



Energy Matters: Designing and Implementing a Net Zero Retrofit

at the University of Wisconsin Arlington Agricultural Research Station

Getting to Zero
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State Energy Policy

- Wisconsin State Statute 16.95 **Powers and duties:**

The [Department of Administration] shall, through a system of comprehensive long-range planning, promote the development and the maximum wise use of the energy, natural, and human resources of the state and develop and implement a

cost-effective,

balanced,

reliable, and

environmentally responsible

energy strategy to promote economic growth.

WISCONSIN'S ESPC Program

- 2005 Act 141 requires major state agencies to develop energy cost reduction plans.
- Plans must include all system and equipment upgrades that will pay for themselves in energy cost reductions over their useful life.
- The Department of Administration (DOA) and the University of Wisconsin System embrace high-performance building standards and energy conservation for state facilities and operations.
- The energy savings performance contracting program provides a process for the UW System to effect energy cost reductions in existing buildings and utility systems.

CONSERVE WISCONSIN

Energy Use in State-Owned Facilities

- **Program:** Energy Bond Fund and Performance Contracting Program
- **Description:** Since the 1990's Wisconsin Department of Administration (DOA) has operated the state's energy bond fund, which provides financing for **energy savings performance contracting (ESPC)** projects across all state facilities owned by agencies (including universities) that opt-in to the program.
- The fund is capitalized at a total of **\$180 million** and received funding in three waves from the state legislature: \$30 million, \$50 million, and \$100 million.
- The **bonding has a maximum term of 20 years** (for project planning purposes, one must assume a 5.25% interest rate and 3% energy inflation) therefore **projects must meet a 16-year simple payback.**

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Goal: Long-term sustainability and effectiveness

Program must successfully address market failures in targeted market sector (Corrections, Higher-Education, and Agricultural)

- **Typical market sector barriers:**

- Access to capital
- Access to trained staff with time to devote to the project.
- Access to clear information

- **Wisconsin's ESPC program details**

- State agencies can implement measures with no upfront capital expenditures.
- DOA borrows through the Capitol Budget Office (CBO) on a monthly basis, which means that the projects are financed upfront with general revenue. Once DOA issues the bond, it compensates the CBO typically at around a 2 to 4% average interest rate.

The DFD assists agencies through the process, so that they are not left alone in negotiating and working with the ESCO. Each project proposal undergoes significant upfront DOA review for technical and financial soundness. DOA also presents proposed projects to the Building Commission for approval (larger projects require the Governor's approval).

- **Establish dynamic feedback on program implementation and process:**

- Close partnership between ESCO, state agency, institution, and DOA results in dynamic feedback loops

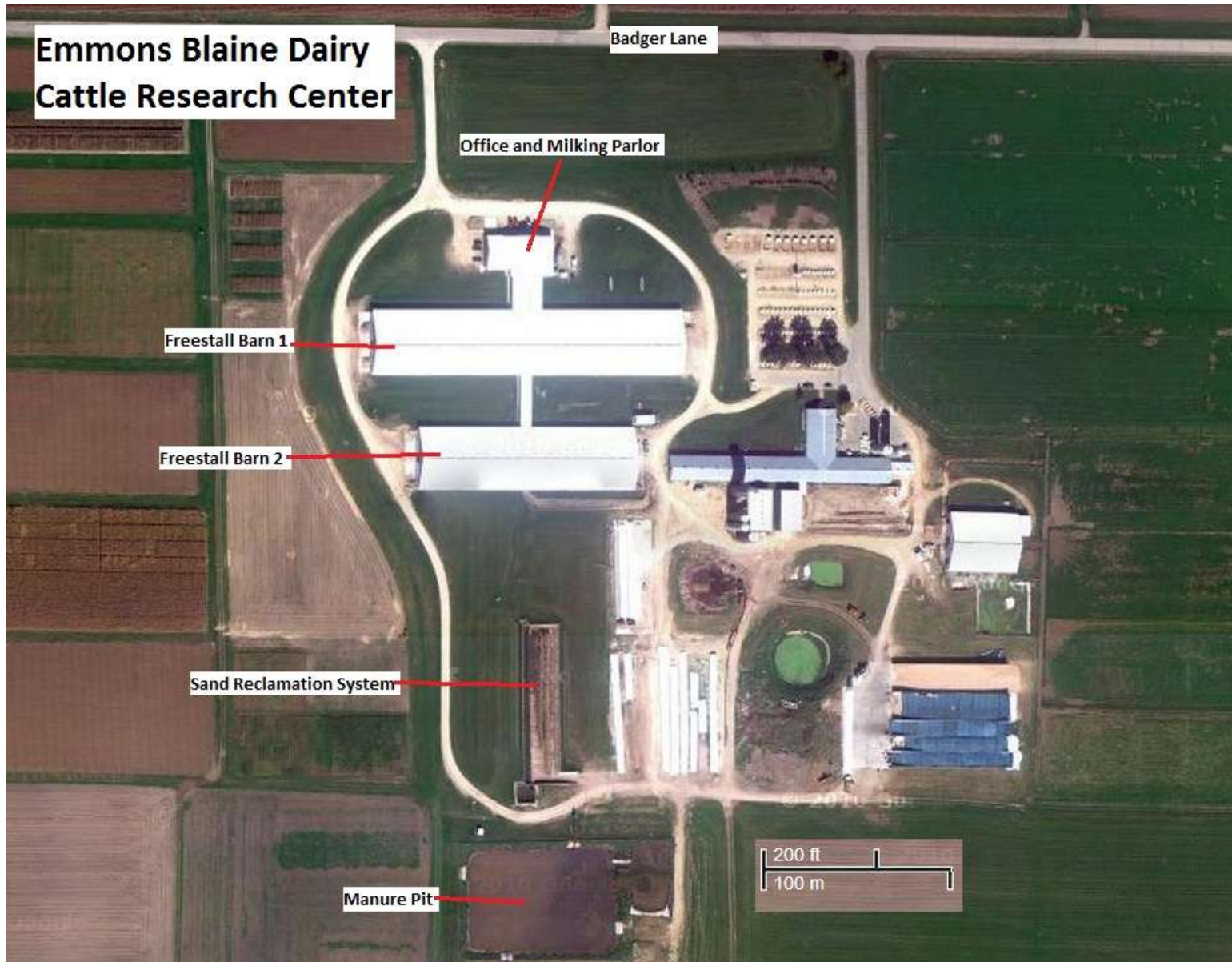
- **“Easy button” test: Establish quality assurance structure**

- Each participating state agency receives the assistance of DOA in managing the project from selection of the ESCO through establishment of the measurement and verification (M&V). The state agency role includes: coordinating site access during audits, assisting in construction coordination (if it chooses to do so), and handling measurement and verification (M&V) after the initial 1-3 year M&V and commissioning period (which is managed by the ESCO).
- The participating agency receives a complete package of services from an ESCO. The ESCO provides a facility energy audit; develops a cost effective proposal; as well as installs, commissions, and conducts the **initial monitoring** of the project.

Case Study: University of WI Arlington Agricultural Research Station



Dairy Barn Aerial View



Fast Facts

- Complex built in 2008
- Consists of 3 buildings
 - Office and milking parlor
 - Freestall barn 1
 - Freestall barn 2
- Currently houses 547 cows
- Lighting retrofit complete
 - installed high bay T-8's in September 2012.
- The Wisconsin Idea: The Wisconsin Idea is the principle that the university should improve people's lives beyond the classroom. It spans UW–Madison's teaching, research, outreach and public service.



WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

Cow Facts

- 487 milking cows and 60 dry cows.
- Average cow weighs 1450 lbs.
- Each cow is milked twice a day.
- Average milk production per cow per day: 91.7 lbs
- Average food consumption is 52,000 lbs of feed per day (107 lbs of food per cow per day)

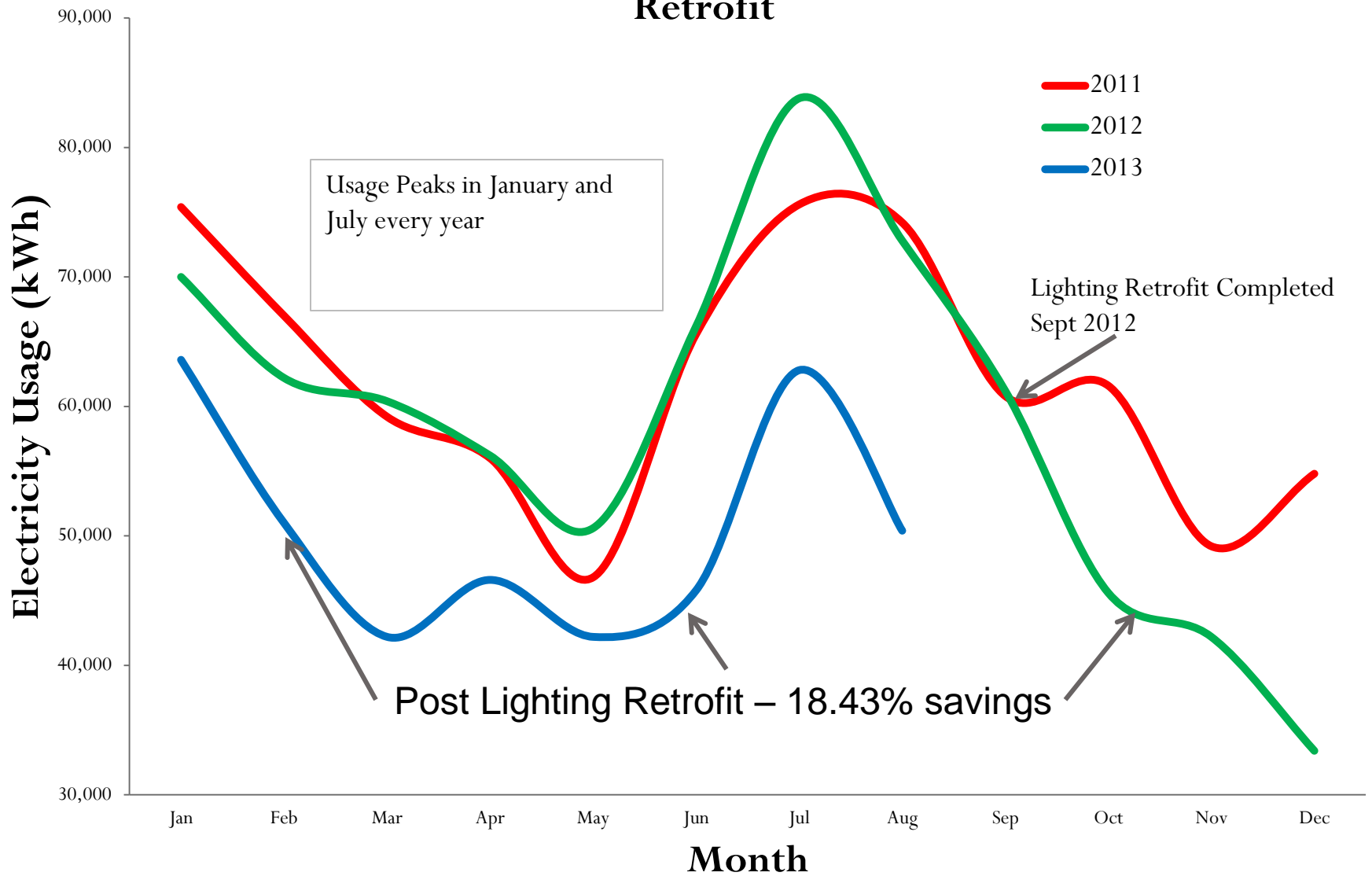


Getting to Net Zero: Phase 1: Efficiency

- Cow environment cannot be disturbed by construction- not a typical retrofit. Lighting completed September 2012.

	Average Monthly Electricity Usage	Average Monthly Electric Bill
Before Lighting Retrofit (Sept 2010–Aug 2012)	60,308 kWh	\$5,416
After Lighting Retrofit (Sept 2012–Aug 2013)	48,917 kWh	\$4,418
Monthly Savings	11,392 kWh	\$998
Percent Reduction	18.89%	18.43%

Arlington Dairy Barn Electricity Use, Pre and Post Lighting Retrofit



Other Efficiency Measures

- Investment Grade Audit is forthcoming- preliminary audit revealed a few good opportunities:
- 43 industrial size fans- potential for motor retrofit
 - Operate 24/7 during the summer months
 - Fan usage accounts for 31,854kWh/month in summer
 - 43.62% of Summer usage before lighting retrofit (June-August, 2011 and 2012)
- Alley Scraper
 - Operates 24/7 in the winter to prevent manure from freezing in the alley
- Well pump motor retrofit
- Chiller upgrade to existing milk cooling system
- Ozone laundry system for dairy

Phase 2: Generate Energy

250 kW Solar Array



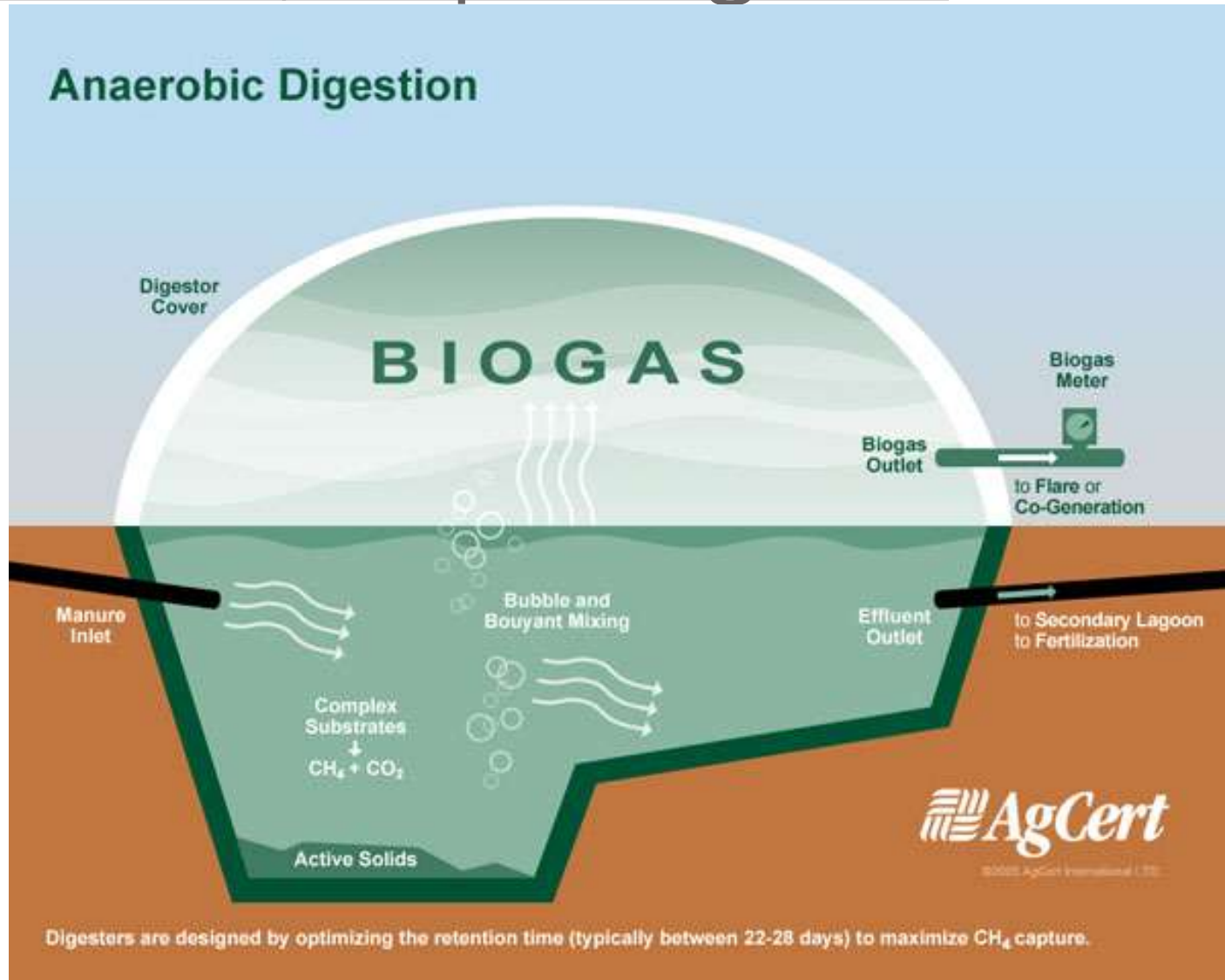
Phase 2, Step 1: Solar Panels

- The favorable pitch of the South-facing barns provides an effective way to offset grid energy usage with solar panels.
- A 250 kW roof-mounted system could generate 298,514 kWh a year, or 50.85% of the total yearly electricity usage of the barn.
(*NREL PVWatts v.2*)

Peak Shaving

- Utility On-Peak time is from 8am to 10pm Monday-Friday
- WI SEO is awaiting peak data for final analysis- solar production should coincide with peak charges.
- Peak rates or Demand Charges account for 30% of Arlington Research Station Energy Bill

Phase 2, Step 2: Digester



Phase 2, Step 2: Digester

- Methane produce by digesting manure is much easier to store than excess solar energy.
- Dairy cow manure is very high in methane, the possibility to co-op different animal feedstocks (1500 swine, 250 beef cows, 547 dairy cows) increases total methane output
- Example of high production smaller-scale digester:
- AA Dairy (Upstate New York)
 - 550 Holstein-Friesian cows
 - Produced 1,433 kWh/day (526,695 kWh/year)
 - Would produce 89.73% of electricity used in the last year at the barn
 - 130 kW engine has been in operation since 1998

Feedstocks – Manure Ponds



Dairy Cow Manure Pond



Swine Manure Pond

Stakeholders and Current Status

- One Million dollars of PRSB funds allocated
- University farmers are enthusiastic, cautious
- Division of Facilities Development Partnership is developing
- Structural analysis and ESCO selection
- Project must be replicable and cost effective above all else.

Conclusion

Electricity Savings	
Total usage before Retrofits or Renewables	687,180 kWh/year
Lighting Savings	136,700 kWh/year
250kW Solar Production Estimate*	298,514 kWh/year
Digester Production Estimate*	526,695 kWh/year
Total Savings*	(274,729) kWh/year

- With the lighting retrofit, solar production, and digester production, the farm **could potentially produce an excess 274,729 kWh/year**.
- Resulting in an average savings of \$58,574 per year
- Potential to create \$24,687 worth of electricity per year- depending on buyback rate, digester efficiency and other variables.