxide (CO₂), which reduces the heating value of the gas, and hydrogen sulfide (H₂S), which is corrosive. WSU researchers evaluated existing biogas purification technologies and are building on their success in removing CO₂ and H₂S. If cost-effective methods for upgrading biogas can be developed for farms, biogas purification could provide dairy farmers with revenue to complement (or replace) electrical power sales. This is especially critical in the Pacific Northwest, where low power rates have prevented cost-competitive power from farm-scale digesters, limiting total dairy-derived power.

The WSU Extension Energy Program team is working with Clean Cities to expand the use of biomethane in transportation. Using biomethane instead of petroleum products as a vehicle fuel can reduce greenhouse gas emissions by up to 88 percent. Biomethane also emits less nitrogen oxide, hydrocarbon and carbon monoxide than gasoline or diesel. In the U.S., biomethane

use in vehicles is in its early stages but is steadily gaining momentum. Over 122,000 vehicles in the U.S. are fueled with natural gas, and because clean biomethane has the same properties as natural gas, it can easily be used in vehicles that are configured for natural gas.

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WSU tested biogas purification technology to look at its potential for use as a vehicle fuel.

Resources

- WSU Extension Energy Program
www.energy.wsu.edu/
- WSU Center for Sustaining Agriculture and Natural Resources
www.csanr.wsu.edu/pages/Home
- WSU Climate Friendly Farming Topics: Anaerobic Digestion
www.csanr.wsu.edu/pages/Anaerobic_Digestion
- Bioenergy at the Washington State Department of Agriculture
www.agr.wa.gov/bioenergy/
- Northwest Clean Energy Application Center
www.chpcenternw.org/
- Pacific Region Bioenergy Partnership
www.pacificbiomass.org/
- Puget Sound Clean Cities Coalition
www.pugetsoundcleancities.org/AlternativeFuelsAndVehicles.htm
- RELCOST Financial software
www.northwestcleanenergy.org/ResourcesSoftwareLinks/Software.aspx
- U.S. Department of Agriculture's Natural Resources Conservation Service, Washington State
www.wa.nrcs.usda.gov

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