

The Role of Technology

“A Manure-to-Energy Primer”

September 8th, 2011

Bob Monley, General Manager

Farm Pilot Project Coordination, Inc.



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Challenge of Implementing Technology:

- **Reclaim energy and nutrients in an environmentally acceptable way.**
- **Generate sufficient financial return to recover capital investment, operating and maintenance cost.**



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Well demonstrated approaches which can combine nutrient and energy benefits (i.e. “ manure-to-energy” technology)

- **Add heat – thermochemical processes**
- **Add bacteria in the absence of oxygen anaerobic digestion (biological process)**



Historical Perspective...Being Resourceful

“Buffalo Chips and Pioneers”

Many of the pioneer companies were very dependent on an important buffalo by-product, the "buffalo chips" - dried excrement, which were gathered for cooking fires when wood was scarce. These are similar to what we'd call "cow pies" today. John Nielsen recorded in 1856:

"Our journey took us along the Platte River. There was plenty of grass and, to the best of my recollections, little wood. Where we could not find wood we burned buffalo chips, 7:312),



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Heritage Gateways

official sesquicentennial K-12 education project sponsored by Utah State Office of Education, the BYU-Public School Partnership and the Utah Education Network.

So what's New About Thermochemical

- **above 55% dry matter will sustain combustion without additional heat**
- **waste can be reduced by 80-90% in weight and volume**
- **sufficient energy content in animal waste to warrant harvesting energy**
- **well suited for dry waste (i.e. poultry litter)**
- **systems are being developed and there are scalable variations**



Manure is a Nutrient Rich Resource Stream; Technology Can Provide Alternate Value Paths



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Manure Has Enough Energy to be Valuable

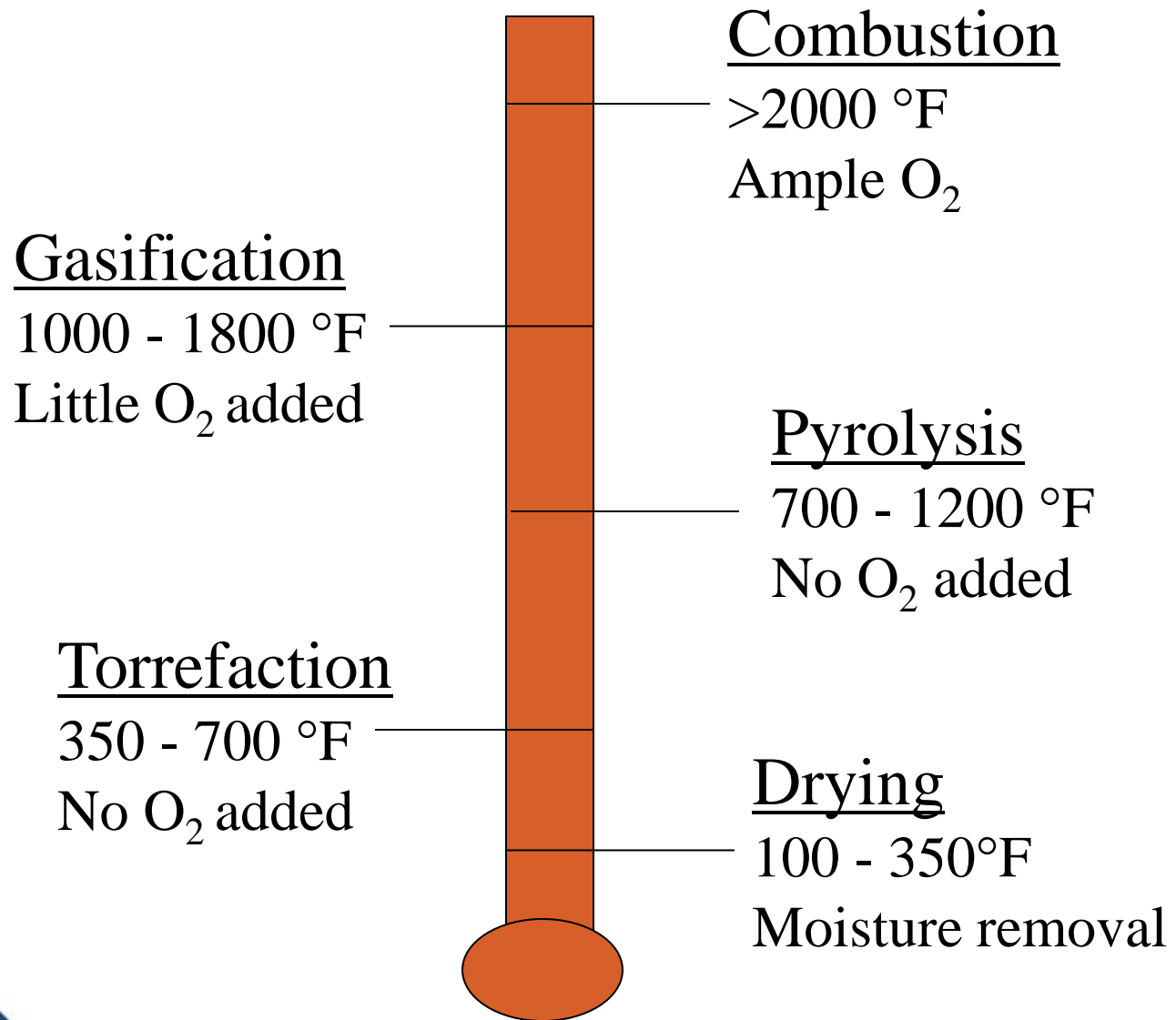
<u>Feedstock</u>	<u>(Btus/lb) *</u>	<u>% Ash *</u>	<u>% Dry Matter</u>
Chicken Litter	6,500	20	70
Swine feces	8,000	15	3
Dairy manure	8,000	10	1-15
Feedlot manure	4,500	30	70
Wood	8,000	3	50
Municipal sewage	4,000 – 8,000	15-60	<1-3
Coal, bituminous	12,000	22	80

* Values reported are based on dry matter basis



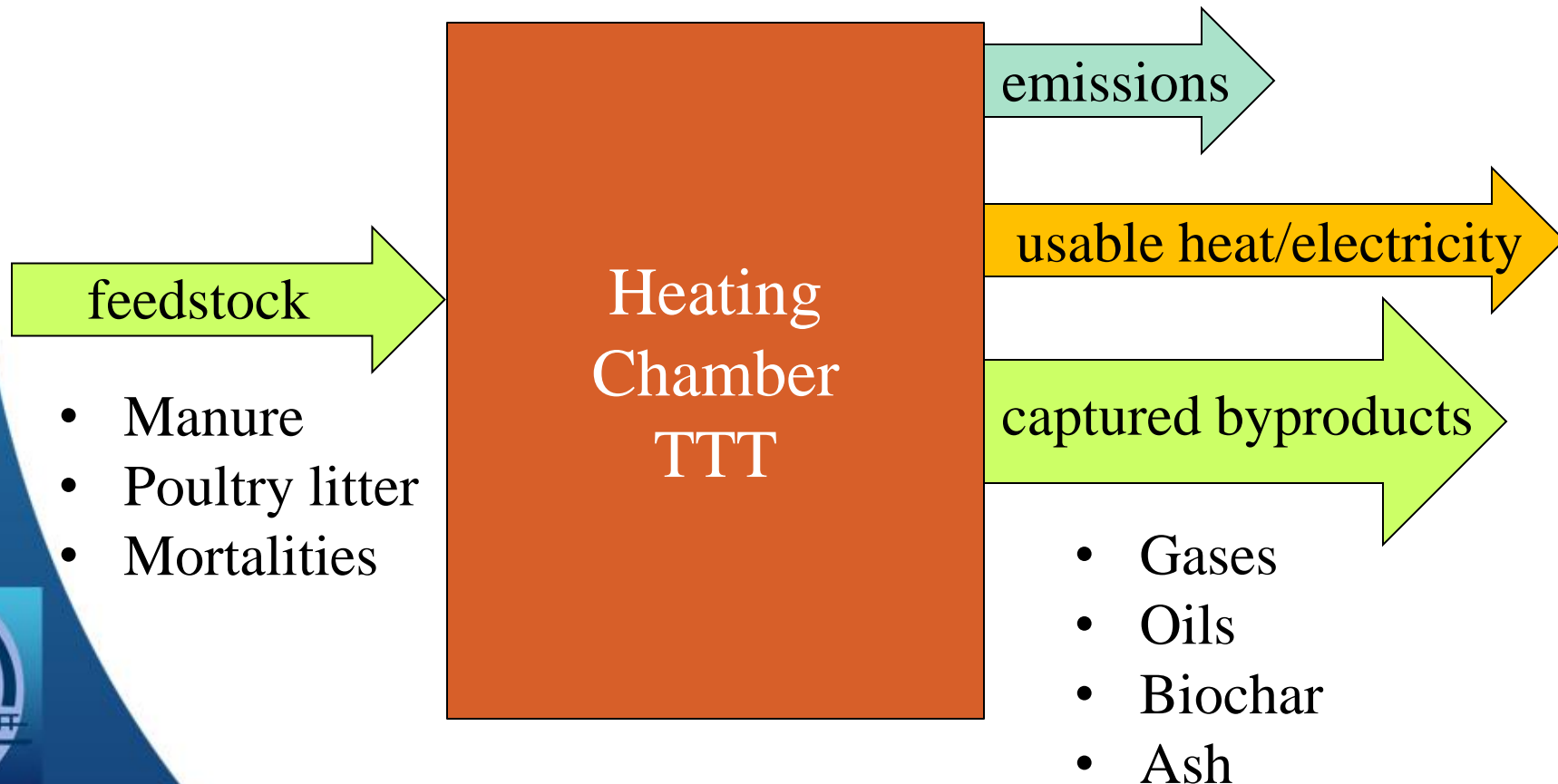
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Thermochemical Processes

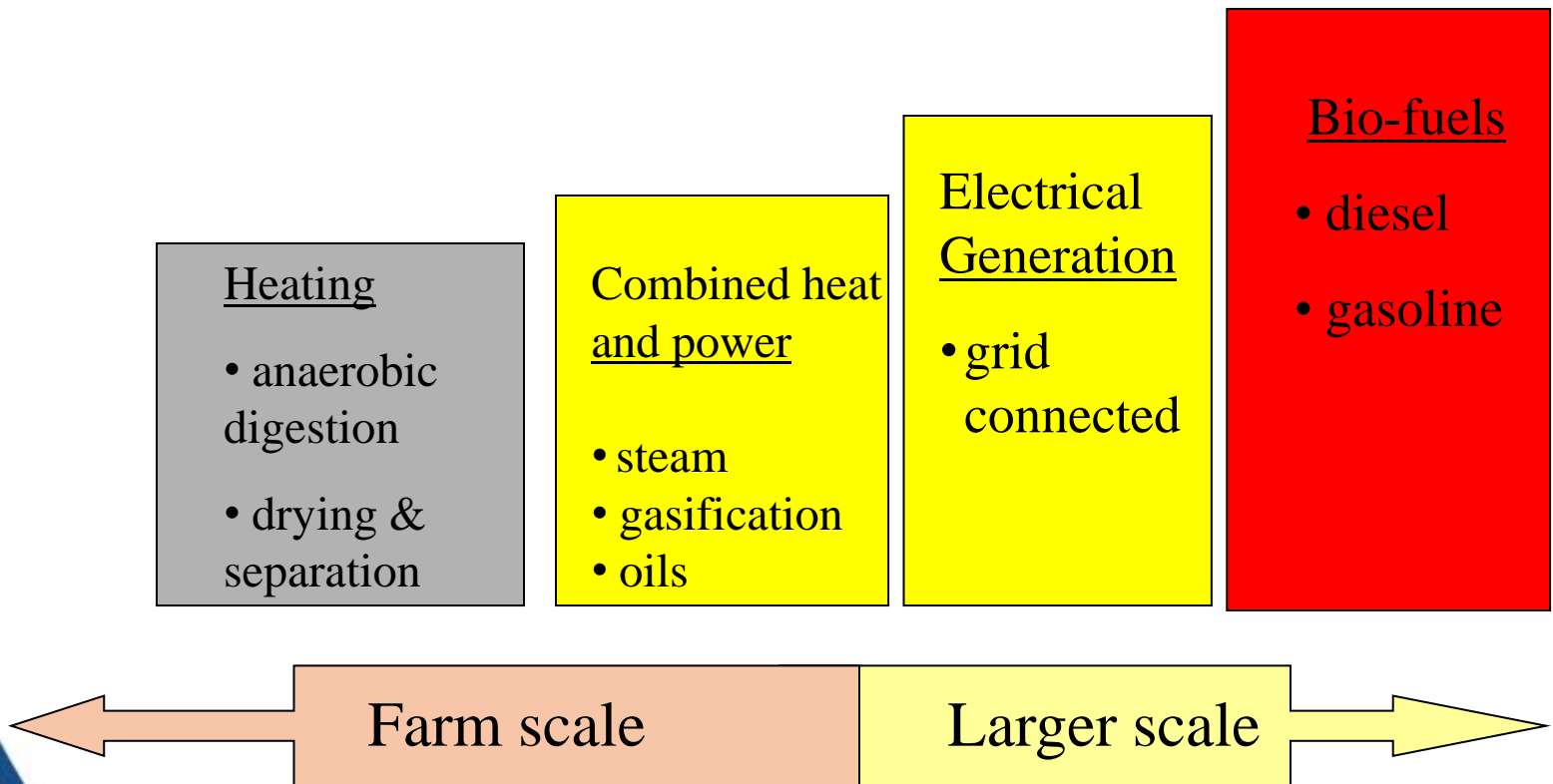


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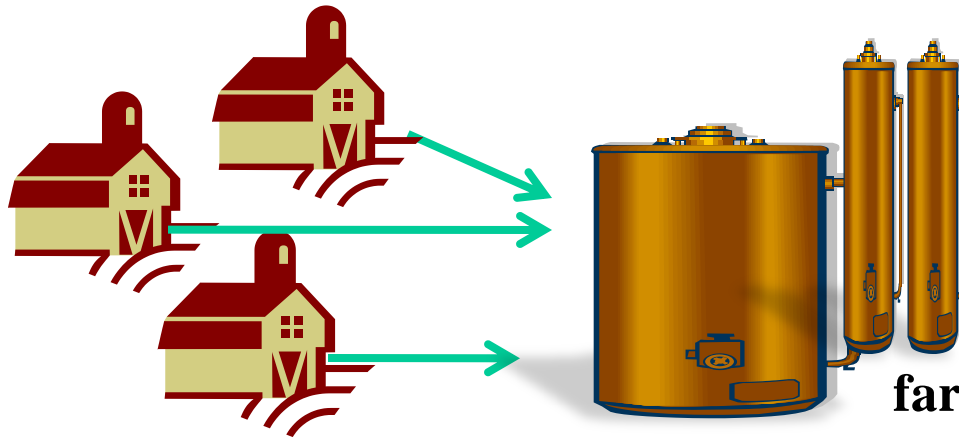
Analysis of Thermo-Chemical Conversion (inputs and outputs)



System Solutions Will Reflect Complexity-Benefits Targeted

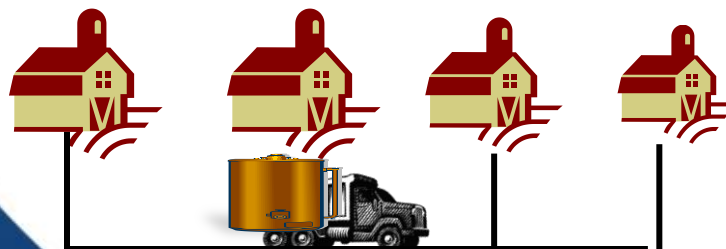
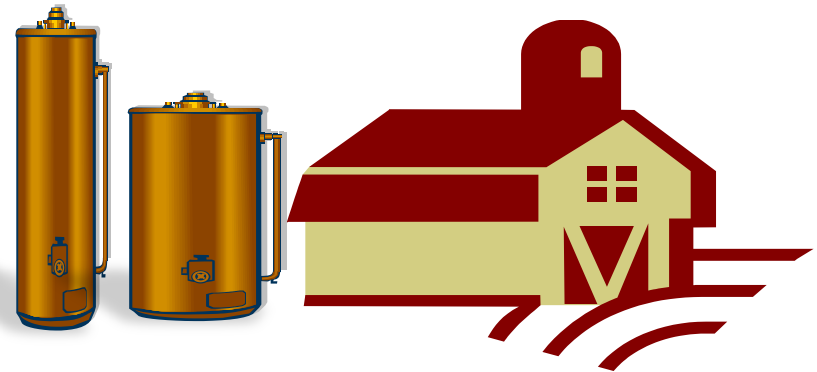


Solutions Must Fit Size of Operation



Hauling waste to a centralized facility may offer a better solution for farms, clustered nearby

Larger farms, remotely located, may be better served with on-site facilities



A service provider may be well suited to treat waste at multiple small farms

Anaerobic Digestion

- Biological process – uses bacteria in an oxygen free environment to convert organic carbon into a biogas called methane CH_4 .
- Methane is typically used to fuel a generator and produce power.



Anaerobic Digestion (AD)

Long and proven history

- producing biogas CH₄
- if methane is consumed then GHG's are reduced
- deployed for wet waste
- approximately 135 operating as manure digesters in US
- many dairy farms employ AD to control odors

Sludge byproduct (digestate) must be managed as liquid nutrient

- nearly all of the NPK remains
- many initiatives underway to develop ammonia stripping and P removal techniques from digestate
- some dairy farms use separation processes to remove solids
 - ✓ recycled bedding
 - ✓ composting operation

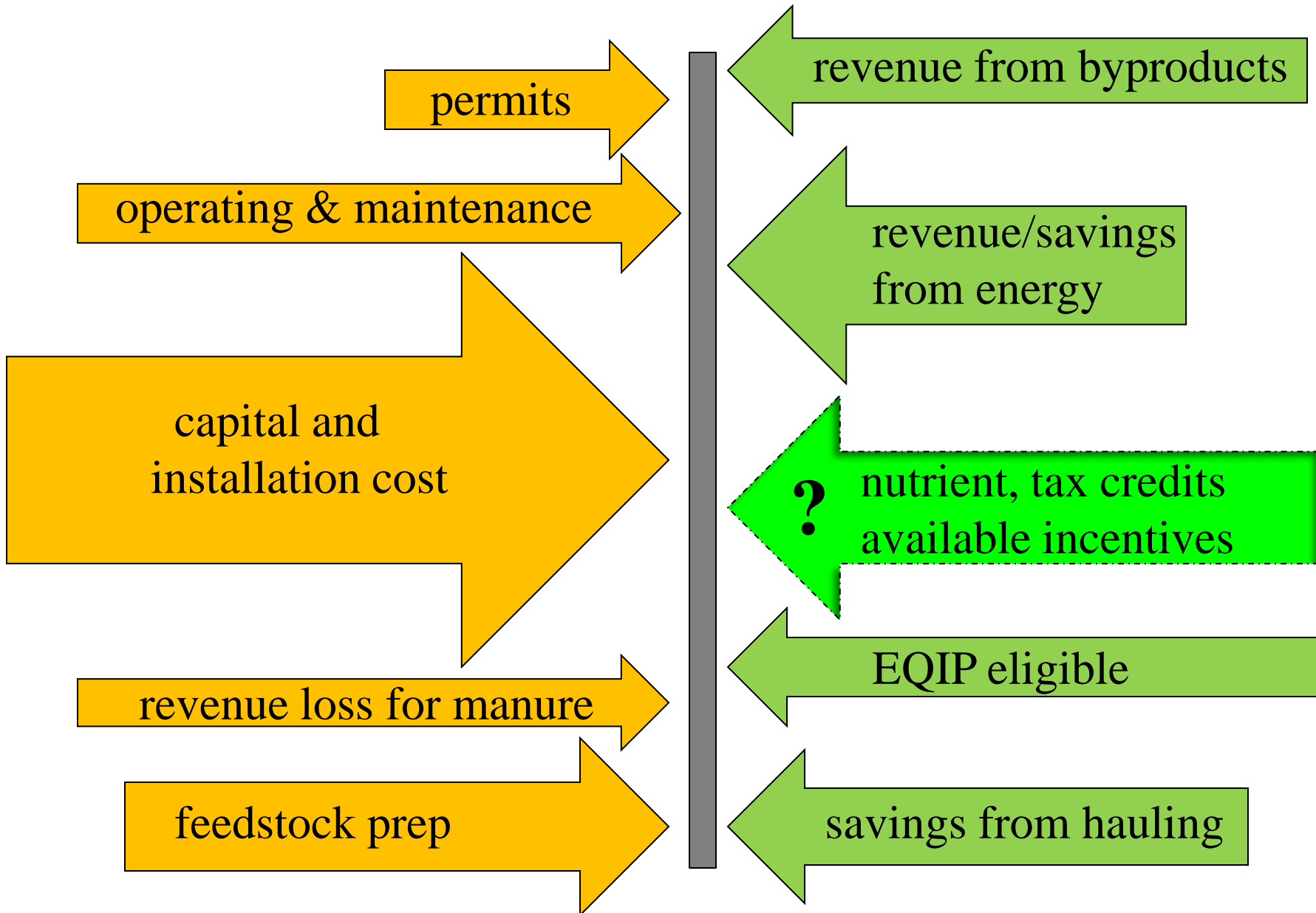


Many Types of Anaerobic Digesters

- solids loading schedule
- flow and mixing pattern
- operating temperature
- microbial growth
- configurations
 - in ground “plug flow” (no mixing)
 - complete mix digesters
 - covered lagoon



Economic Reality (Cost/Benefit)



Summary

- One size/technology does not fit all.
- Understanding: waste stream = resource stream
- Lessons learned – partial solution does not generate full economic returns.
- New byproducts need to be fully developed and linked to new markets.
- Available incentives at state and local level are important elements in determining economics.

