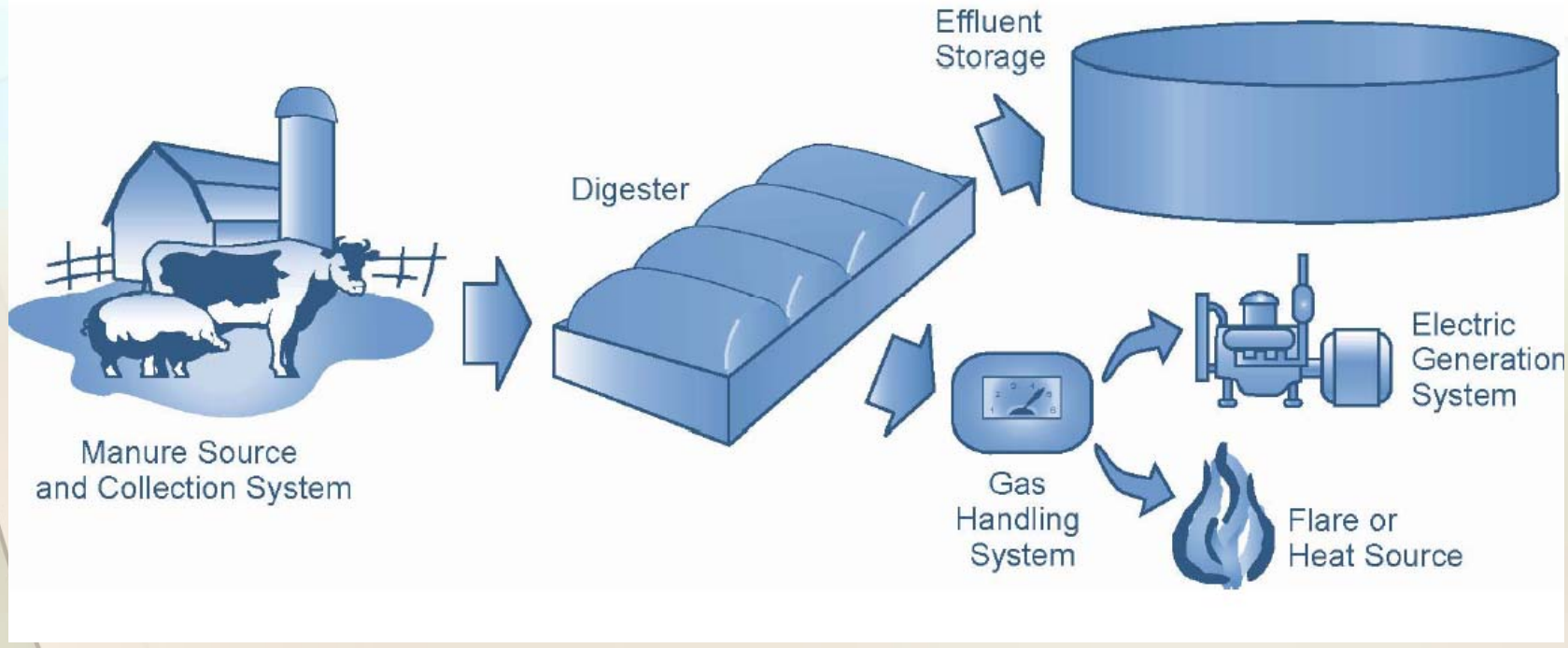
Digester Technology: Trends & Costs

William F. Lazarus
Department of Applied Economics
University of Minnesota

Transition to a Bioeconomy: The Role of Extension

June 30 – July 1, 2009
Double Tree Hotel, Little Rock, Arkansas

Components of a Typical Digester System



Source: Thompson and Voell, Introduction to Anaerobic Digester Biogas Systems, Nebraska Methane Recovery Workshop, 4/3/09

Potential Sources of Value from a Digester

- **Energy**
- **Odor Control**
- **Methane (Greenhouse Gas) Destruction**
- **Reduction in Pathogens and Oxygen Demand**

(If coupled with solids separation equipment)

- ***Solids (Fiber) for Bedding or as a Soil Amendment***
- ***Phosphorus and Nitrogen Reduction***

Digester Designs and Components

Covered lagoon digester

Complete mixed digester

Plug flow digester

Engine-generator set


Haubenschild Farms Plug Flow Digester, Princeton, MN


Fangel biogas digester in Denmark

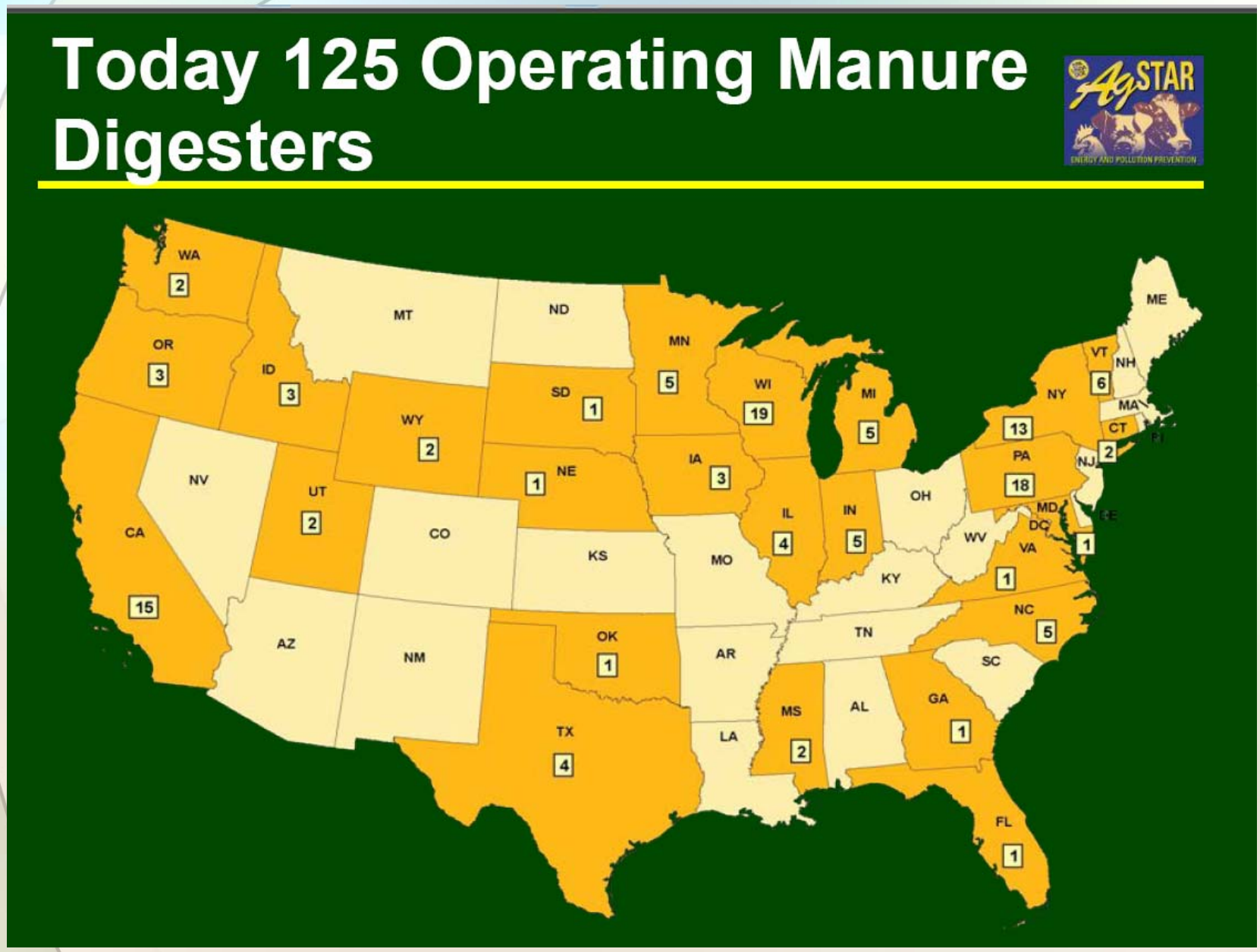
Digester Projects by Operational Status

Farm Type	Operational	Construction	Planned	Total
Dairy	107	18	55	180
Swine	19		6	25
Layers	3	1		4
Duck	2			2
Broiler	1			1
Beef	2	2	1	5
Mixed	1	1	1	3
Veal			1	1
Total	135	22	64	221

Electrical generation equipment is installed on 113 of the 135 operational systems.

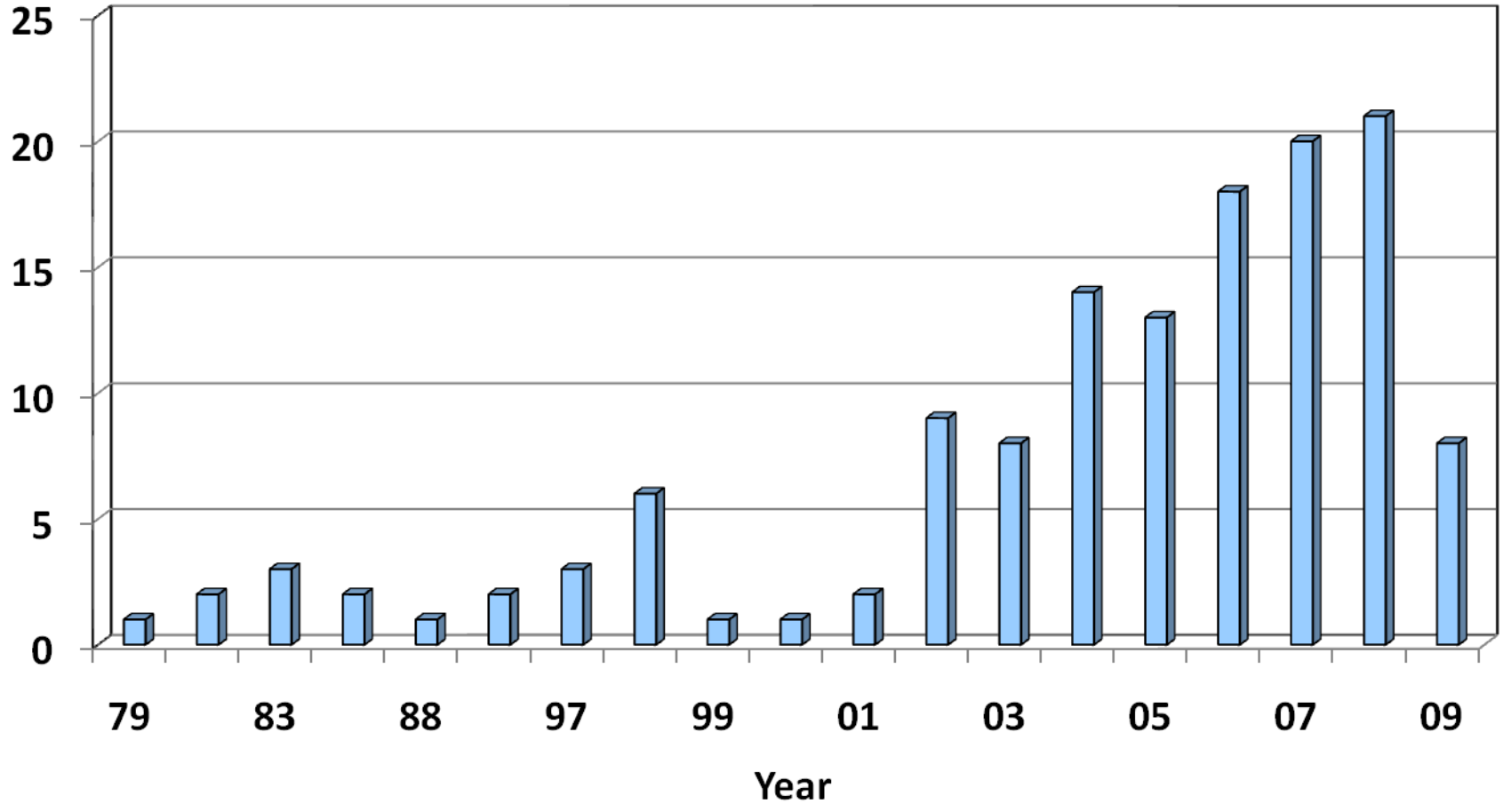
Source: AgSTAR

Today 125 Operating Manure Digesters



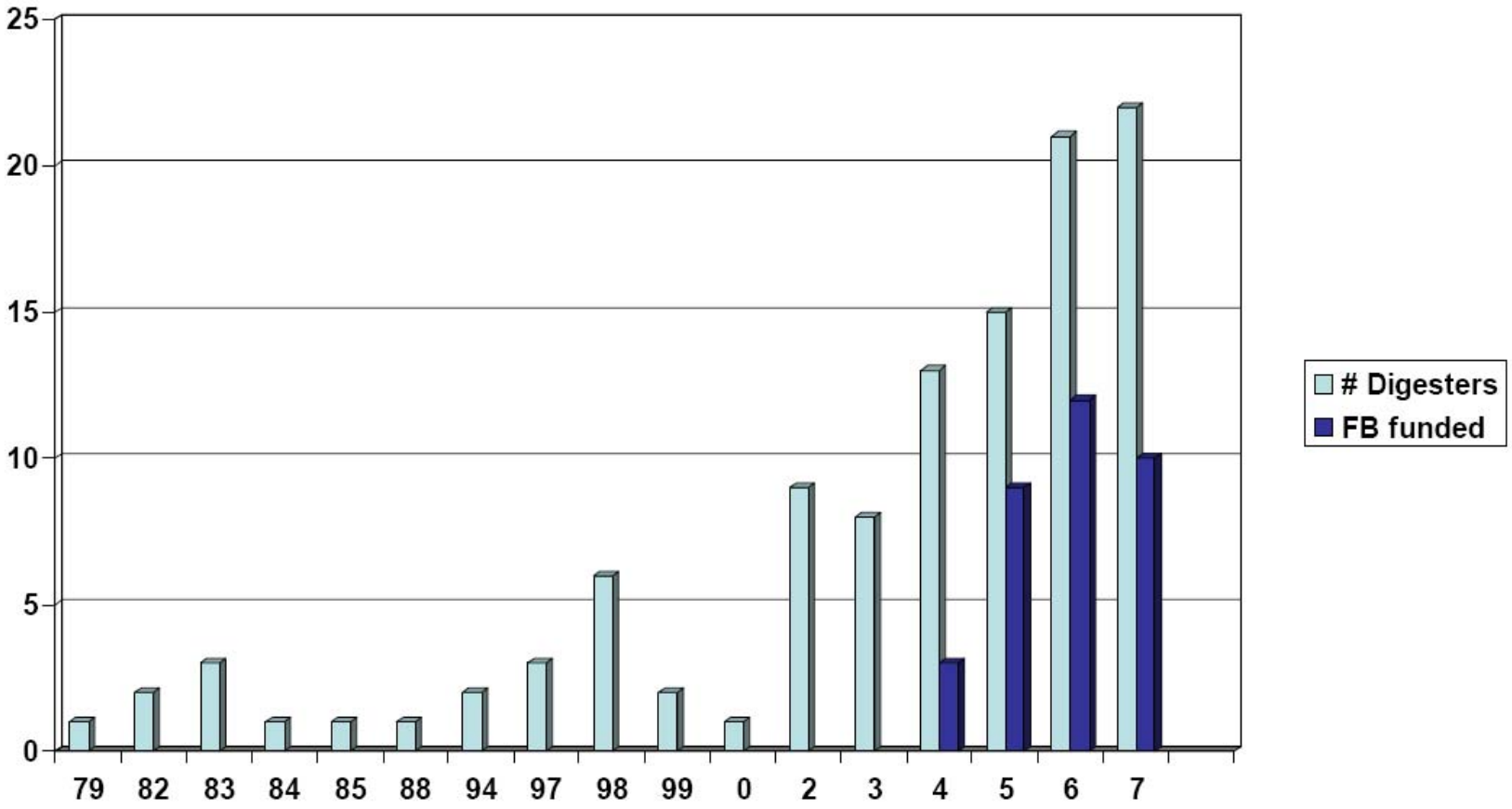
Source: Kurt Roos, Expansion of the U.S. Digester Market in the Dairy and Pork Sector, 2009 AgSTAR National Conference, Baltimore, 2/24/09

Number of Digesters Becoming Operational by Year (1979-2009)



Source: AgSTAR

Number of Digesters Becoming Operational Per Year (1979-2008)



Source: Thompson and Voell, Introduction to Anaerobic Digester Biogas Systems, Nebraska Methane Recovery Workshop, 4/3/09

How Much Can Biogas Contribute to the Energy Supply?

- The 35 MW generating capacity of the currently-operating U.S. farm digesters compares to total U.S. electrical generating capacity of 1,067,010 MW.
- AgSTAR estimates that 6,500 large dairy and swine operations could potentially operate profitable biogas systems and provide 802 MW (0.1% of the U.S. total).
- In Germany, over 3,700 biogas plants are in operation with a combined capacity of 1,270 MW. This would represent around 1% of Germany's electricity needs.

Sources: EPA AgSTAR, EIA, German Energy Agency.

Assumptions for Economic Scenarios

Investment Requirement:

Regression equation based on 16 recent plug-flow digesters:

$678,064 + $563/dairy cow

Utility connection charges and H2S treatment could add ~ 13%

Investment requirement at two example farm sizes:

700 cows -	$1.2 million	$1,714/cow
2,800 cows -	$2.5 million	$893/cow

Capital cost (6%, 20 year life): 9% of investment/year

Operation and maintenance costs: 5% of investment/year?

Electricity output: 1,000 KWH/cow/year

Sources: Investment equation from Crenshaw, electricity output from Gooch.

Typical Digester Electricity Pricing Arrangements

- Buy all – sell all
- Surplus sale with standby charges
- Net metering

Economic Scenarios

	700 cows	2,800 cows
Investment	$1.2 million	$2.5 million
Electricity breakeven prices (cents/KWH)		
• No subsidies or other value	22 cents	12 cents
• REAP grant 25% of investment	18	10
• REAP grant & bedding value	14	6

Electricity market

- Retail price (EIA, 4/09): U.S. average 9 cents
  range 5 cents (ID) to 16 cents (CT)
- Generation cost (my estimates): average 5.4 cents
  range 2 cents (ND) to 11 cents (CT)

Value of odor control, carbon credits, RECs, pathogen reduction, other??

Trends and New Developments

Policy

- Developing carbon markets, partly in anticipation of a U.S. mandatory policy
- Concerns about engine NOx emissions
- Tighter limits on nutrient emissions, emergence of water quality trading

Technical

- New designs, pretreatment techniques and larger digester sizes
- Cheaper systems for removing H2S and other biogas impurities
- More digesters on swine and poultry operations?
- Digesters integrated into further treatment systems to reduce nutrient emissions
- Co-digestion with organic wastes from off-farm sources
- Biogas injection into the natural gas grid or compressed for vehicle use

Economic/information

- More involvement of third parties in operation and ownership of digester systems

Thank you!

Questions?