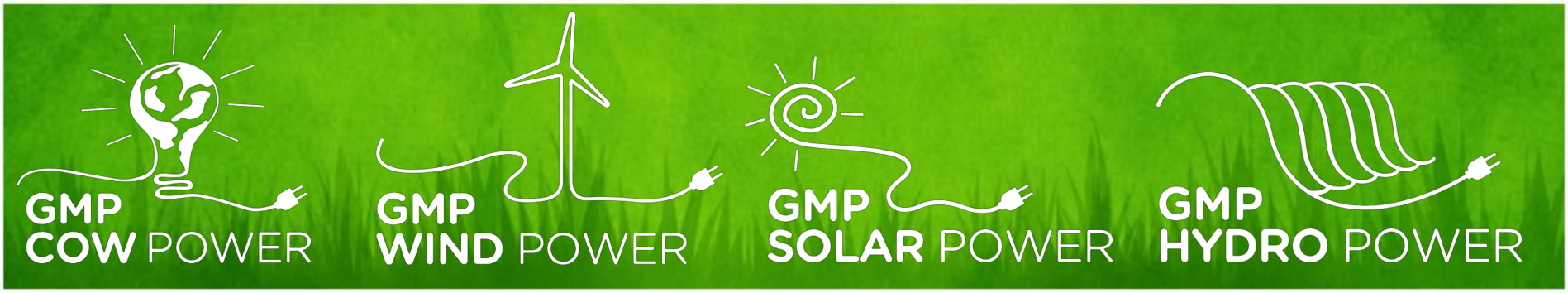
The National Academies of
SCIENCES · ENGINEERING · MEDICINE

Electricity Use in Rural and Islanded Communities:
A workshop supporting the
Quadrennial Energy Review

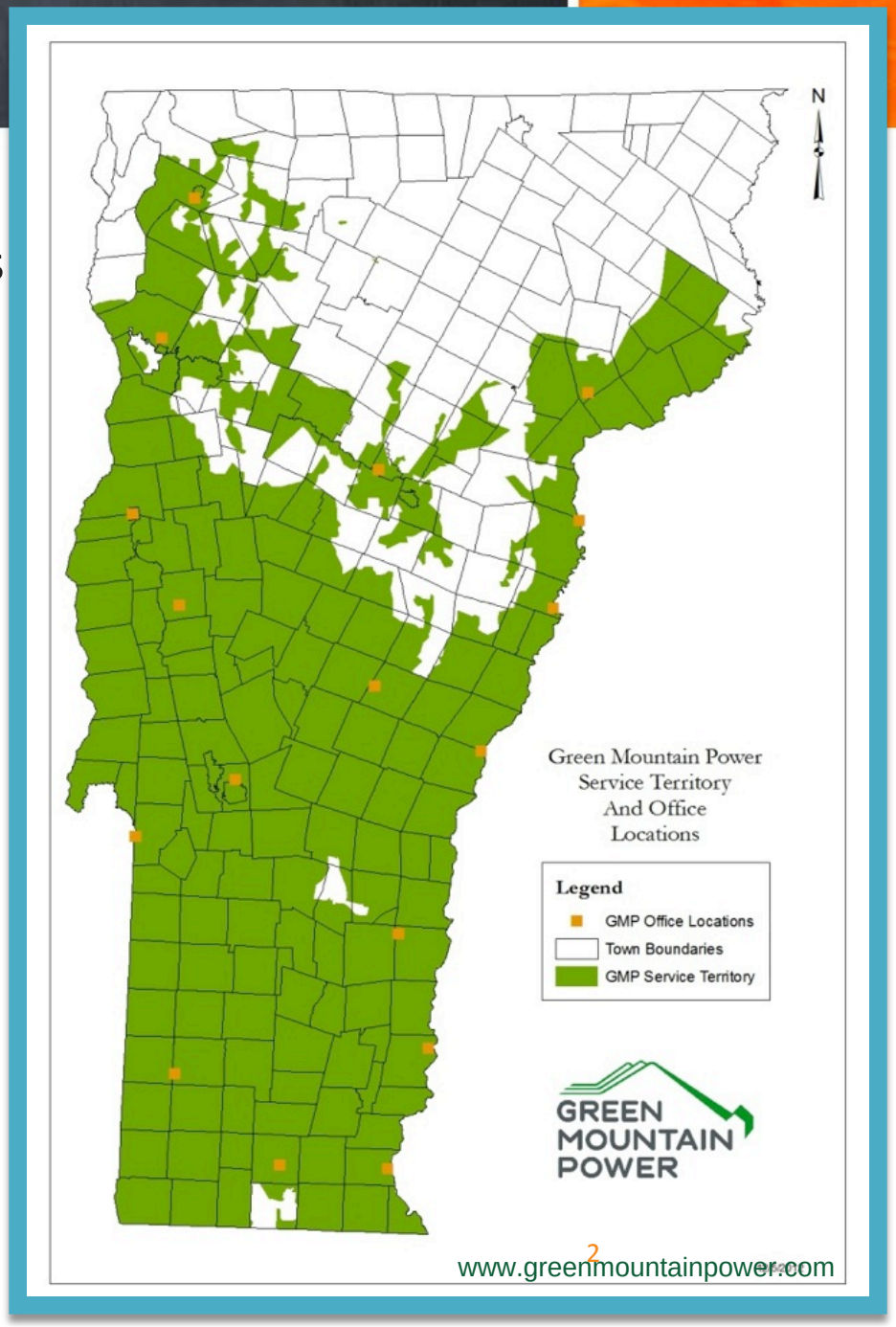
GMP's Clean Energy, Clean Water Projects in Vermont



Green Mountain Power

- Founded in 1893 in Vergennes, VT
- 261,294 customers in 202 VT towns
- First utility in the World to earn B-Corp certification.
- 92% GMP Customer Satisfaction
- Vermont's energy company of the future!

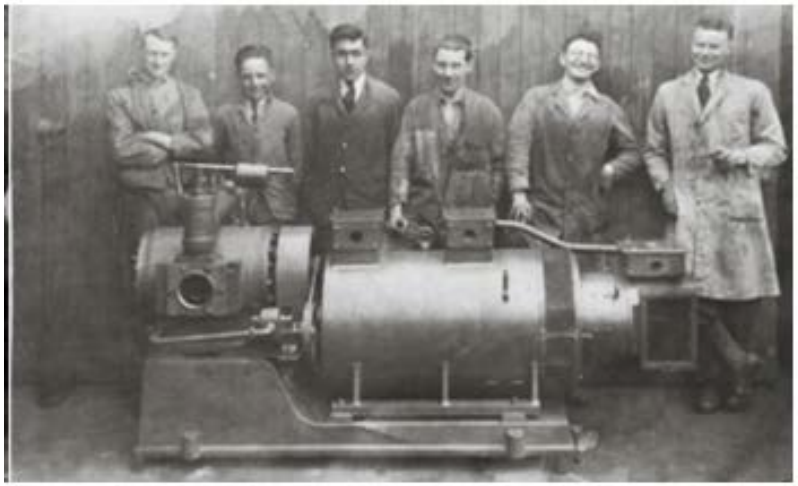
Employees	560
Customers	70%
Area served	63%
Line miles	12,000
In-State Hydro	32 stations 103 MW



Anaerobic Digester

A brief History

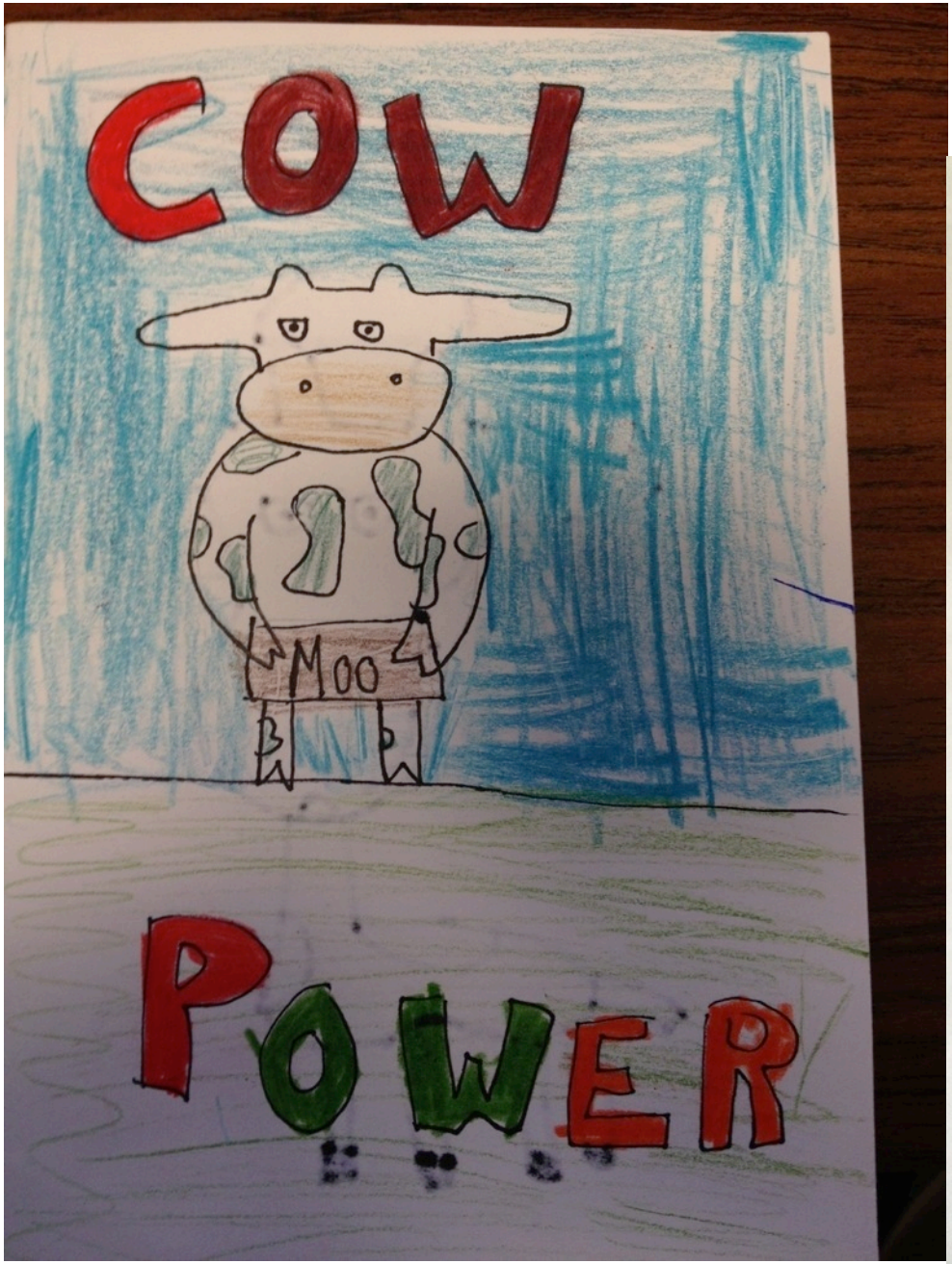
- Biogas was used for heating bath water in Assyria during the 10th century BC.
- The first digestion plant was built in Bombay, India in 1859
- England in 1895 biogas was recovered from sewage treatment facility and used to fuel street lamps in Exeter.
- Six to eight million low-tech digesters provide biogas for cooking and lighting.



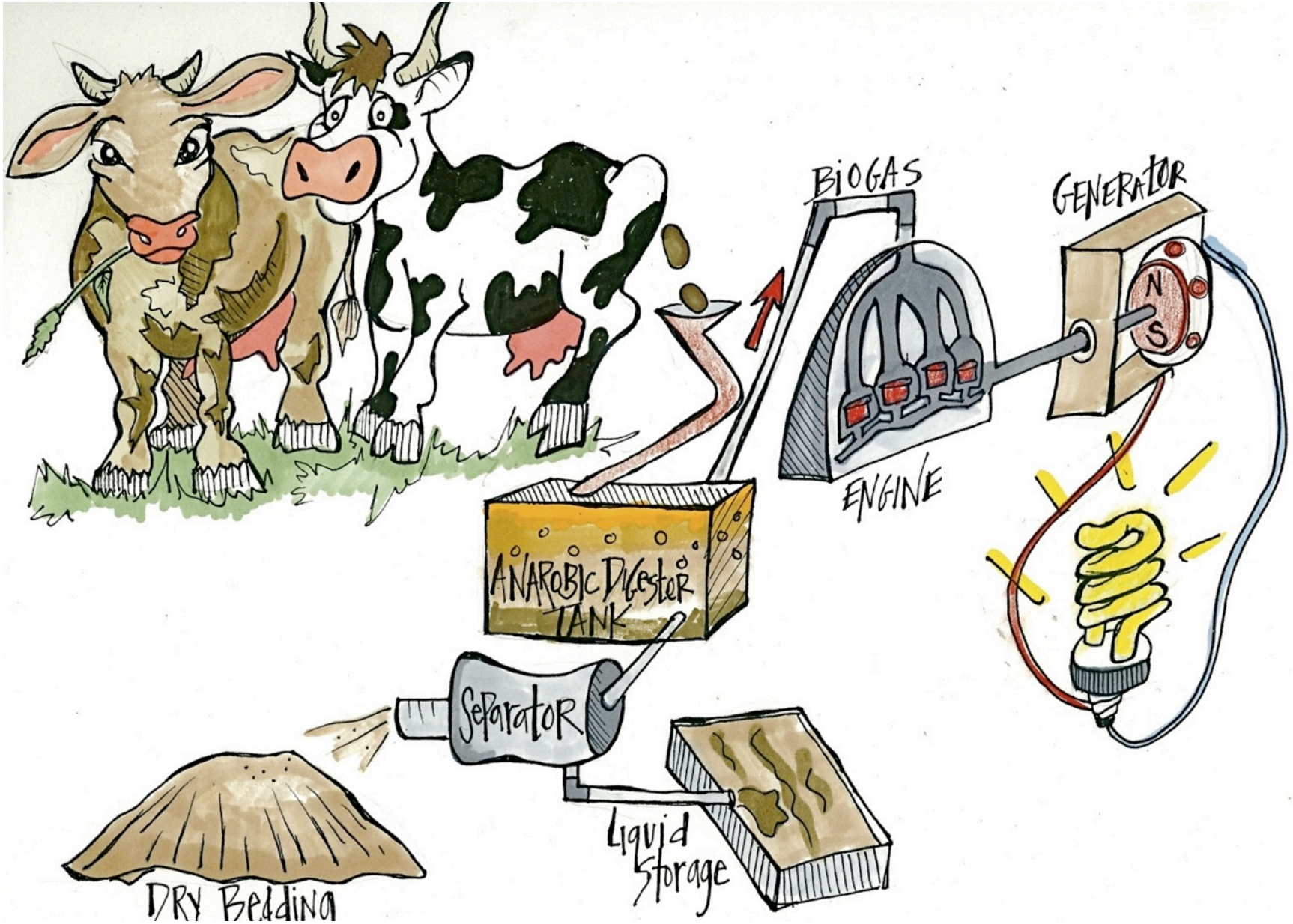
Vermont’ First Farm Digester
Foster Brothers Farm 1982

Directly linking customers to farms.

- Provides customers a renewable **choice**.
- Provides farmers with new **revenue**
- Provides tools to **protect** the environment.


COW
Moo
POWER

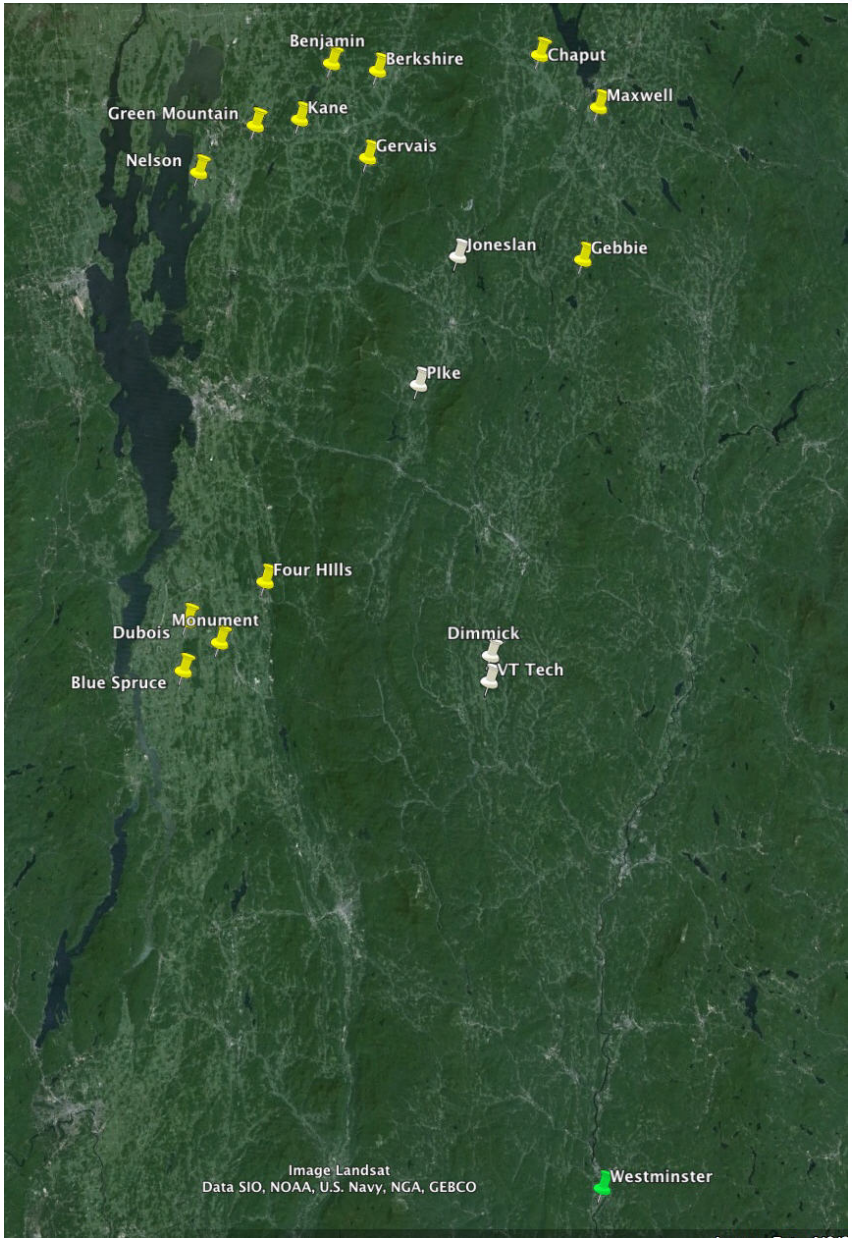
Annette Compton 1959-2012



Cow Power™ Projects

• Audet's Cow Power	January 2005
• Bershire Cow Power	December 2006
• Green Mountain Dairy	March 2007
• Nelson Boys Dairy Farm	September 2007
• Neighborhood Energy	December 2008
• Gervais Family Farm	February 2009
• Chaput Family Farm	august 2010
• Dubois Energy	November 2010
• Monument Three Gen	September 2011
• Kane's Cow Power	November 2011
• Gebbies Maplehurst Farm	July 2012
• Four Hill Farm	September 2012
• Benjamins Riverview Farm	February 2014

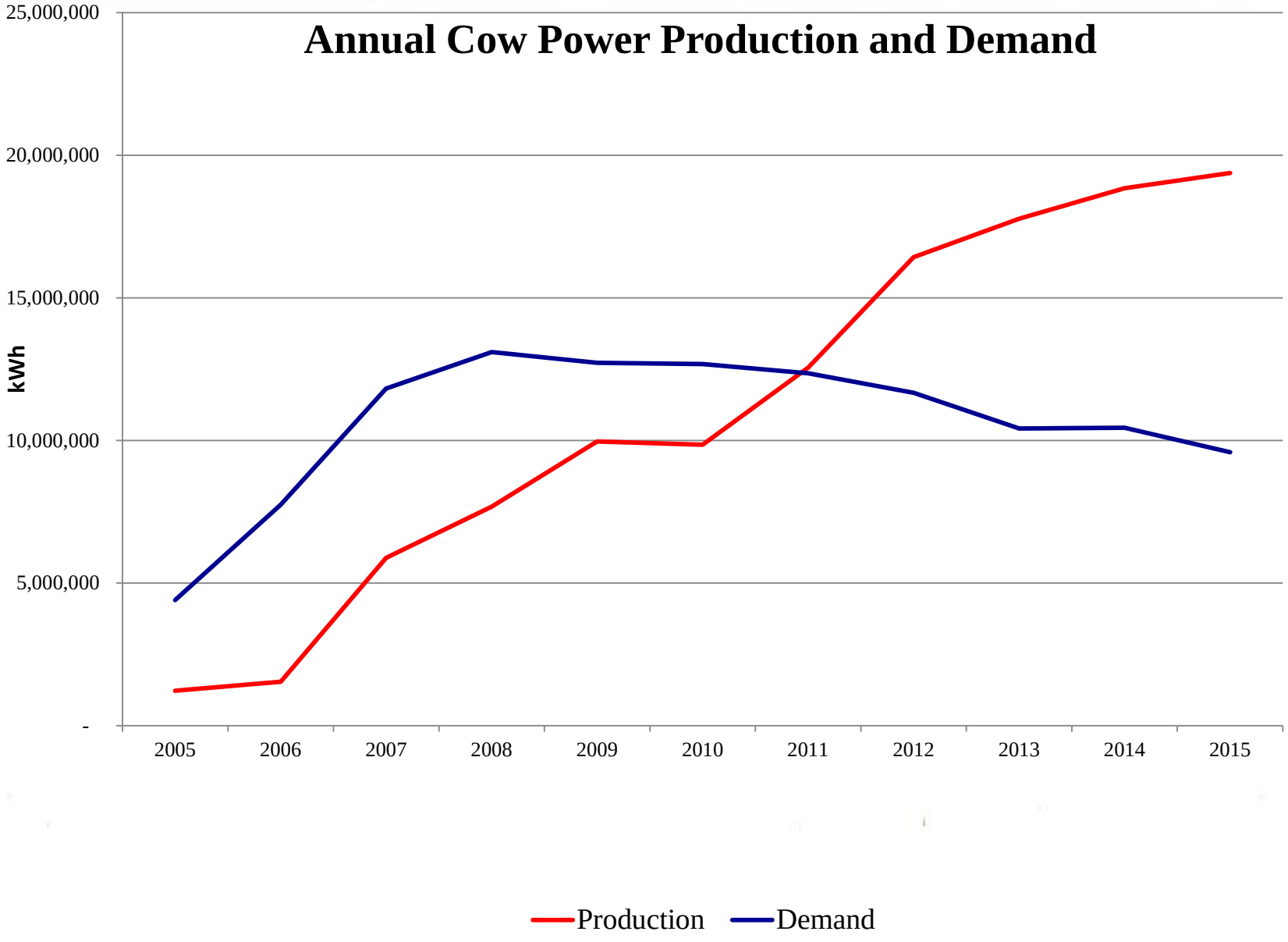
Green Mountain Power



Cow Power Supporters

Killington

Cow Power Production



Environmental Benefits

Annual methane destruction from 13 participating farms is approximately

44,370 MTCO2e

PLUS grid offset of 6,500 MTCO2e

Like removing 10,700 cars from the highway burning over 5.7 million gallons of gasoline every year!!

(264,700 MT Methane plus 38,900 MT Grid since 2005)

http://www.epa.gov/cleanenergy/energy-resources/calculator.html

Clean Energy, Clean Water project

- Use cow manure and food waste to **generate electricity 24-7**
- Reduce methane emissions and manure odor
- Improve water quality by capturing and exporting excess phosphorus
- Operate as an integrated system with the dairy farms in the community.

Modern Agricultural Practices

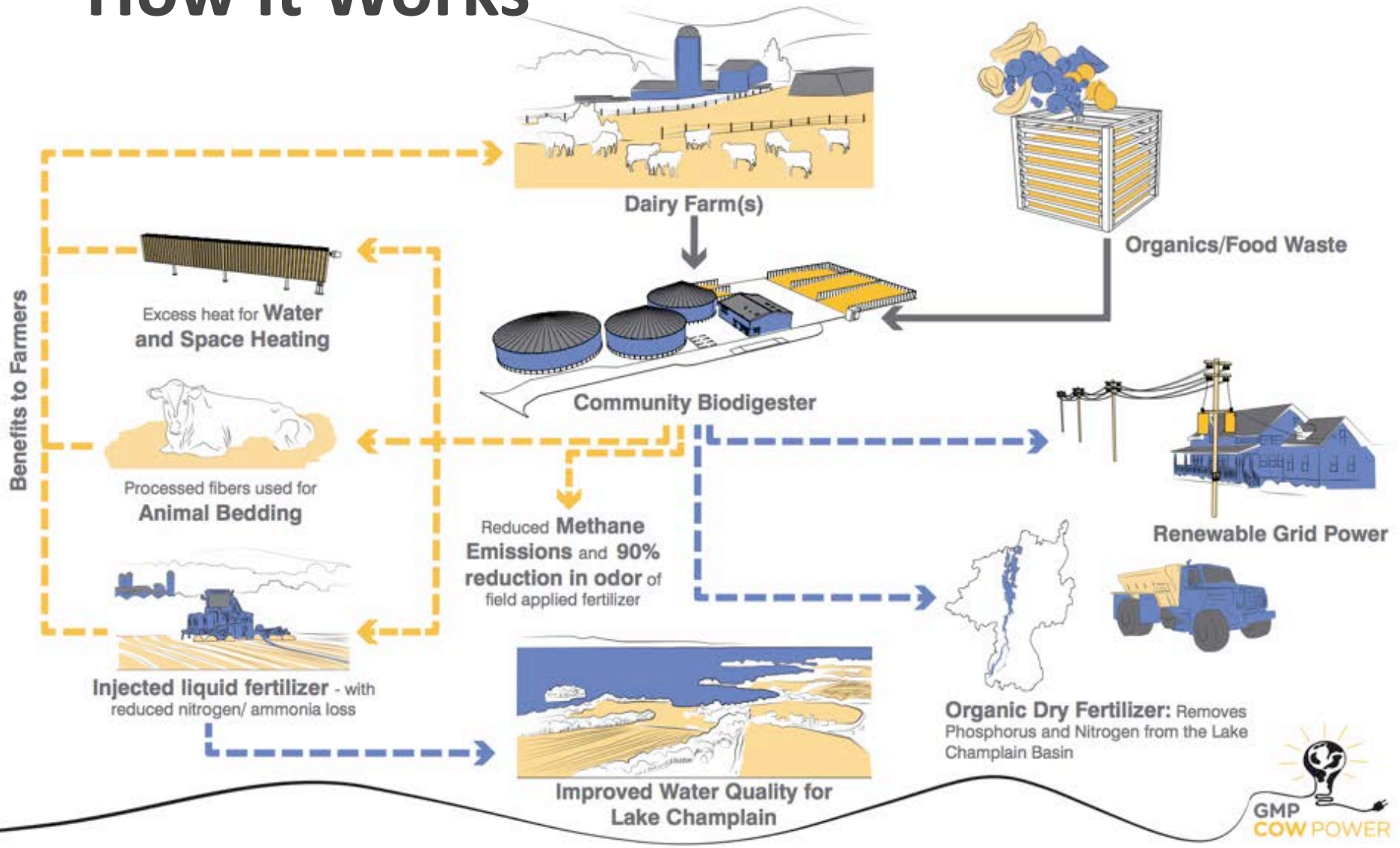
– agricultural runoff can be the greatest contributor to phosphorous load in a watershed


Beadles Cove
Catfish Bay
Image USDA Farm Service Agency
Imagery Date: 7/15/2006 43°50'2

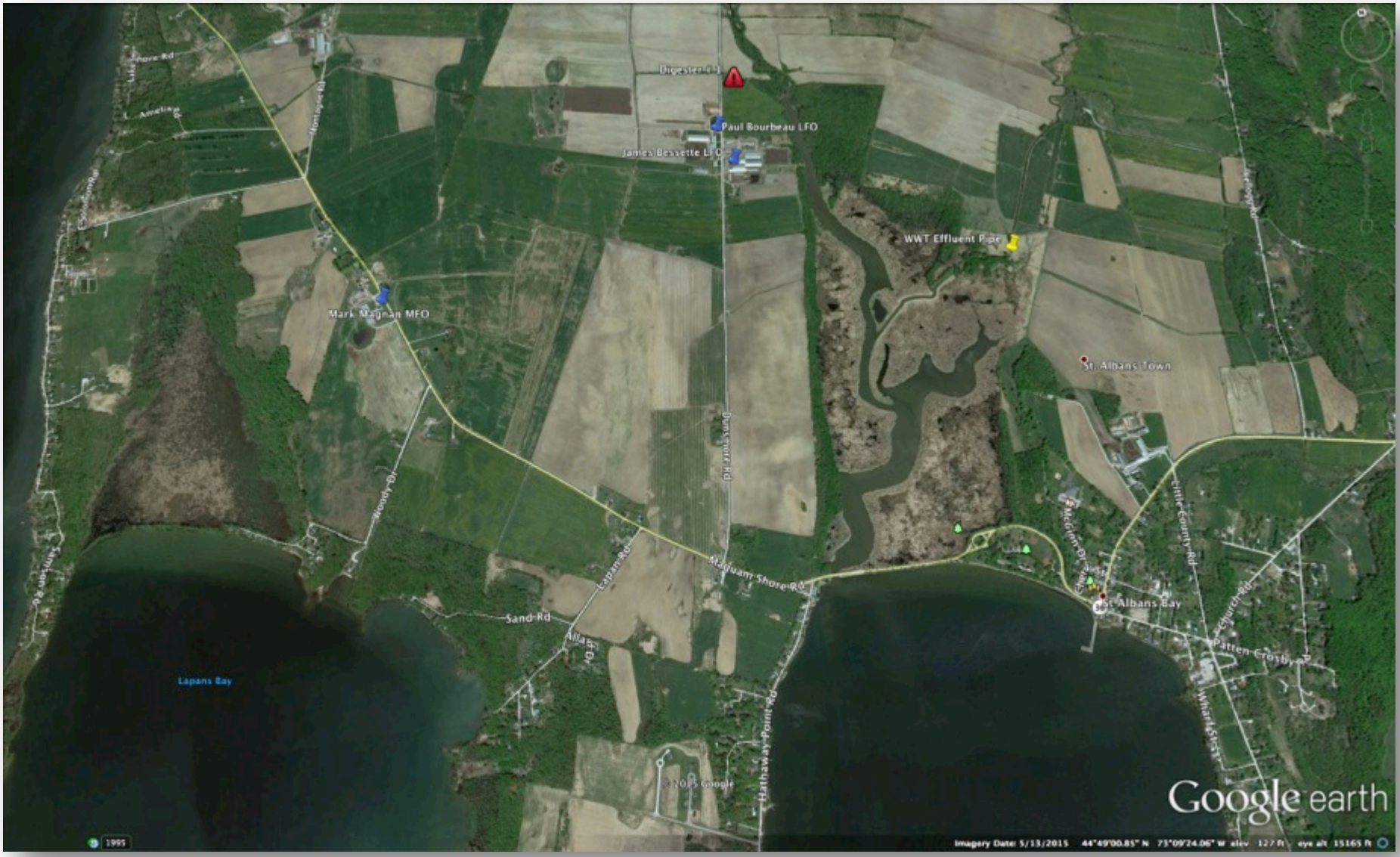

Beadles Cove
Catfish Bay
Image USDA Farm Service Agency
Imagery Date: 7/19/2003 43°50'2

GMP | Clean Energy Cleaner Water

How it Works

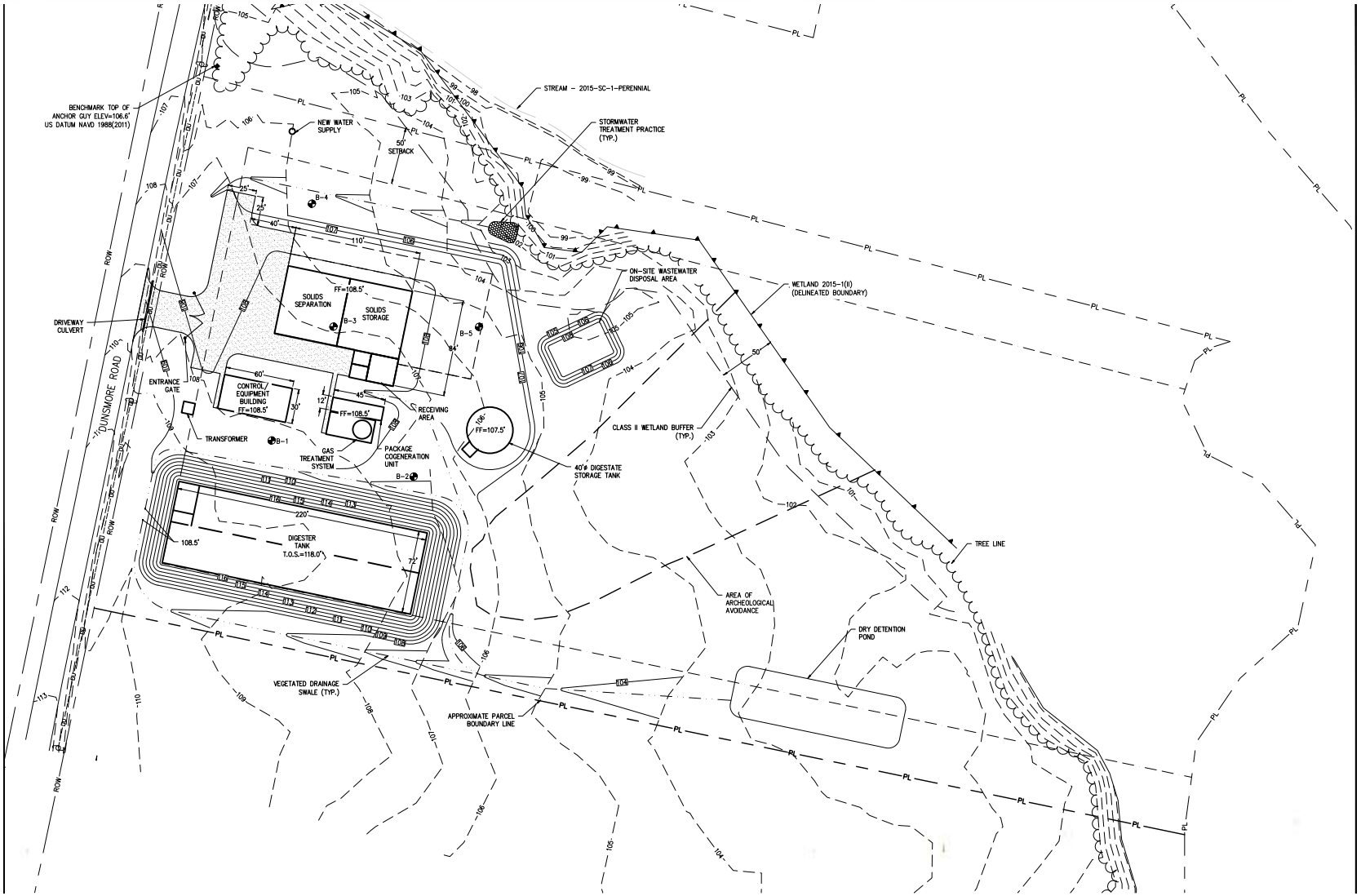


Project proximity to Lake Champlain




Digester # 1
Paul Bourbeau LFO
James Bessette LFO
Burnstmarsh Rd
© 2015 Google
Google earth
1995
Imagery Date: 5/13/2015 44°49'40.72" N 73°09'05.16" W elev 114 ft eye alt 2908 ft

Proposed Site Plan



Organics Processing

Depackaging Next?

Genset Technology

- Martin Energy Group as the Genset supplier.
- Nameplate capacity is 800 kW.
- State of the art for emissions and sound control

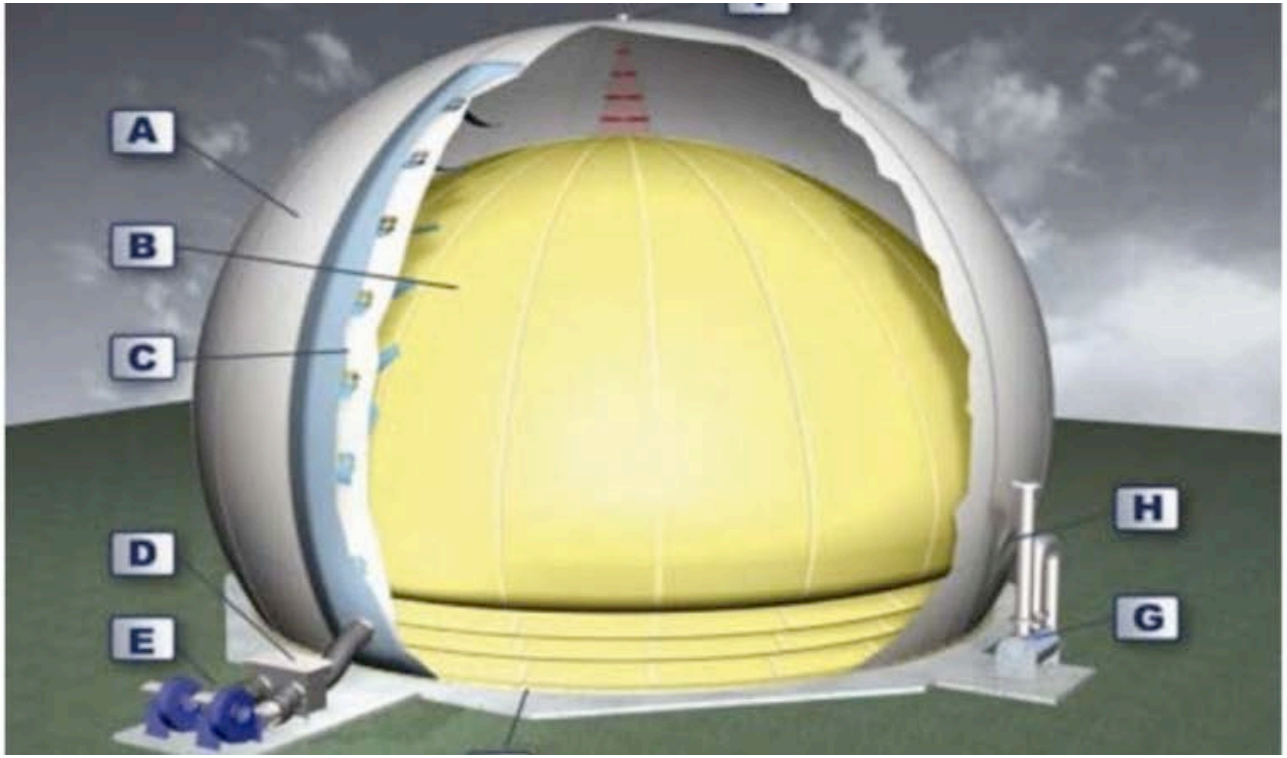
Air Quality Benefits

- **90%+ Reduction of odor** in the manure after digestion process.
- **Reduction of ~ 6,500 Metric Tons of CO2 equivalent from methane destruction** (~removing over 1,300 cars from the highway http://www.epa.gov/cleanenergy/energy-resources/calculator.html
- Genset latest technology includes exhaust catalyst and biogas scrubbing to **reduce NOx, SOx, CO, CHOH, and other regulated emissions**.

Grid of the Future

- This project is part of a GMPs broader grid transformation including micro-grid.
- Serves the local energy needs.
- Future grid automation will keep power on even if transmission system is down.

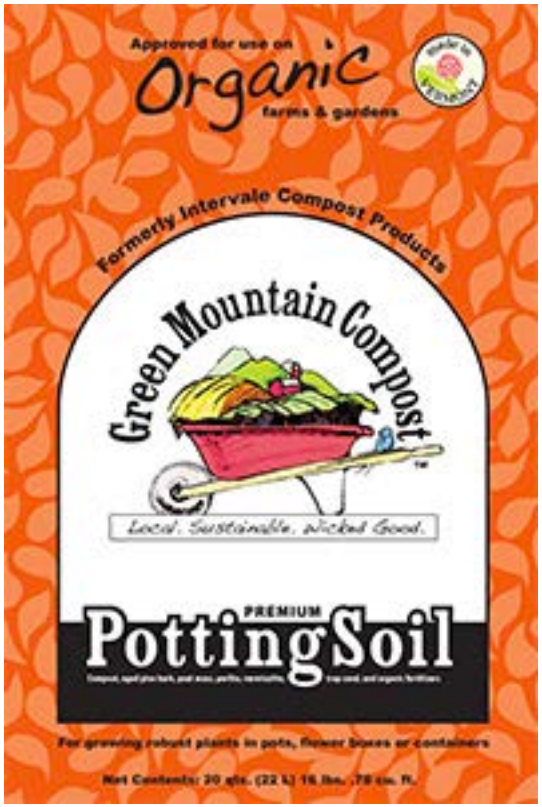
Biogas Energy Storage



B	Inner Membrane
C	Air Flow System
D	Non Return Valve
E	Radial Ventilator
F	Anchor Ring
G	Safety Valve
H	Inspection Window


BAUER
Separator


MOO MIX
FORTIFIED PROFESSIONAL POTTING SOIL
Approved for ORGANIC FARMS
Made in Organic Matter
Cured over 6 Months For Maturity & Quality
No Sewage or Municipal Sludge
Enjoy the benefits of mature compost™
1 Cubic Foot • 28 (Dry) Liters
Great For:
Perennials • Annuals • Greenhouses • House Plants
Ornamentals • Herbs • Hanging Baskets
UDDERLY THE BEST™
Made in Vermont
MOO
PROFESSIONAL POTTING SOIL


Approved for use on
Organic
farms & gardens
Formerly Intervale Compost Products
Green Mountain Compost™
Local. Sustainable. Picked Good.
PREMIUM
PottingSoil
For growing robust plants in pots, flower boxes or containers


MAGIC DIRT™
GROW GREAT GARDENS...NATURALLY
ORGANIC GARDEN AND POTTING MIX
SUSTAINABLE ALTERNATIVE TO PEAT MOSS
Every cubic yard of Magic Dirt™ comes from generating more than 100 kWh of renewable energy and removing over 1,800 pounds of greenhouse gases from the environment.
Volume
1 Cubic Foot

Water Quality Benefits

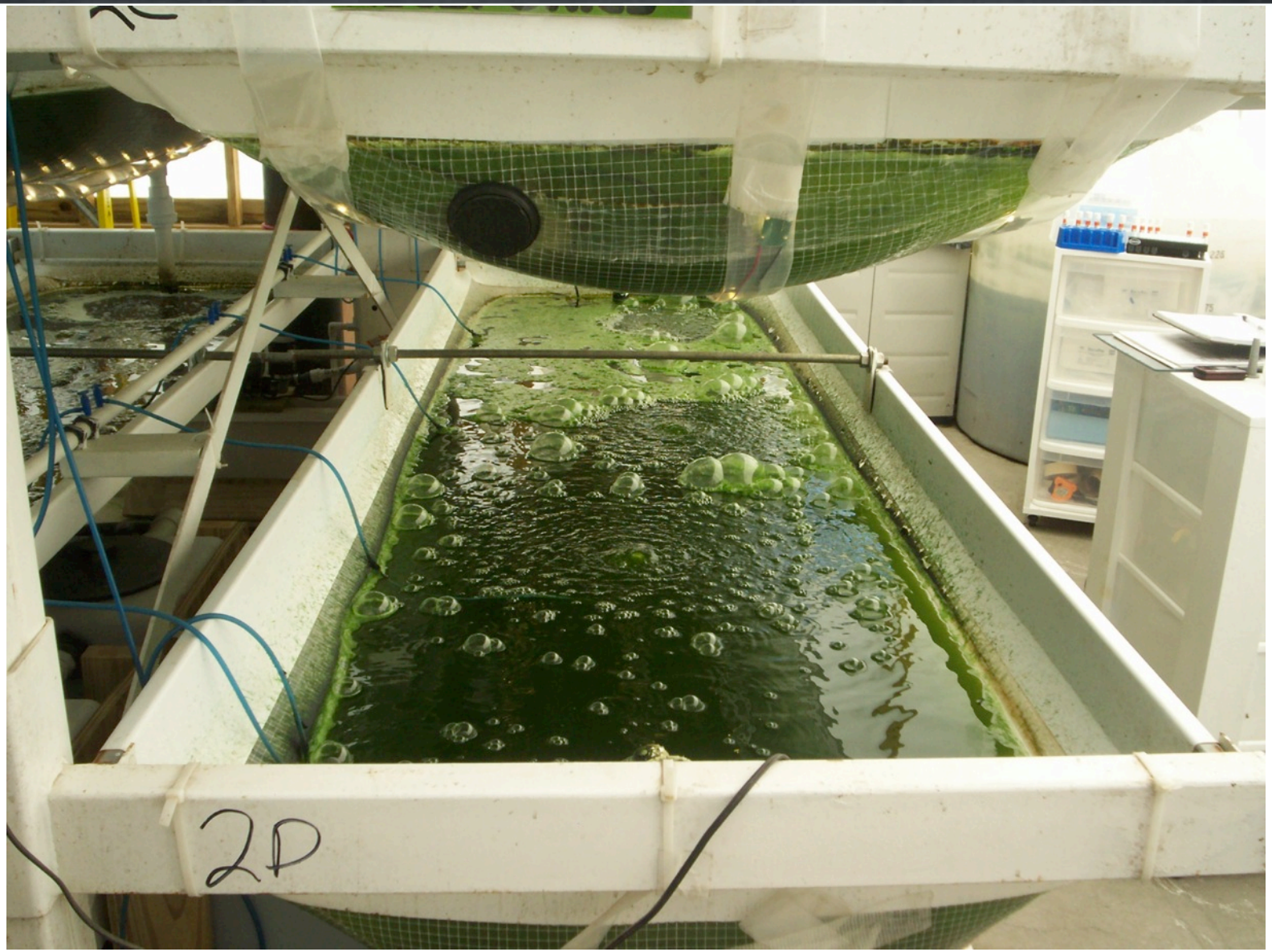
- Systems can **remove up to 80% of the phosphorus** from the effluent and return only what the farm needs for crops.

Phosphorous Recovery Value

Successive solids removal steps

- Removing bedding solids and 10% of P
- Removing DAF Solids and 70% additional P

Algae?



Vermont Policies

- Act 148 **Universal Recycling, Food Waste Diversion**
- **SPEED Standard Offer Pricing for Electricity**
- Act 56 "RES" **New In-State Renewables 10% by 2032**
- State Energy Plan to achieve **90% Renewables by 2050**
- Agency of Agriculture Dairy Farm **NMP Regulation**
- USEPA and Lake Champlain **Vermont TMDL**
- **SmartGrid/Micro Grid** Implementation
- Long Term, stably priced energy, capacity
- Reducing System Losses

What we've learned:

- Ability to layer in multiple community and environmental benefits linking energy, nutrient, air, and water quality benefits
- Three phase infrastructure needs funding for generation project expansion and grid of the future
- Anti-Islanding controls/DTT via radio/fiber until capacity grows
- New Grid hardware and automation to allow reverse power flow and regulation

What can the Federal Government do?

- Fund scale-up of new innovative concepts where multiple benefits like electricity and fuels are produced (Algae Culture)
- Expand Carbon Trading like CARB/RGGI.
- Cross agency teaming is critical DOE, USDA, and EPA (ie AgSTAR) etc. for multi faceted rural projects.
- funding to understand the AD microbial communities (methanogens and bacteria) to optimize methane production, pathogen destruction.

Questions?

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