Animal Waste Technologies to Reduce Greenhouse Gas Emissions in Maryland

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UNIVERSITY OF MARYLAND EXTENSION

AgFS Agriculture & Food Systems

Presentation Outline

Manure in Maryland

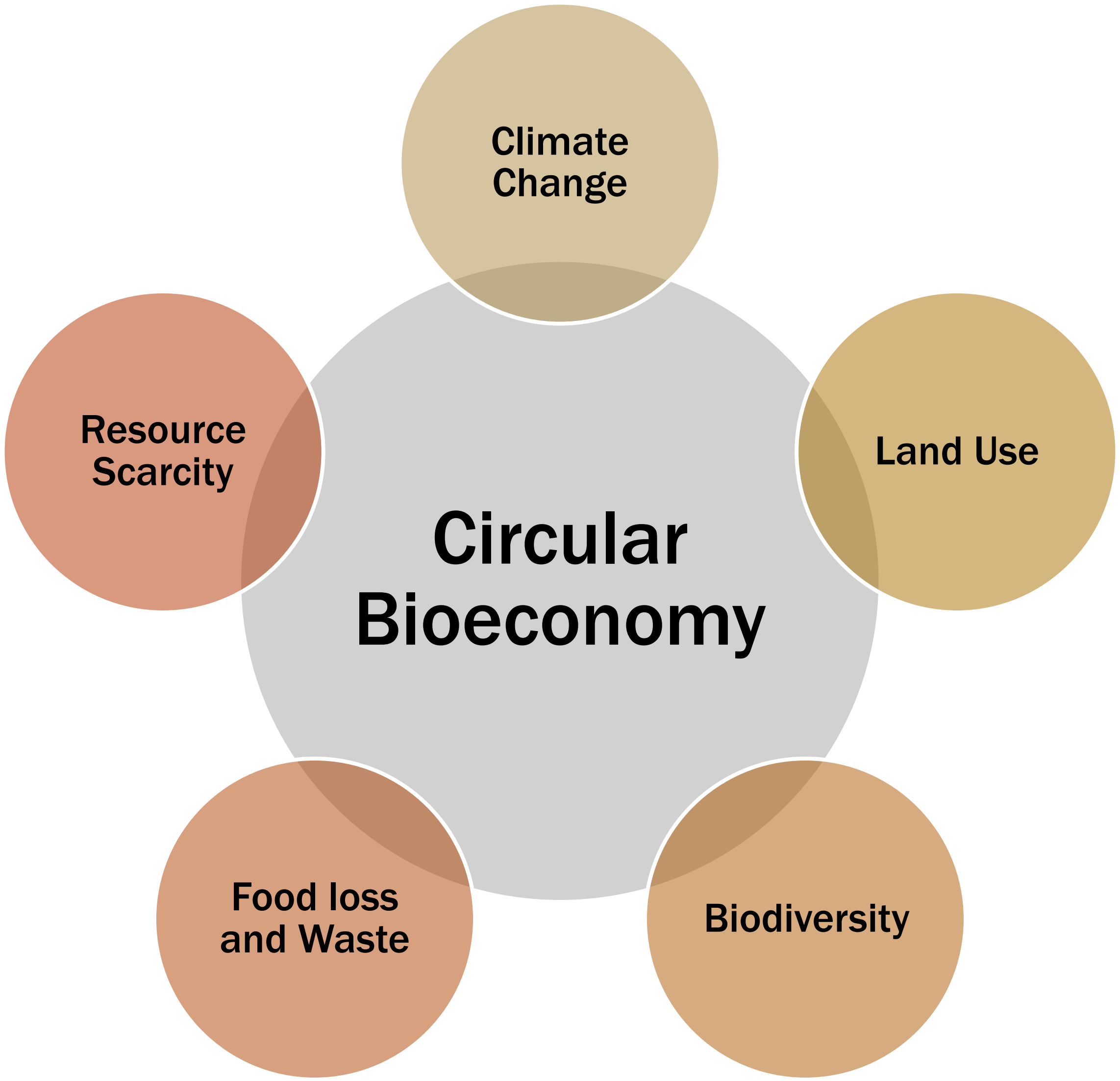
Animal Waste Technologies

Greenhouse Gas Emission Reductions

Food Waste

Research and Extension in a Circular Bioeconomy

Approach: Integrating research and extension within a Circular Bioeconomy using biotechnologies.



Animal Waste Technology Evaluation

Animal Waste Technologies evaluated: Anaerobic Digestion, Composting, Thermochemical processing, Manure Injection.

Interviews, surveys, and focus groups helped us gauge understanding and acceptance of the technologies, expected future changes, and the effect of these technologies on surrounding communities through an environmental justice (EJ) perspective.

Maryland Animal Waste Technology Assessment and Strategy Planning

Funded by Maryland Department of Agriculture (MDA)'s Animal Waste Technology Fund

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Report, FactSheets, and more information at https://go.umd.edu/AWTF

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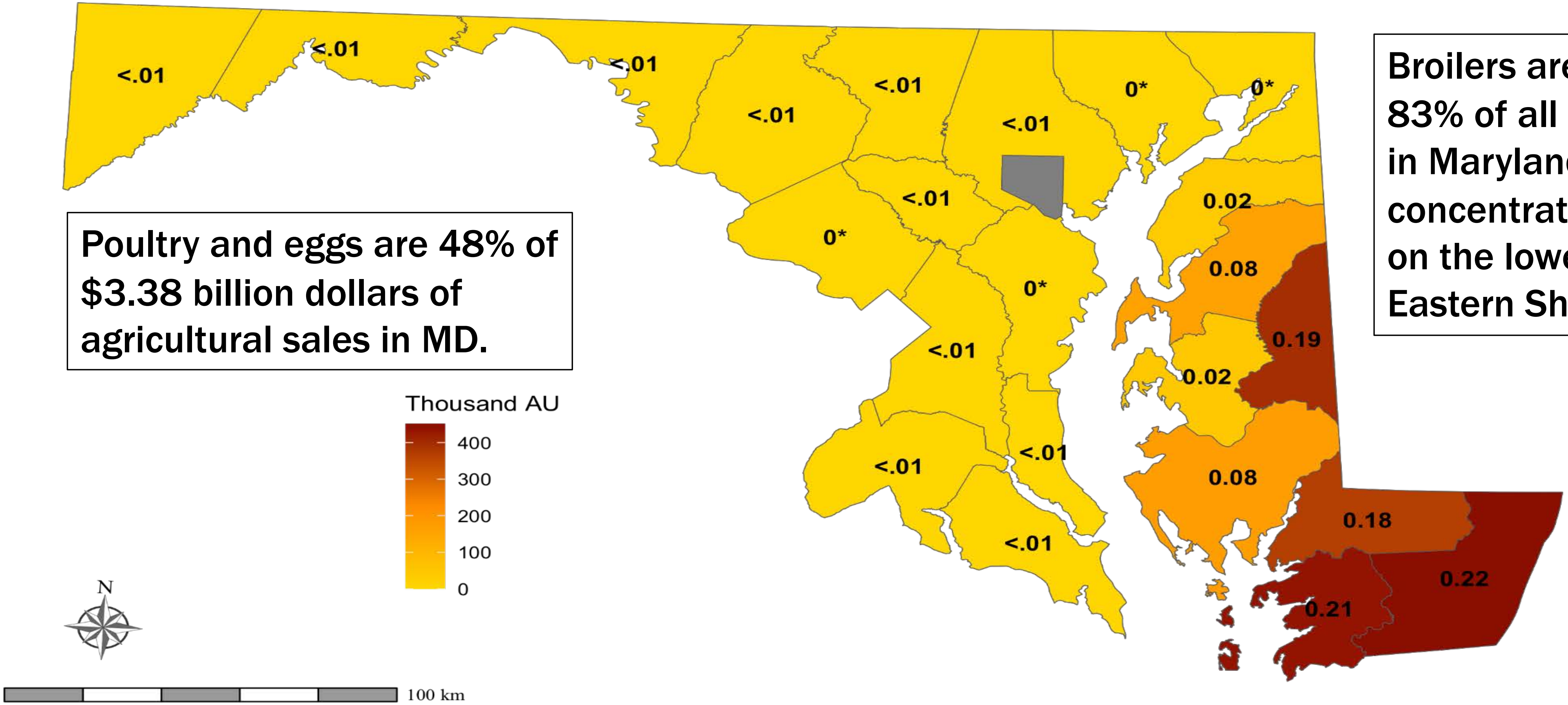
Broiler Operations in Maryland



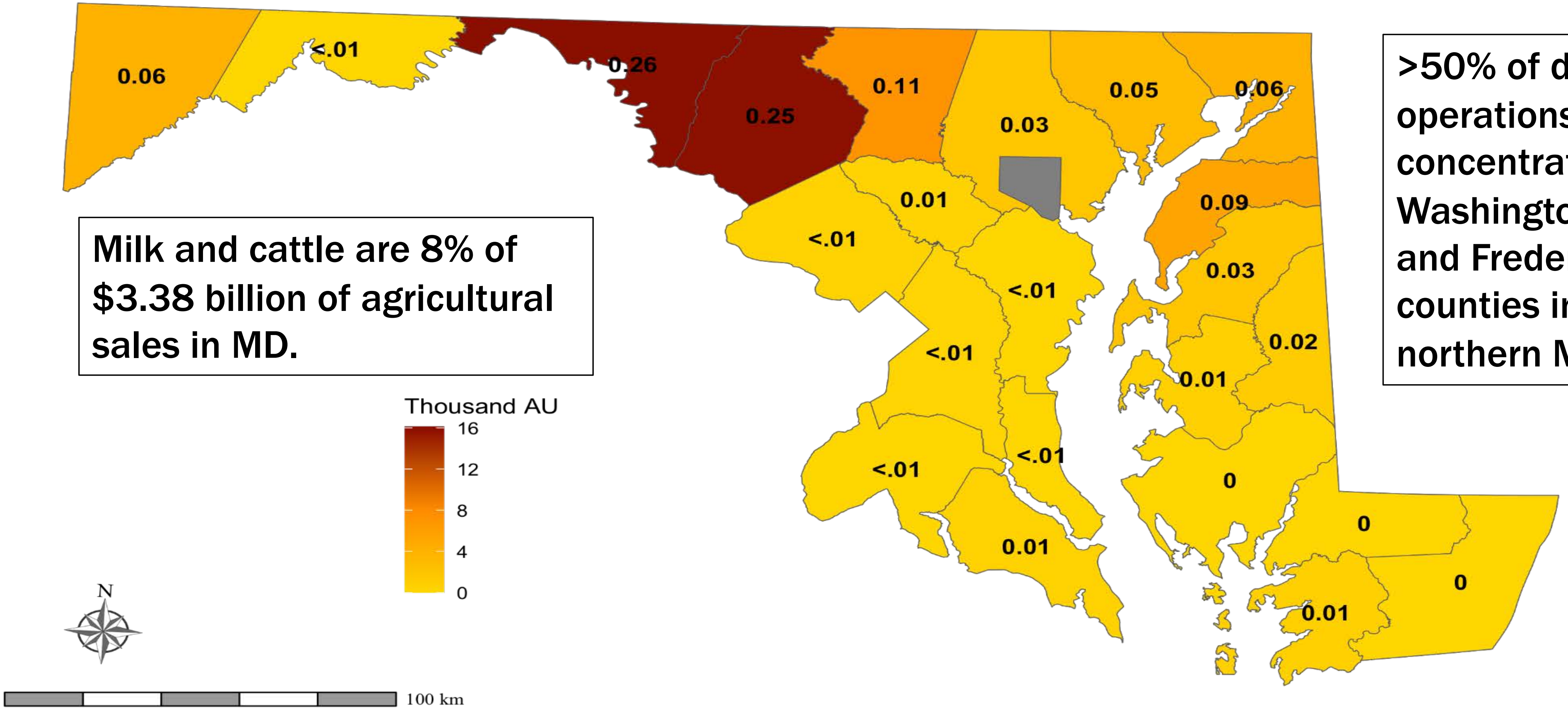
Poultry and eggs are 48% of $3.38 billion dollars of agricultural sales in MD.

Broilers are 83% of all AUs in Maryland, concentrated on the lower Eastern Shore.

Figure shows percent of Animal Units (AU) in each county, with shading showing total count of AUs (in thousands).
Animal Units (AU) conversion: 1,000 lb cow = 1 AU; Approximately 125 chickens = 1 AU.

Dairy Operations in Maryland

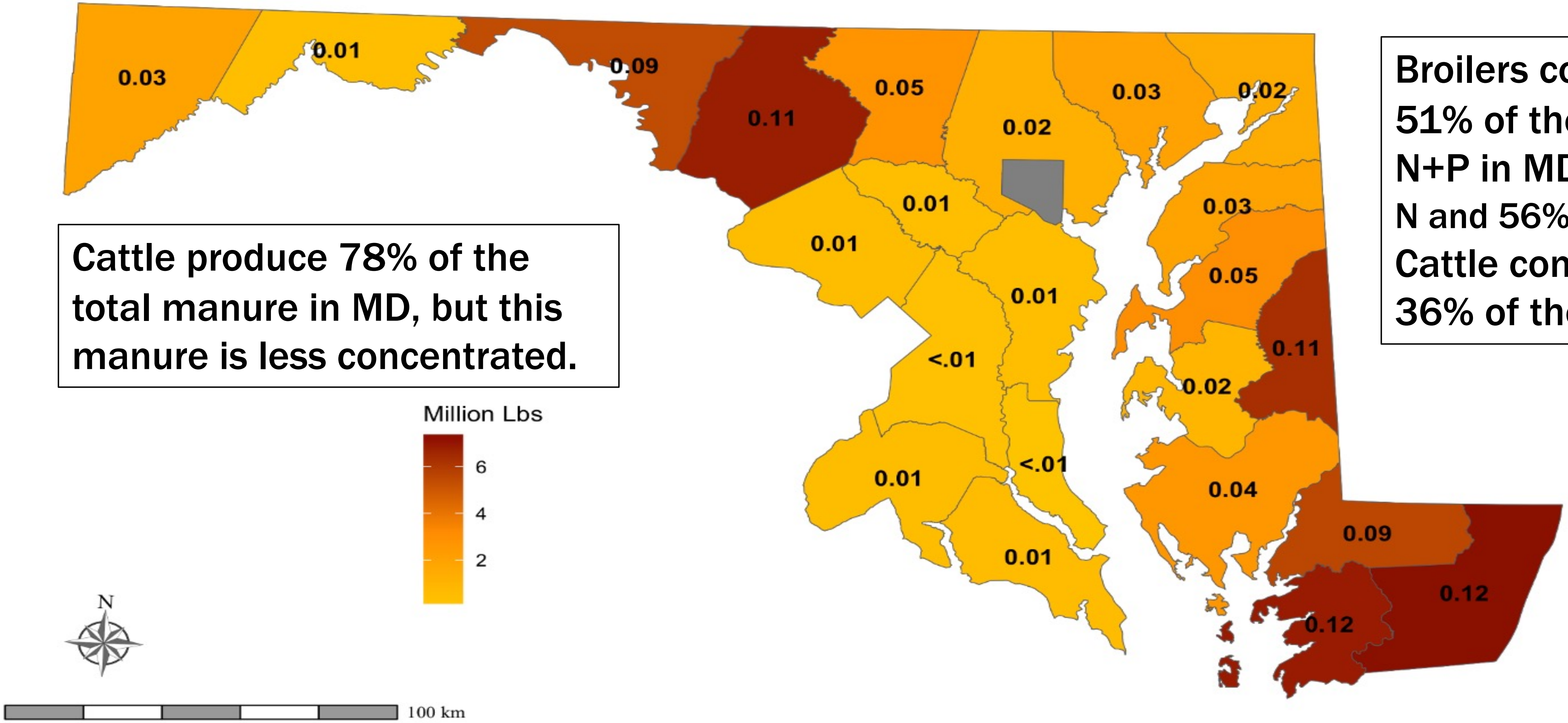
Milk and cattle are 8% of $3.38 billion of agricultural sales in MD.



>50% of dairy operations are concentrated in Washington and Frederick counties in northern MD.

Figure shows percent of Animal Units (AU) in each county, with shading showing total count of AUs (in thousands). Animal Units (AU) conversion: 1,000 lb cow = 1 AU; Approximately 125 chickens = 1 AU.

Manure and Nutrients in Manure



Cattle produce 78% of the total manure in MD, but this manure is less concentrated.

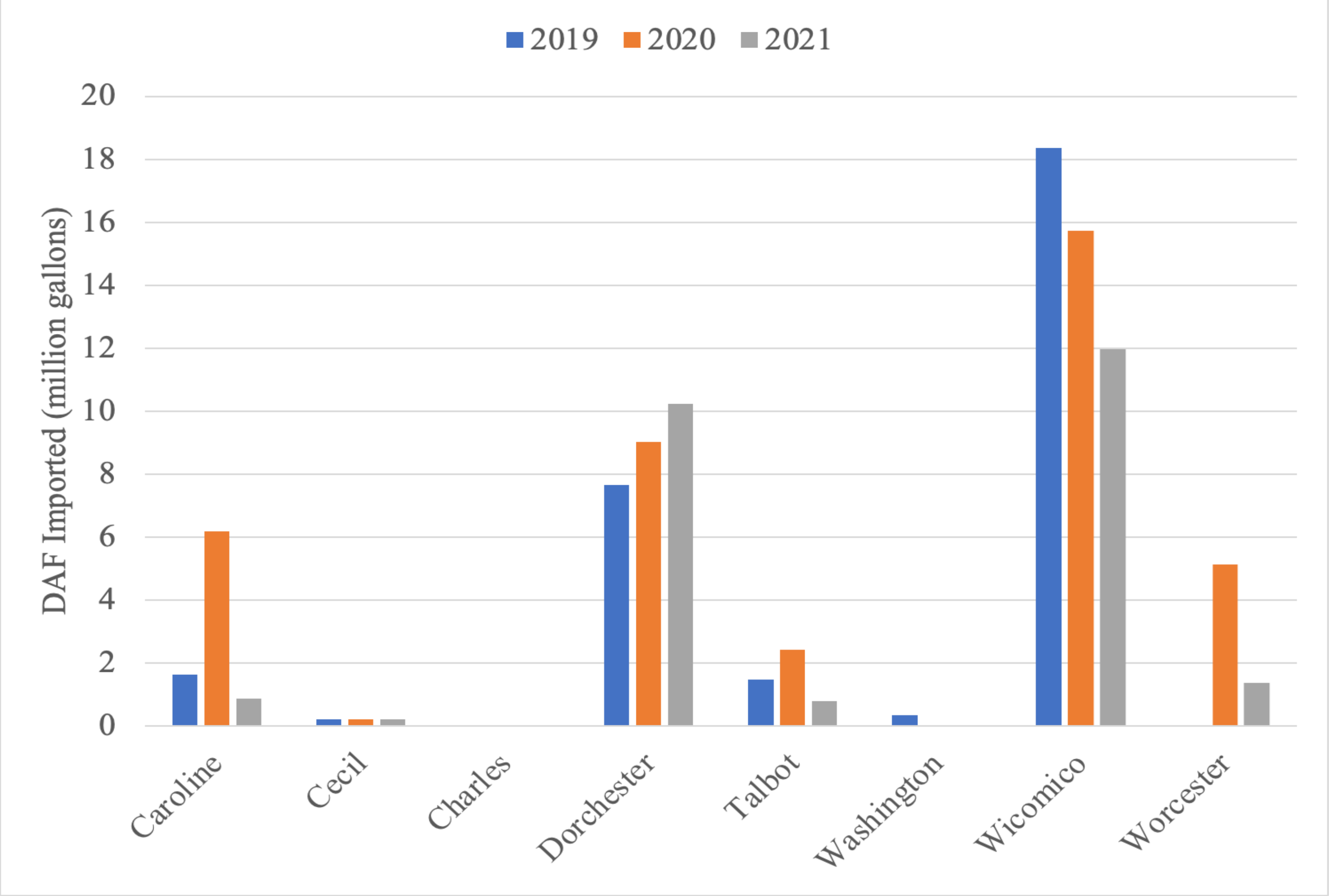
Broilers contribute 51% of the total N+P in MD (43% of N and 56% of P). Cattle contribute 36% of the N+P.

Figure shows percent of N+P mass for each county (in million lbs.), shading showing the lbs of N+ P (millions).

Food Residual Processing Waste

- Dissolved air flotation (DAF) is a byproduct from food processing facilities that contains nutrients that can be used to grow crops.
- DAF is composed of solids, proteins, and fat (with their associated nutrients) that rise to the surface and removed by mechanical scraping during waste processing from food processing facilities, with the remaining water cleaned and discharged.

Dissolved Air Flotation (DAF) Utilization in Maryland



DAF is 93% water and N:P ratio of 1.5 : 1 : 0.

72% of DAF (2022) was generated out of state (85% in 2019).

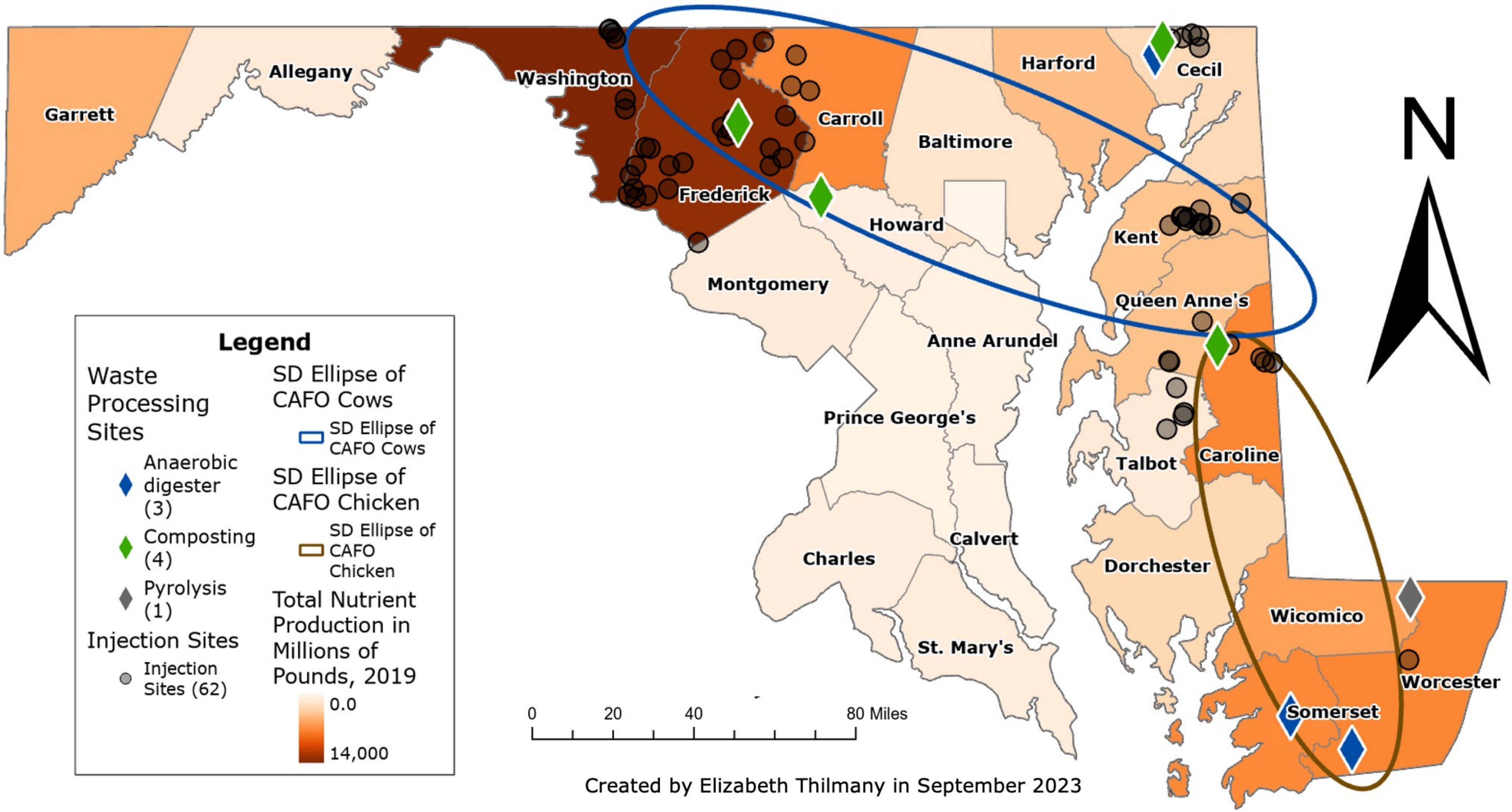
DAF imports moved to PA (increased from 0.8 to 6.8 million gallons) from 2020 to 2022.

Figure shows percent of DAF imported into each county for field application (in million gallons) for 2019-2021.

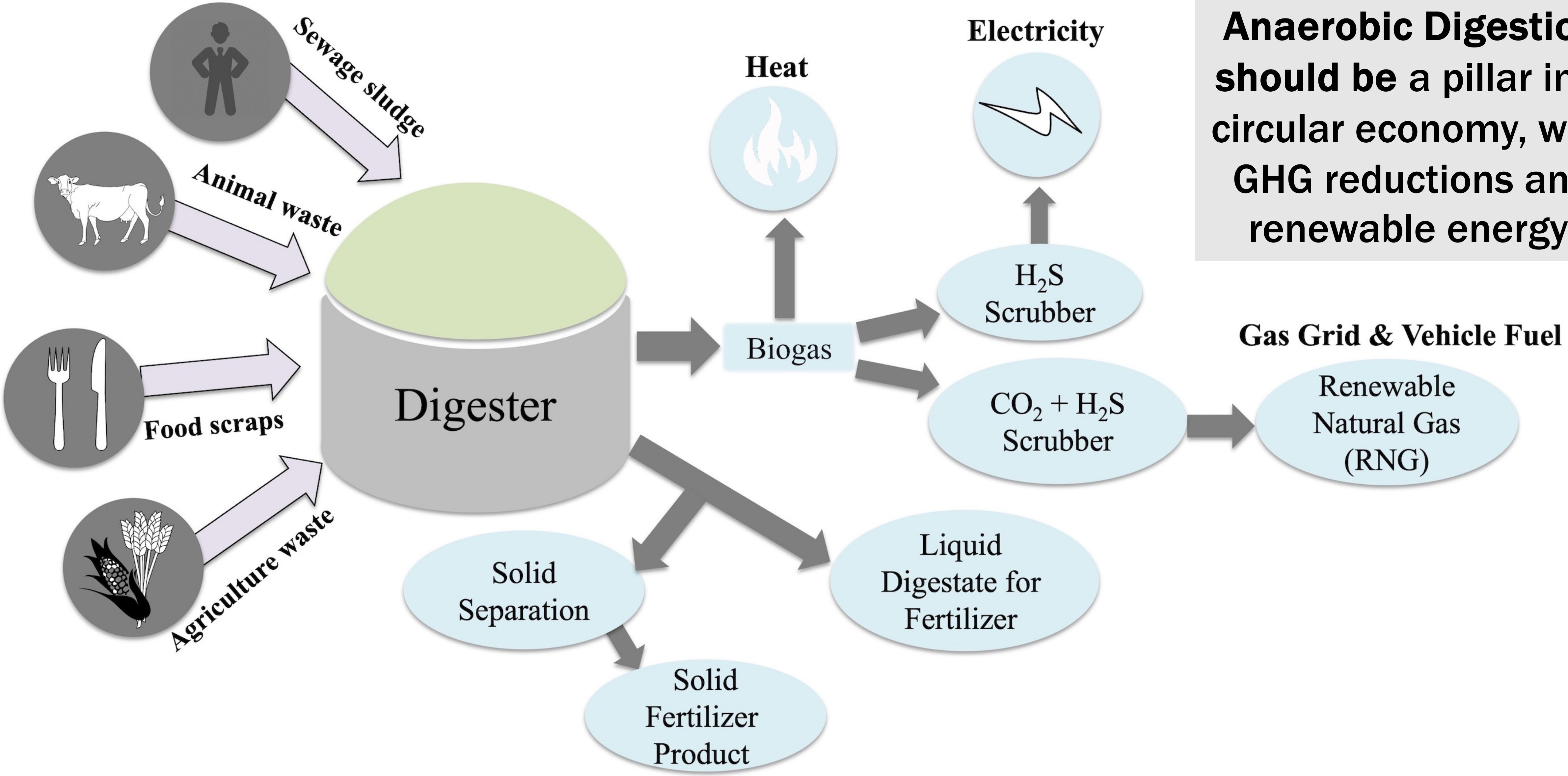
Animal Waste Technologies

- Anaerobic Digestion
- Composting
- Thermochemical Processing (create biochar)
- Injection

Livestock, Poultry, and Waste Technologies in Maryland



Anaerobic Digestion

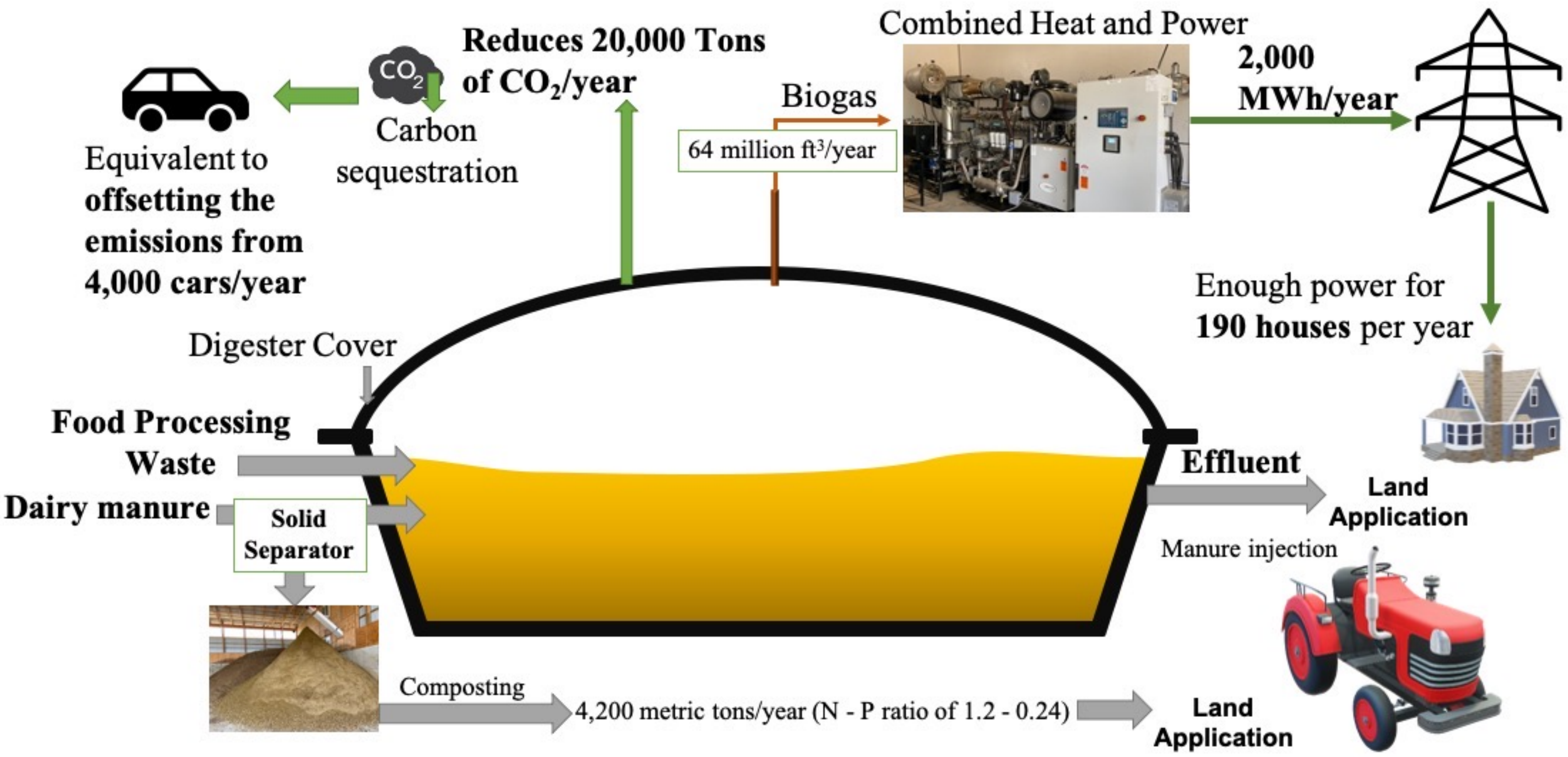


Anaerobic Digestion should be a pillar in a circular economy, with GHG reductions and renewable energy.

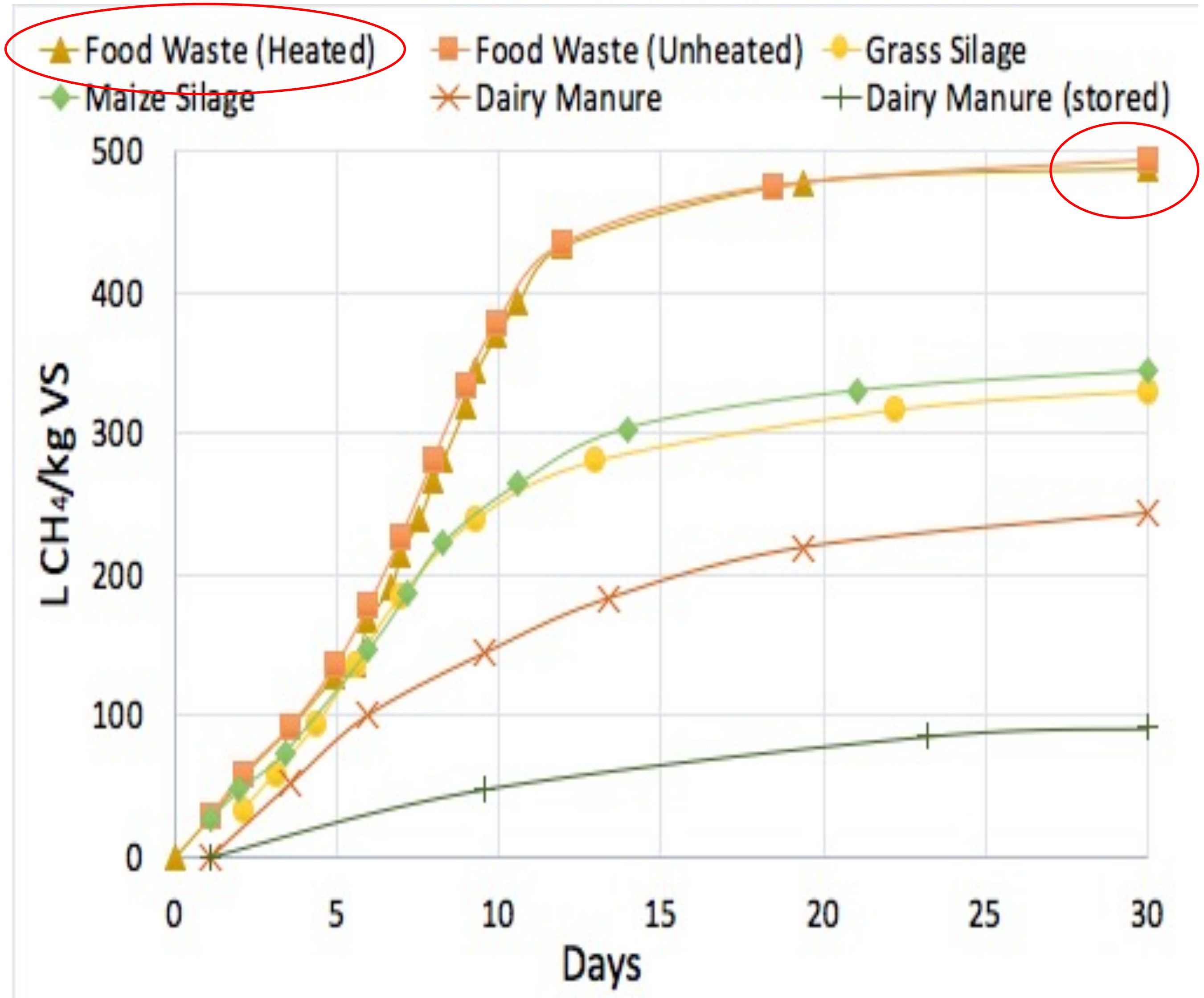
Anaerobic Digestion – Waste to Energy

Covered lagoon digester treating dairy manure and food waste, producing renewable electricity and reducing GHG emissions - Cecil County, MD

Anaerobic Digestion – Cecil County, MD

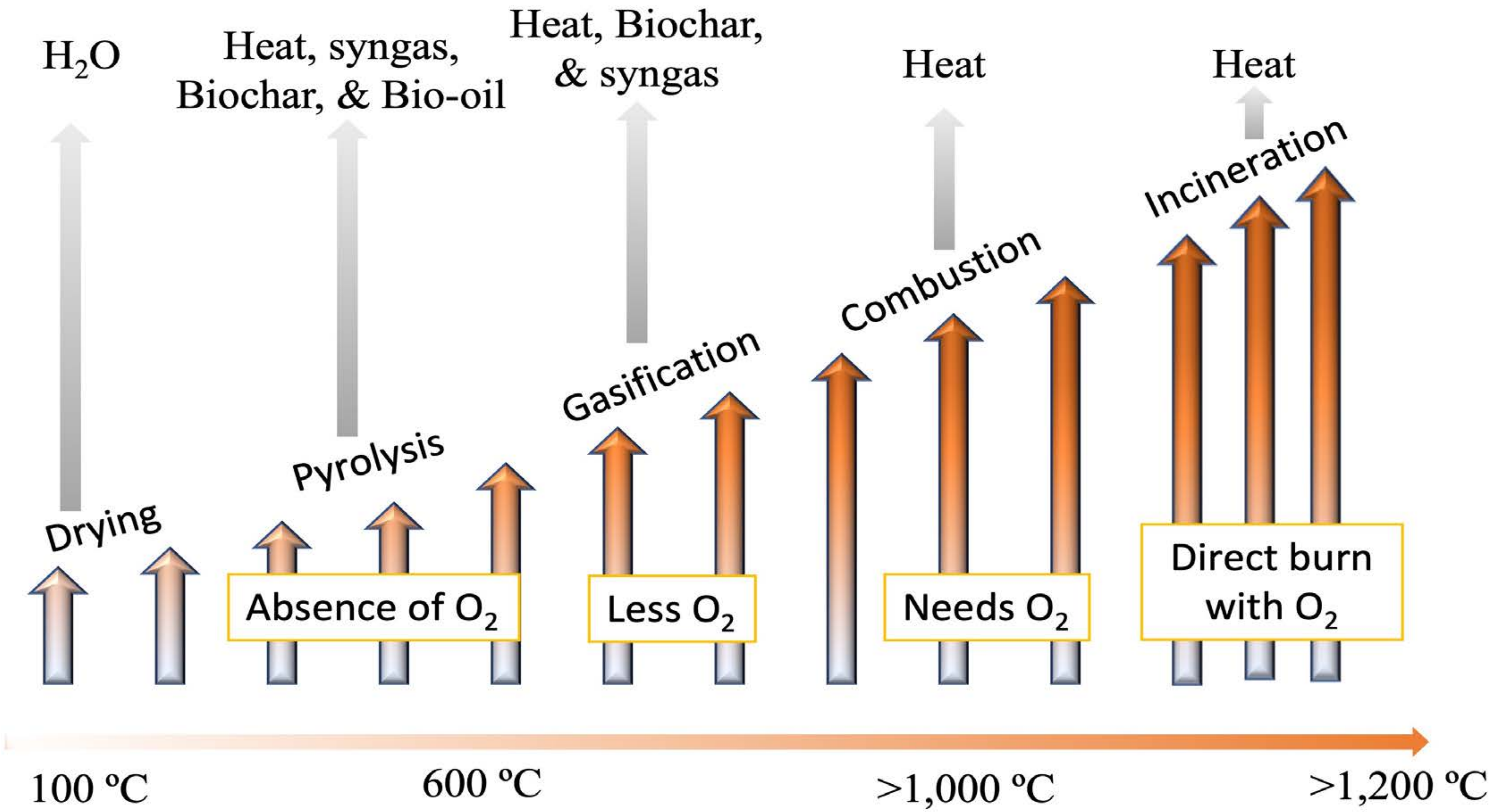


Food Waste Co-digestion at a German Farm



- Food waste increased gas production by 400% and maize silage by 275% compared to only digesting manure.
- Food waste had 90% of the energy produced in the first 14 days compared to fresh manure with 50% in this time.
- 70% of the energy was from food waste, which was < 1/4 of the digester volume.

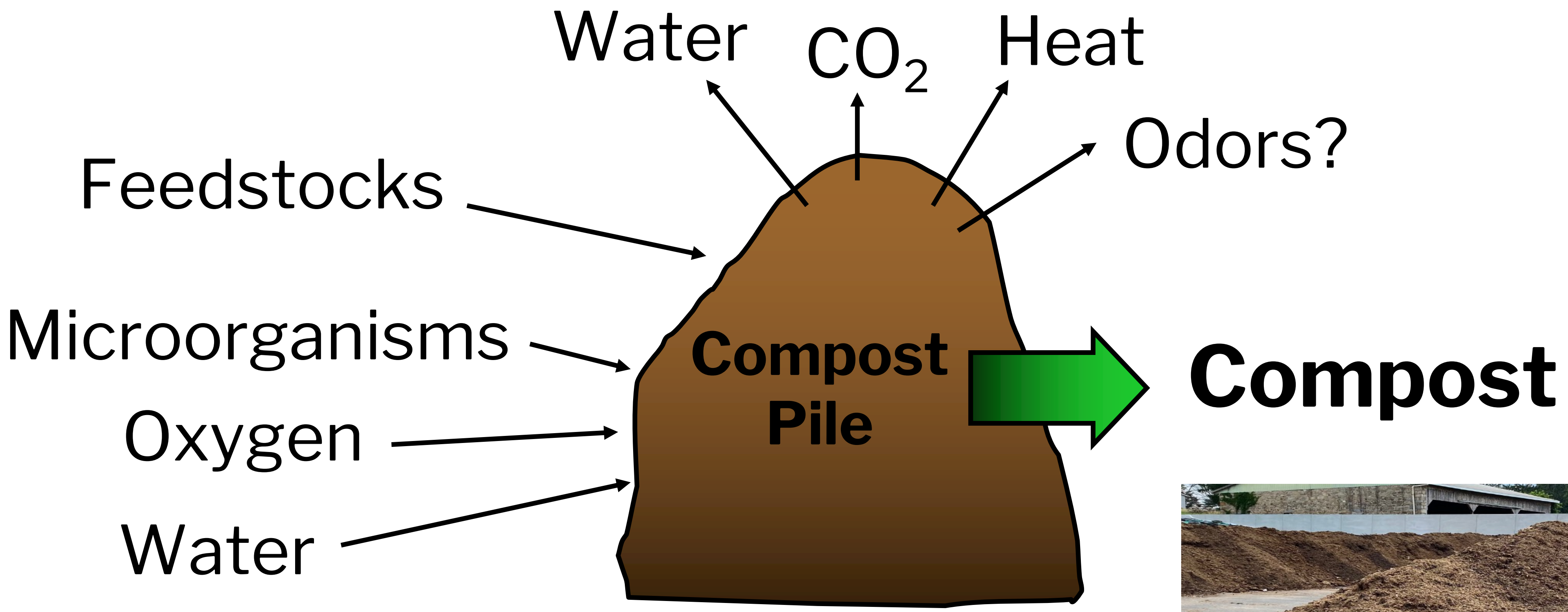
Thermochemical Processing



Biochar Sorption

- Sorption studies have shown that the addition of biochar can sorb excess nutrients, metals, and enhance soil properties.
- Important to understand the source of the biochar to understand its fertility properties.

Composting


Water
CO_2
Heat
Odors?
Feedstocks
Microorganisms
Oxygen
Water
Compost Pile
Compost

Manure or DAF Injection

Greenhouse Gas Emissions from Manure

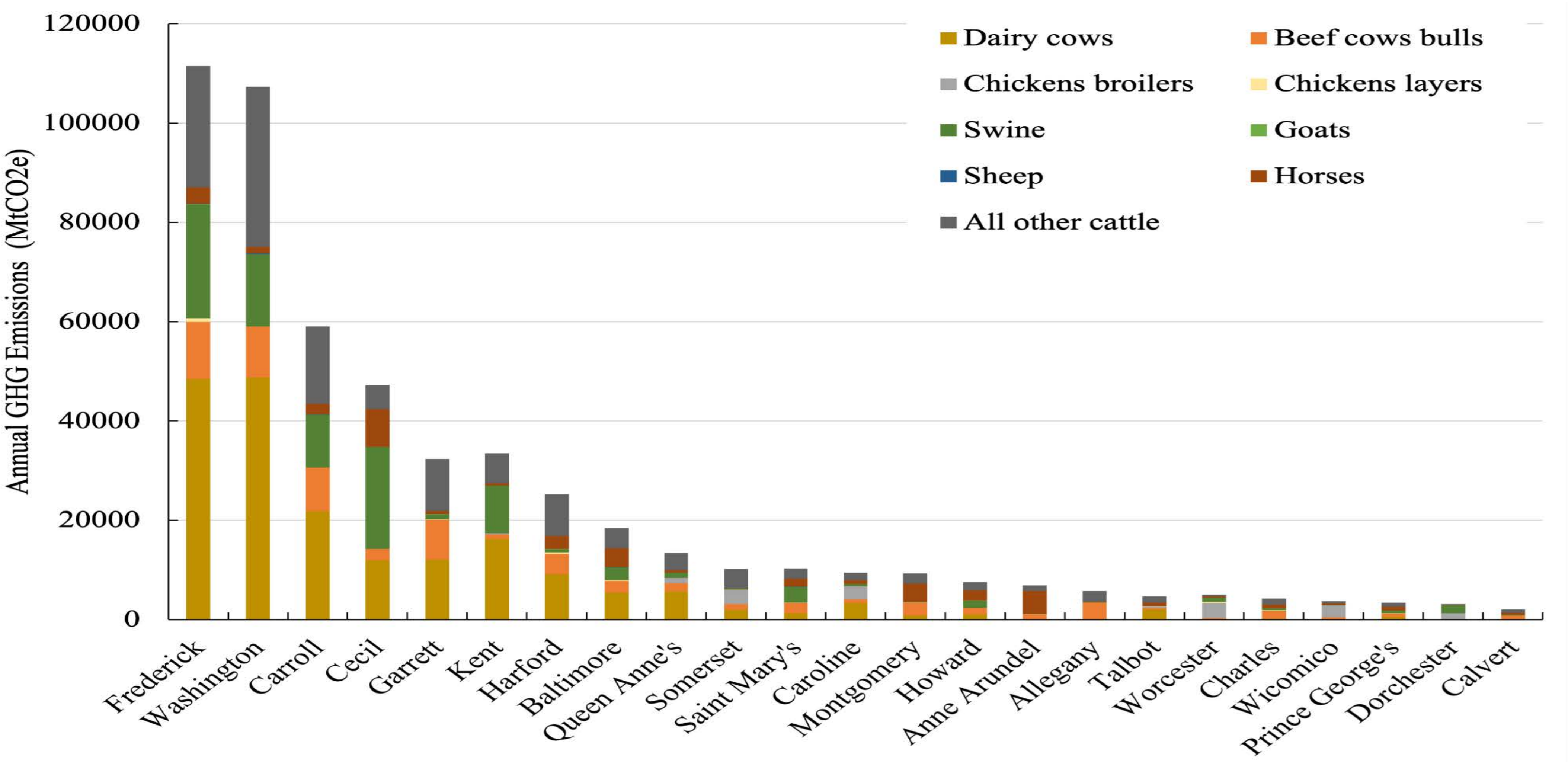


Figure shows annual greenhouse gas emissions from different manure sources located in each county.

Greenhouse Gas Emissions Reductions

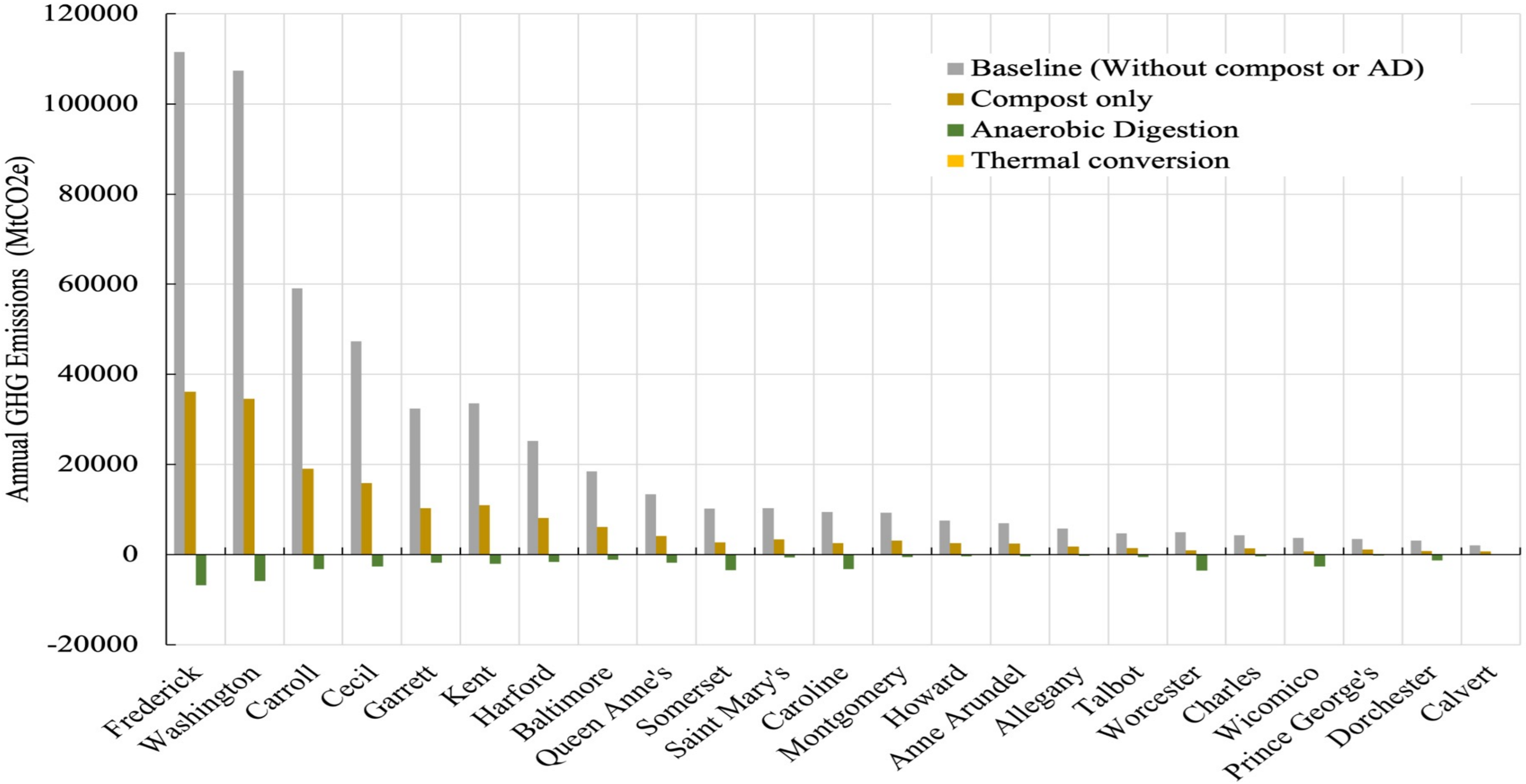


Figure shows annual greenhouse gas emissions reductions from employing animal waste technologies.

Greenhouse Gas Emissions from Manure in MD

CAFO Type	No waste technology (baseline) ($MtCO_2e$)	Compost ($MtCO_2e$)	Thermal conversion ($MtCO_2e$)	Anaerobic digestion ($MtCO_2e$)
Broiler Litter	4,200	517	30	-4,440
Layer Litter	4,260	541	34	-4,510
Dairy	147,000	49,200	-	-8,160
Horses	3,120	1,164	-	-173
Other Cattle	20,500	6,202	-	-1,123
Sheep and goats	2	1	-	-0.199
Swine	3,850	1,281	-	-215

Greenhouse gas emissions for all manure from confined animal feeding operations (CAFOs) in Maryland and GHG emission reductions implementing three animal waste technologies over one year.

Greenhouse Gas Emissions from Manure

	Annual GHG Emissions production ($MtCO_{2e}$)			
	Without Compost or AD or Thermal conversion (baseline)	Compost only	Thermal conversion	AD only
Dairy manure	70.4	23.5	-	-3.9
Other cattle	66	20	-	-3.62
Broiler litter	13.8	1.7	0.1	-14.6
Layer litter	12.6	1.6	0.1	-13.3
Swine manure	154	51.2	-	-8.58
Horses	85	31.8	-	-4.71

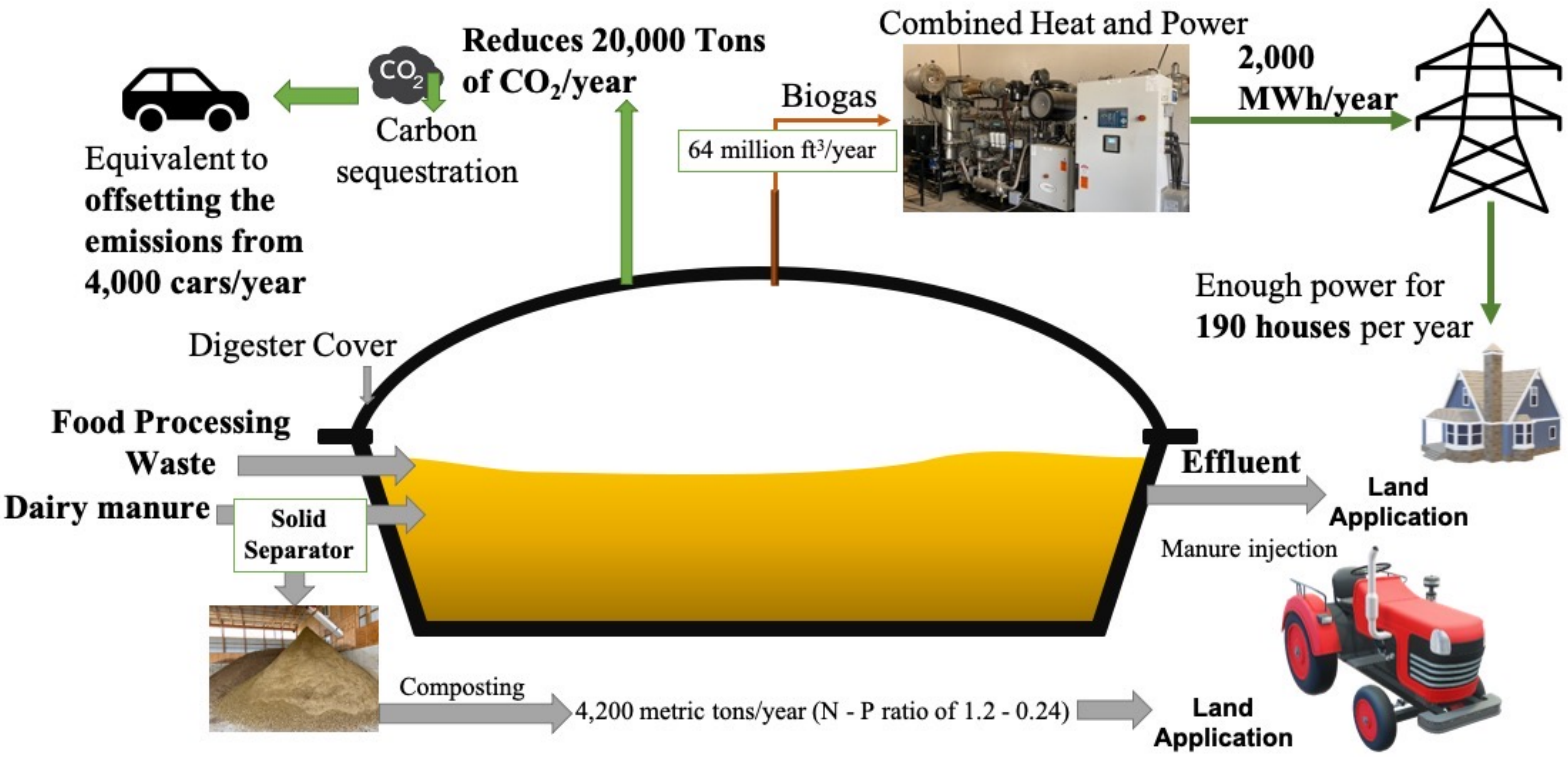
Annual greenhouse gas emissions from processing one one ton of manure per day and GHG emission reductions implementing three animal waste technologies over one year.

Anaerobic Digestion: GHG Reductions and Energy Potential

		200 AU	600 AU
Dairy manure	Number of animals	143	429
	Manure production (ton/day)	6.5	20
	GHG emissions ($MtCO_{2e}$/year)	-26	-77
	Annual Electricity Production (MWh)	131	393
	Annual RNG Production (m^3)	20,200	60,500
Poultry litter	Number of animals	27,000	81,000
	Manure production (ton)	1.4	4.0
	GHG emissions ($MtCO_{2e}$)	-18	-54
	Annual Electricity Production (MWh)	92	275
	Annual RNG Production (m^3)	14,000	42,000
Swine manure	Number of animals	3,600	11,000
	Manure production (ton)	14	42
	GHG emissions ($MtCO_{2e}$)	-120	-360
	Annual Electricity Production (MWh)	600	1,800
	Annual RNG Production (m^3)	93,200	280,000

Annual GHG emissions reductions and renewable energy potential for 200 and 600 AUs using anaerobic digestion.

Anaerobic Digestion – Cecil County, MD



Renewable Electricity Production from Digestion

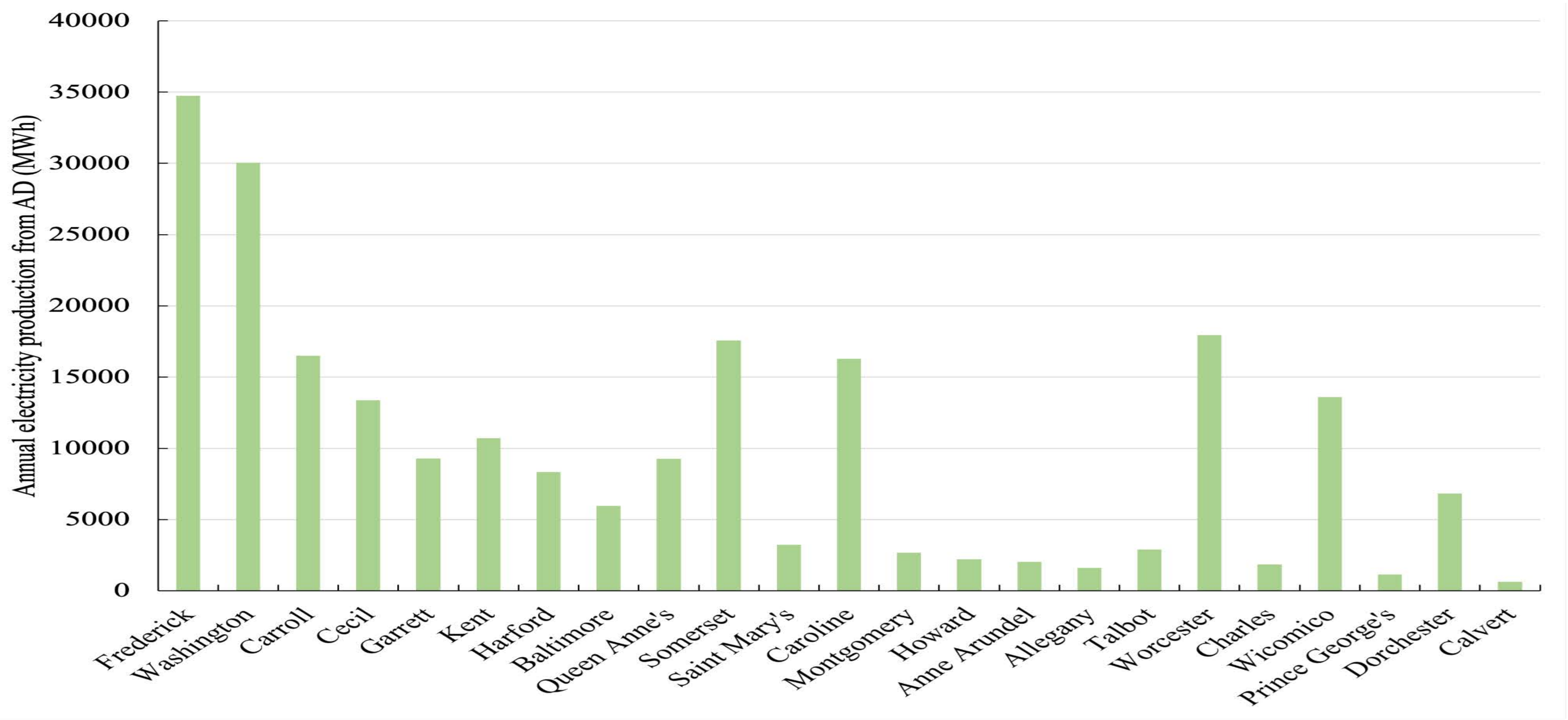


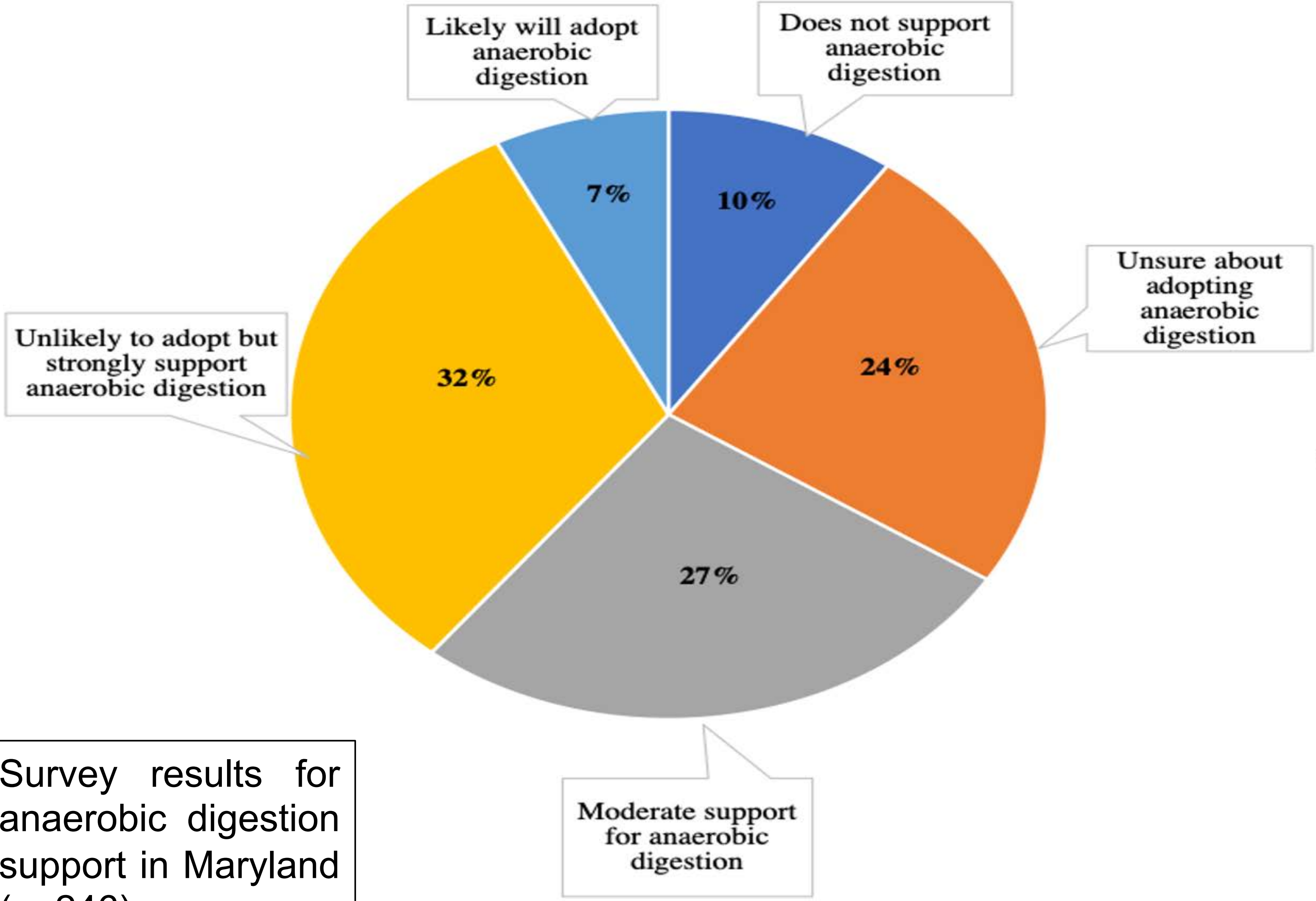
Figure shows annual renewable energy production from employing anaerobic digestion on all manure resources.

Life Cycle Assessment (LCA) Reductions

Impact Category	Unit	Scenarios		Annual Reductions
		Anerobic Digester and Composting	Baseline (No Digester or Composting)	Digester and composting (compared to Baseline)
Global Warming	T CO_2 eq/year	4,495	23,751	81% decrease
Acidification	T SO_2 eq/year	-166	75	319% decrease
Eutrophication	T N eq/year	-65	19	448% decrease

Annual reductions in global warming, acidification, and eutrophication impact categories for two scenarios: Anaerobic digester with solids composting and baseline with no digester/composting based on processing one ton of dairy manure through anaerobic digestion with solids composting.

Technology Adoption and Policy



Survey results for anaerobic digestion support in Maryland (n=246)

- Adoption barriers are high capital costs, long lead times, limited subsidies, and complex regulations.

- More incentives, permit assistance, and education are needed.

- Targeted policies, such as in CA and NC, to see GHG emission reductions and non-intermittent renewable electricity benefits.

Environmental Justice (EJ) and Waste Technologies

- Maryland's climate change goals are intertwined with environmental justice (EJ) concerns.
- EPA's EJScreen Mapping & Screening Tool adds a conscious layer to project planning.
- Depending on traffic and community concerns, electricity generation could have less EJ concerns than upgrading biogas to RNG.
- Manure resources and manure transport could help identify priorities for waste technology.
- Using an EJ framework would show potential exposures, engagement levels, and social vulnerability challenges.

Recommendations: Animal Waste Technology Assessment

- More education to increase technology adoption, engage communities, permitting, and counter misinformation.
- Legislation to increase technology adoption and show how technologies can meet state climate change goals.
- More collaboration is needed between state agencies, electric companies, farmers, industry, and policy makers to ensure project timelines are met.
- MDA's Animal Waste Technology Fund (AWTF) decisions should be backed by GHG emissions and nutrient calculations, community support letters, or EJ screening tools supported by MDA assistance.
- More funding is needed to increase technology adoption – see successful programs in California and North Carolina.

Report, FactSheets, and more info at https://go.umd.edu/AWTF

Food Waste and Loss

*13.5 million people are **without fresh food access***

*The 63,000 grocery stores to **can’t verify freshness to donate***

***33% of food** in the US is wasted, producing 3% of our GHGs*

Incentive Food Waste Collection

Municipal Solid Waste Characterization

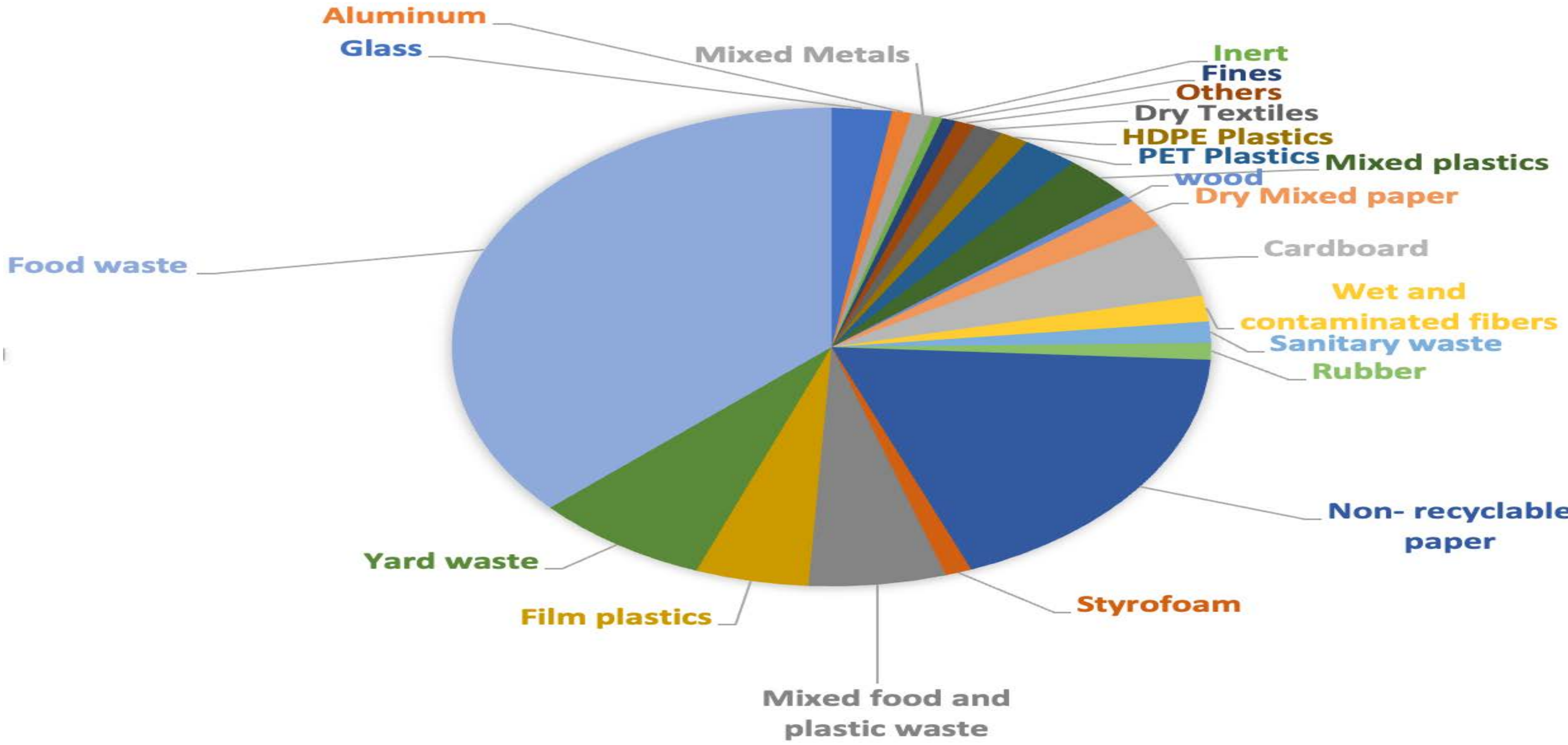
Mapping and valorizing trash from:

- Restaurants
- Schools
- Universities/Institutions
- Grocery Stores
- Landfills

Show the incentives for creating a circular bioeconomy

DOE funding

Energy from Trash – MSW Composition

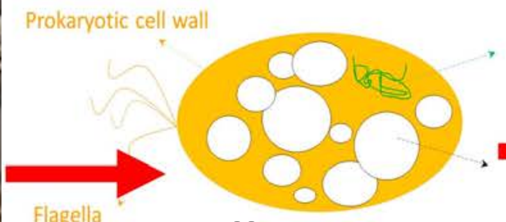


Bioplastics Production from Food Waste

Use dark fermentation of food waste to produce bioplastics (PHAs), using a halophilic bacteria (*Haloferax mediterranei*).

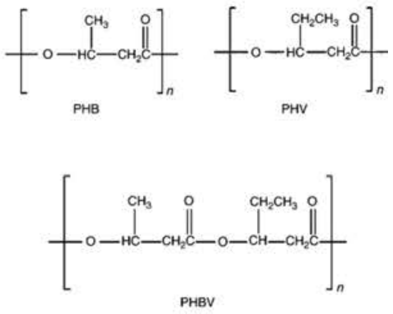
Dark Fermentation Liquid

Halophilic Culture



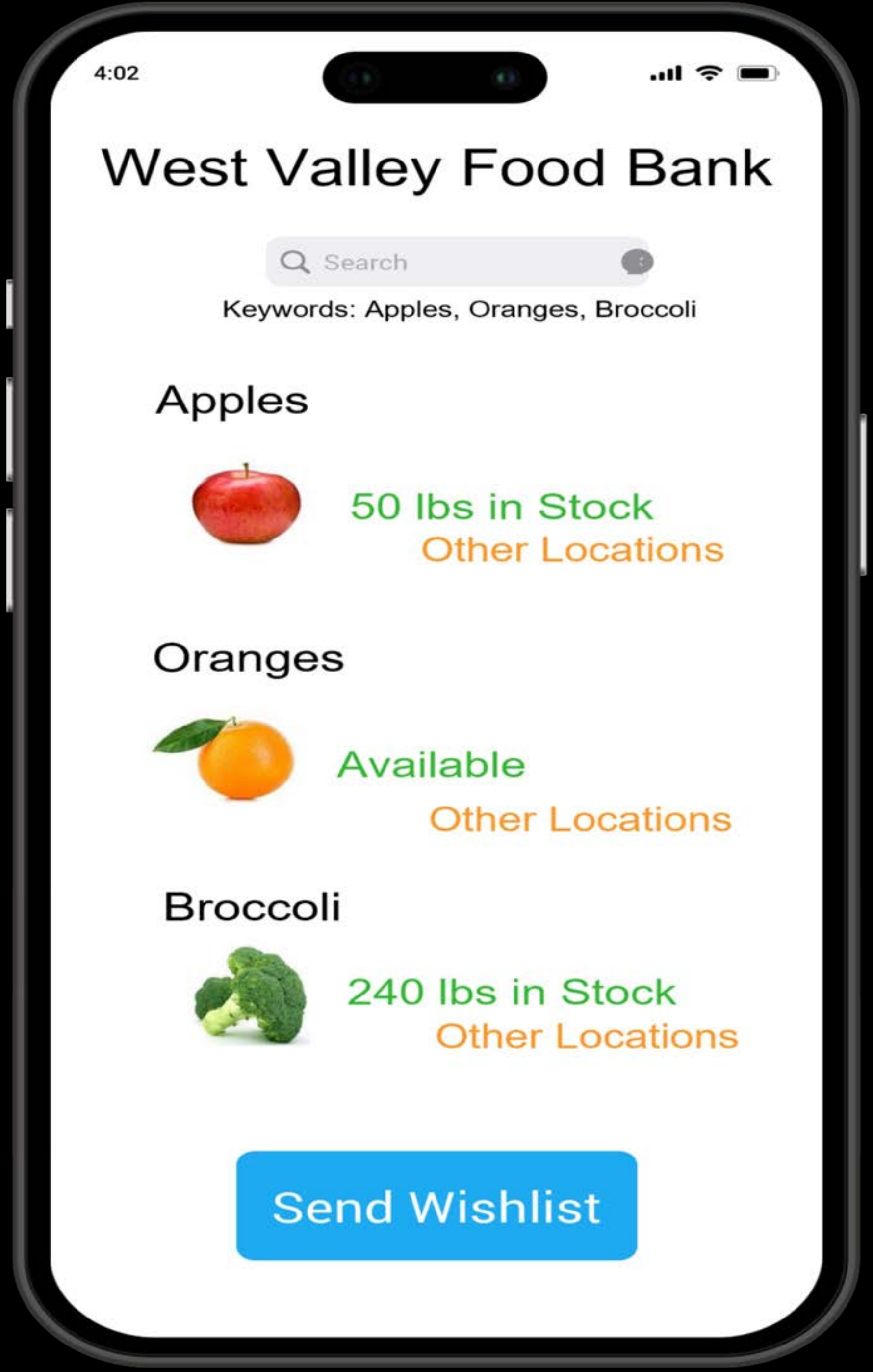
Cell containing PHA

Extraction & purification



PHA

DOE funding



FoodLoops for end-users experiencing food insecurity

FoodLoops App & Website:

- User-friendly interface (En/Sp)
- Mapping function
- Data collection (non-identifying)

NSF funding

Quantum Nose

Device measures freshness through gas emissions using quantum physics.

First prototype that quantities food safety

NSF funding

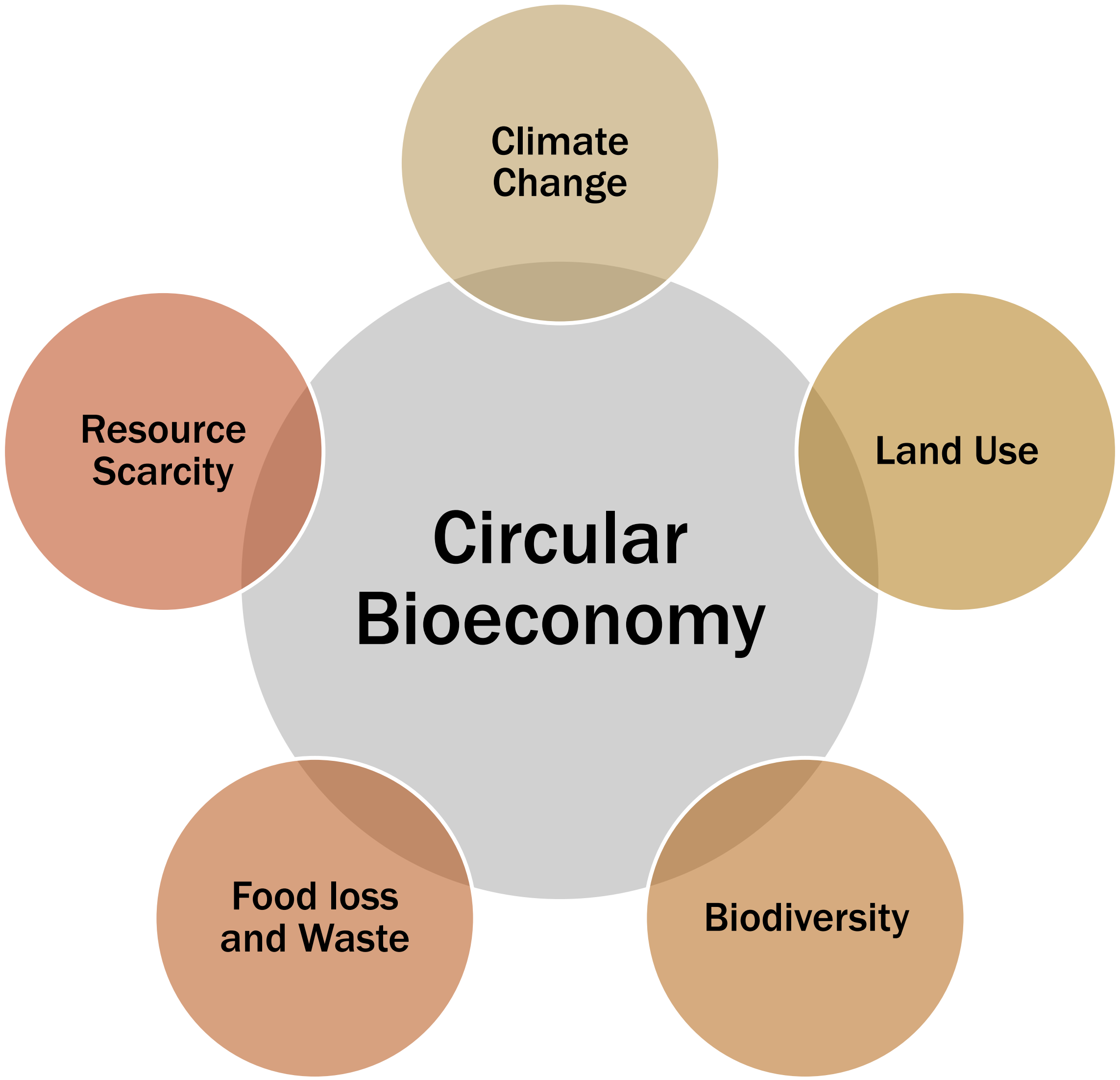
Patent Application #1: WO 2022/140634

Patent Application #2: 63/584,943

Research and Extension in a Circular Bioeconomy

Need to reduce waste but also need to find the highest value for the waste that we have:

- **Feed People**
- **Renewable Energy**
- **Fertilizer**



Thank you!

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