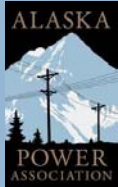


# Emerging Energy Technology Forum

*Programs & Opportunities for Alaska*



# Improving Cold Region Biogas Digester Efficiency

## Cordova Electric Cooperative

Clay Koplin

CEO - Cordova Electric Cooperative

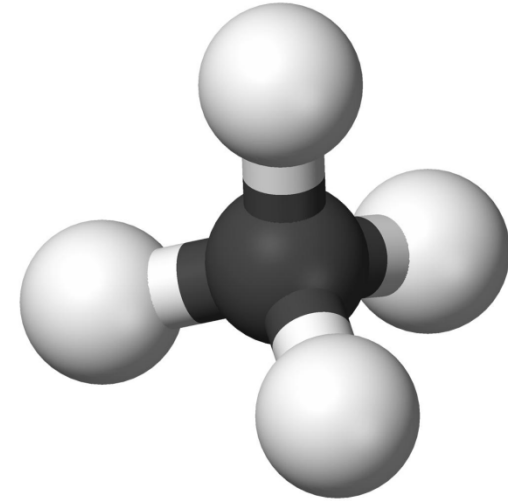
Casey Pape

Research Technician - University of Alaska, Fairbanks

James Allen, Ben Americus, Craig Bailer, Shannon Lindow,  
Sophia Myers, Jessica Smyke and Adam Low

Cordova High School

# Project Summary



- ❖ **Cordova Electric Cooperative**
  - ❖ Cordova High School
  - ❖ University of Alaska, Fairbanks
- ❖ **Location:** Cordova High School- Cordova, AK
- ❖ **Technology:** Cold-weather Anaerobic Digestion for Methane Production
- ❖ **Project Goal:**

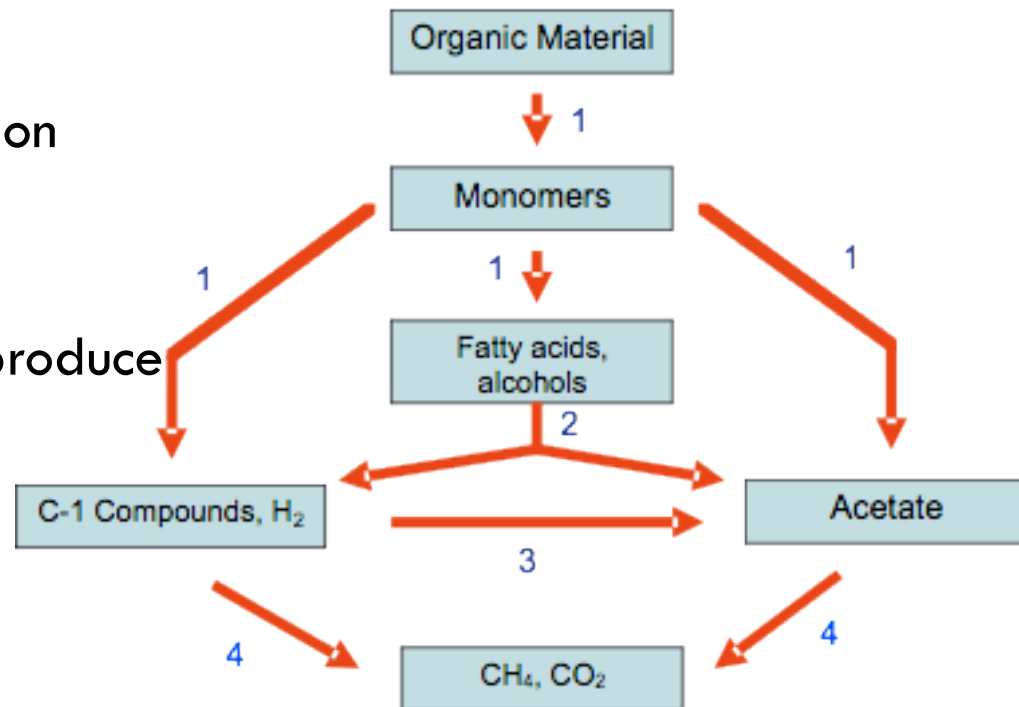
“Improve conventional anaerobic digester efficiency through use of *psychrophilic* (cold adapted) bacteria cultivated from arctic lake sediments found in Alaska in order to provide cooking and heating fuel for Alaskan households.”

# Technology Overview

## Anaerobic Digestion

- ❖ Bacteria obtain energy by consuming organic material in an anaerobic environment.
- ❖ Results in the formation of carbon dioxide and methane ( $\text{CH}_4$ )
- ❖ *Methanogens*- bacteria which produce methane as a waste product.

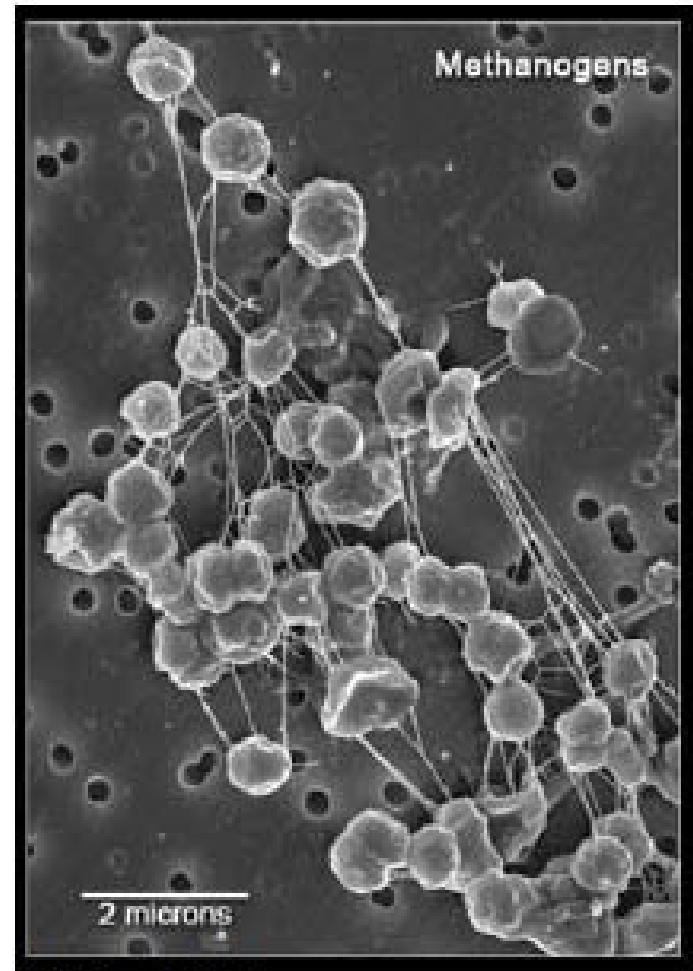
Metabolic pathway for biogas production



# Methanogens

*Mesophilic* - Moderate temperatures, typically between 25 and 40 ° C (77 and 104 ° F).

*Psychrophilic* - Cold temperatures, ranging from -15° C to +15° C.



NASA and STScI

# Current Application - Small-Scale

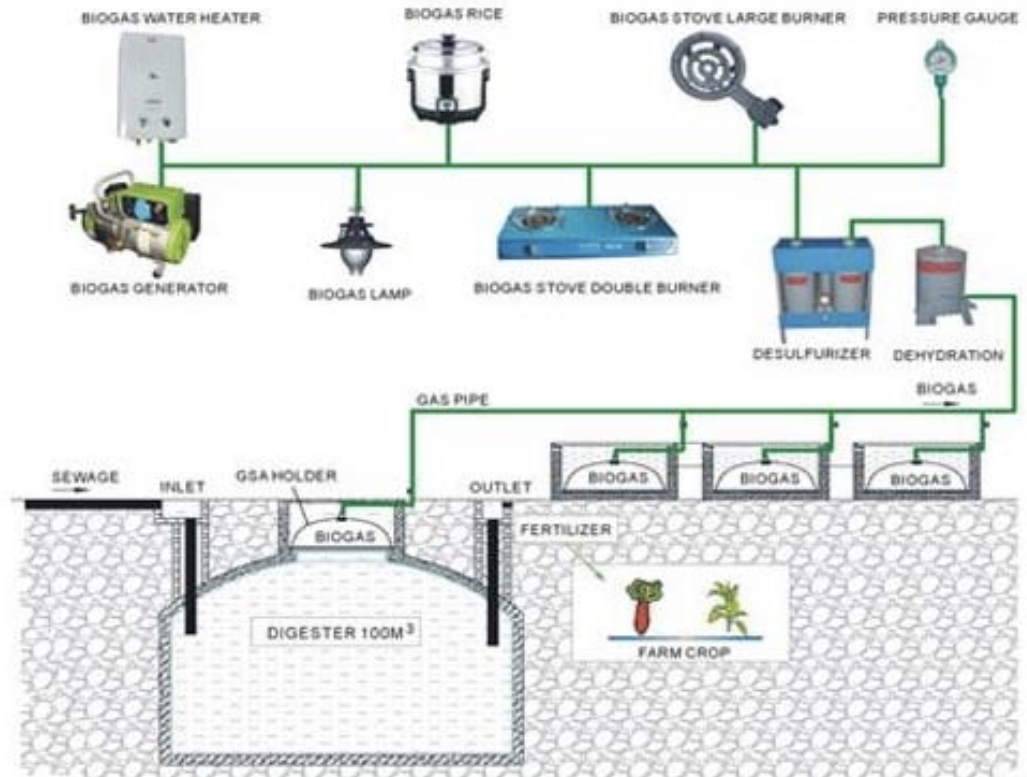


# Current Application - Small-Scale

India: 8 Million Biogas Digesters



China: 20 Million Biogas Digesters



# Current Application - Industry



imagination at work

**SIEMENS**



Biogas Kristianstad  
Kristianstad, SE

Capacity: 3000 MWh



Vanderhak Dairy  
Lyden, WA

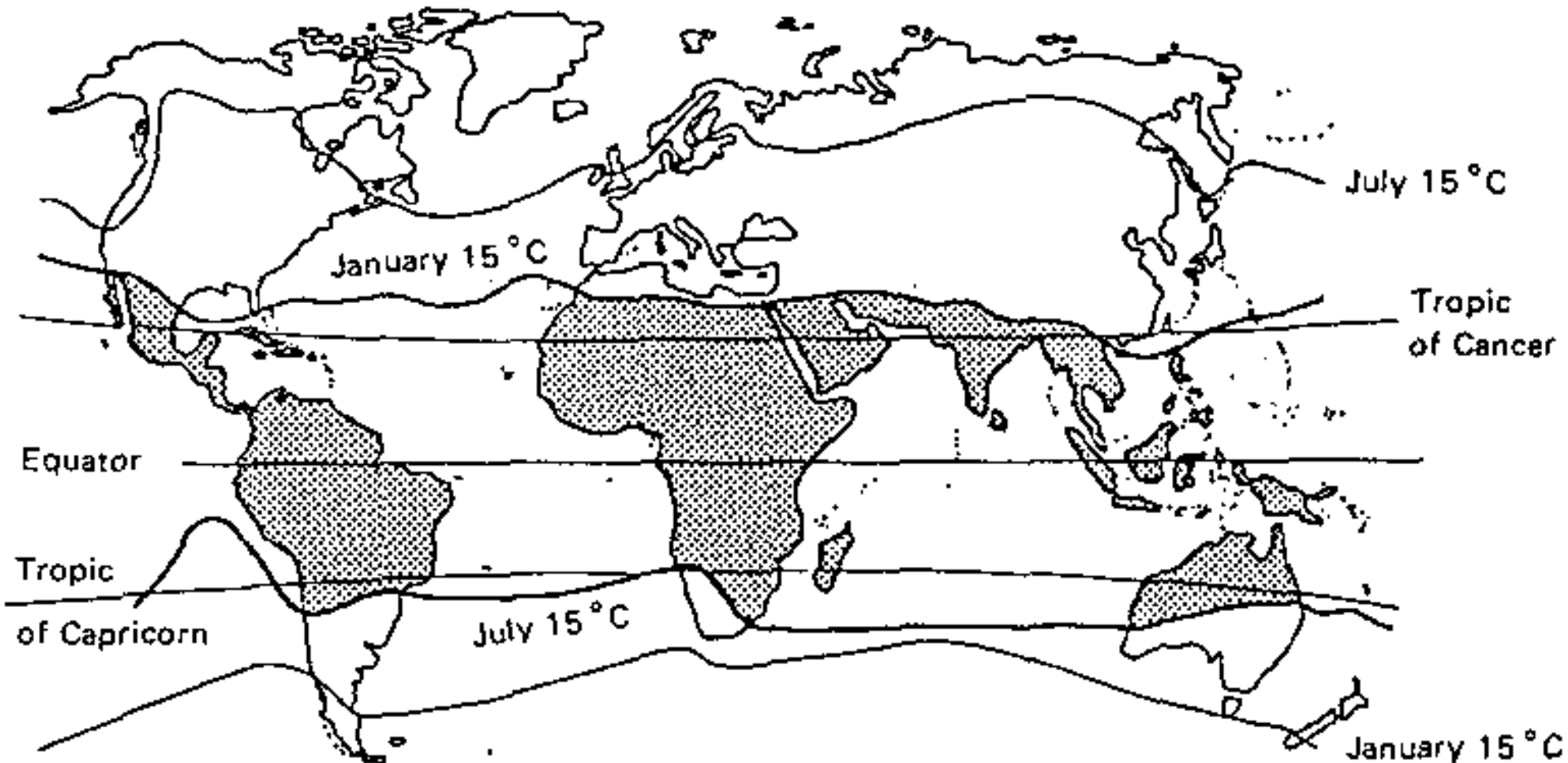
Capacity: 500kWh



Bio-Teere Systems, Inc.  
Eugene, OR

Capacity: 150kWh

# Temperature Limitation



# Psychrophiles

Where do we find cold-loving methanogens?

## Alaskan thermokarst-lake sediments



Photo Credit: Casey Pape



Photo Credit: Laurel McFadden

- Methane production at 0-1° C to 21° C
- Recently discovered (Zimov et al. *Science* 1997; Walter et al. *Nature* 2006)
- 4x more efficient than European psychrophiles that live at 5° C

# Alaska Application

## Opportunities for Alaskan use

### ❖ Small-scale

- ❖ Individual homes/rural communities
- ❖ Offset high diesel fuel cost
- ❖ Feasible?-Goal of this study

### ❖ Large-scale

- ❖ Fisheries wastes: Coastal Southeast/Southcentral
- ❖ Municipal wastes: ubiquitous throughout AK
- ❖ Agri-business: Anchorage, Palmer

# Alaska Application

## Benefits

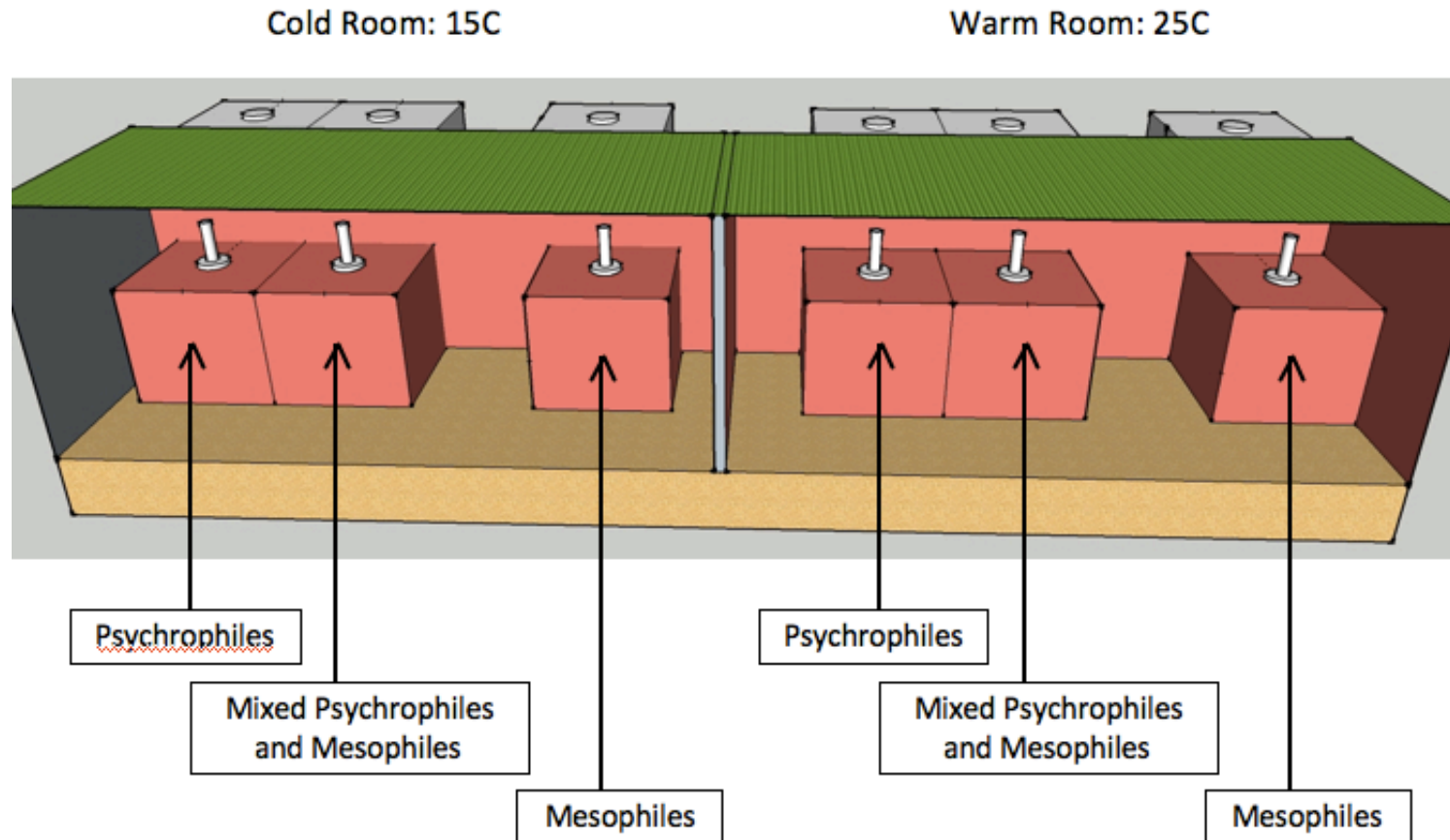
- ❖ Produces a renewable fuel from locally available resources.
- ❖ Mitigates health and environmental safety problems associated with waste disposal.
- ❖ Reduces fossil fuel demands.
- ❖ Produces fertilizer for agricultural efforts.
- ❖ Reduces greenhouse gasses released into the atmosphere.
- ❖ Puts Alaska at the head of cold-adapted digestors globally and makes Alaska one of the initiating areas to use digestors in the USA.

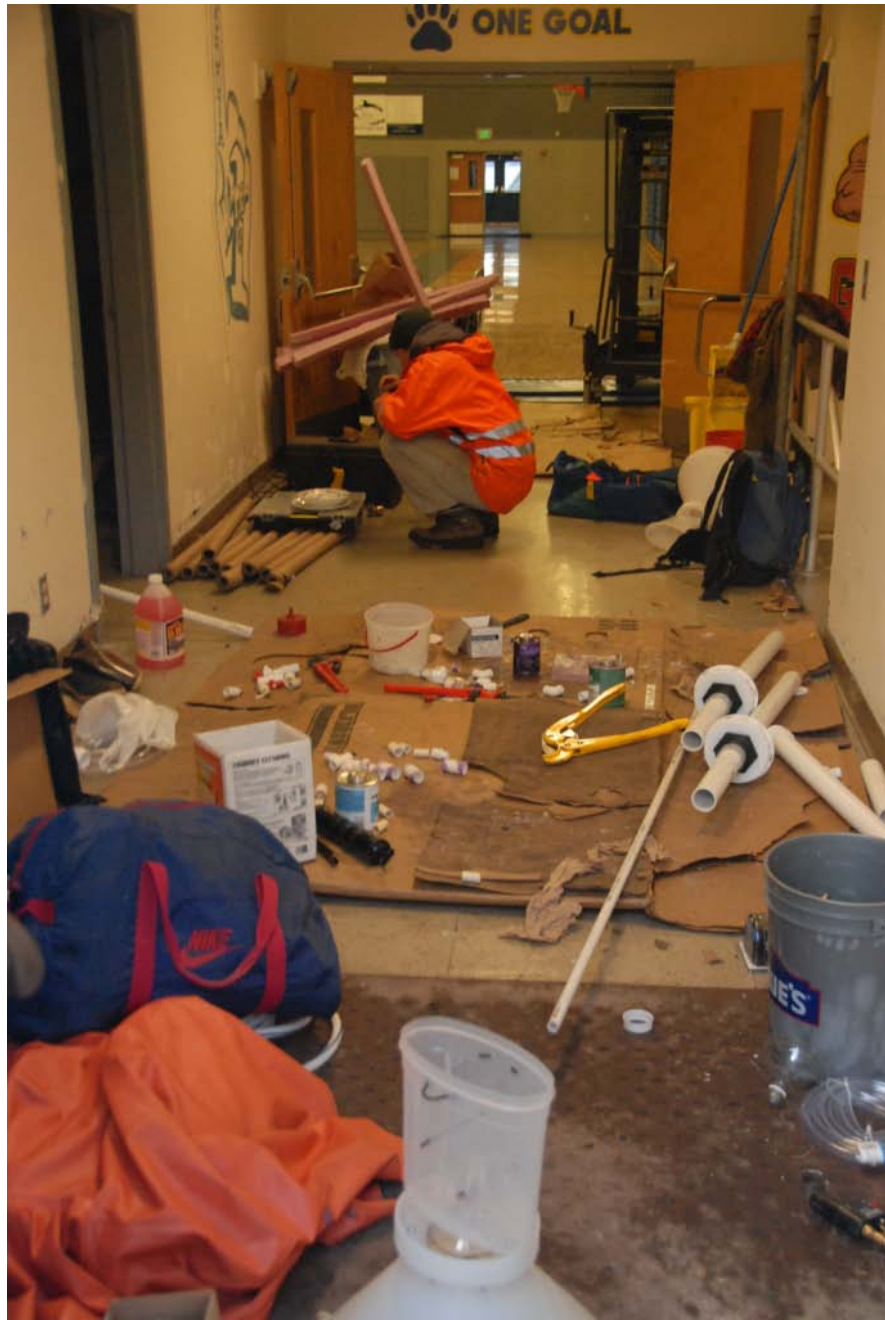


Photo Credit: Laurel McFadden

# Tasks & Timeline -Phase 1

- ❖ Phase 1 - Experiment with different types of methanogens in two controlled environments.







# Biogas Flame Test

Digestor	First Biogas Produced
1	1/31/2010
2	2/15/2010
3	1/22/2010
4	2/1/2010
5	1/21/2010
6	1/26/2010

Digestors sealed on  
January 19, 2010



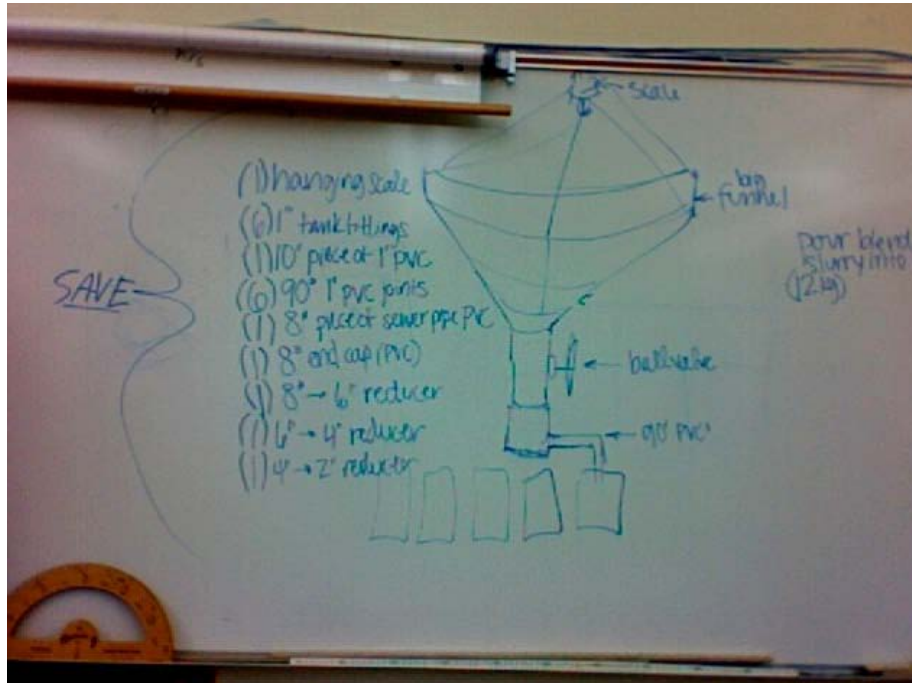
# Tasks & Timeline -Phase 1

## Food Processing

- **Collect school lunch scraps**
- **Blend into “slurry”**
- **Feed digester**



# Engineering in Action

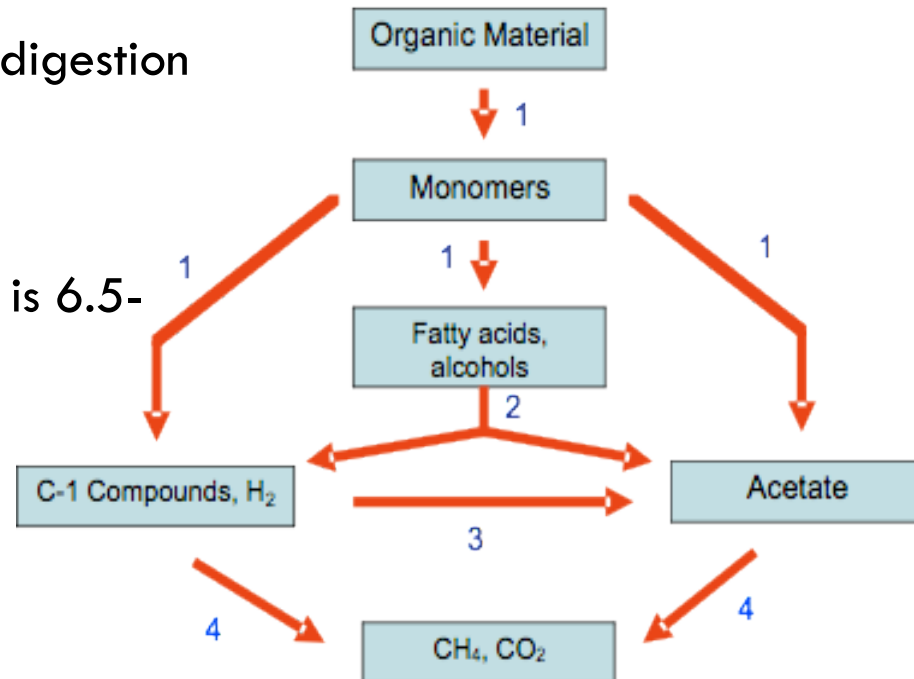


Student-driven engineering of food processing and feeding.

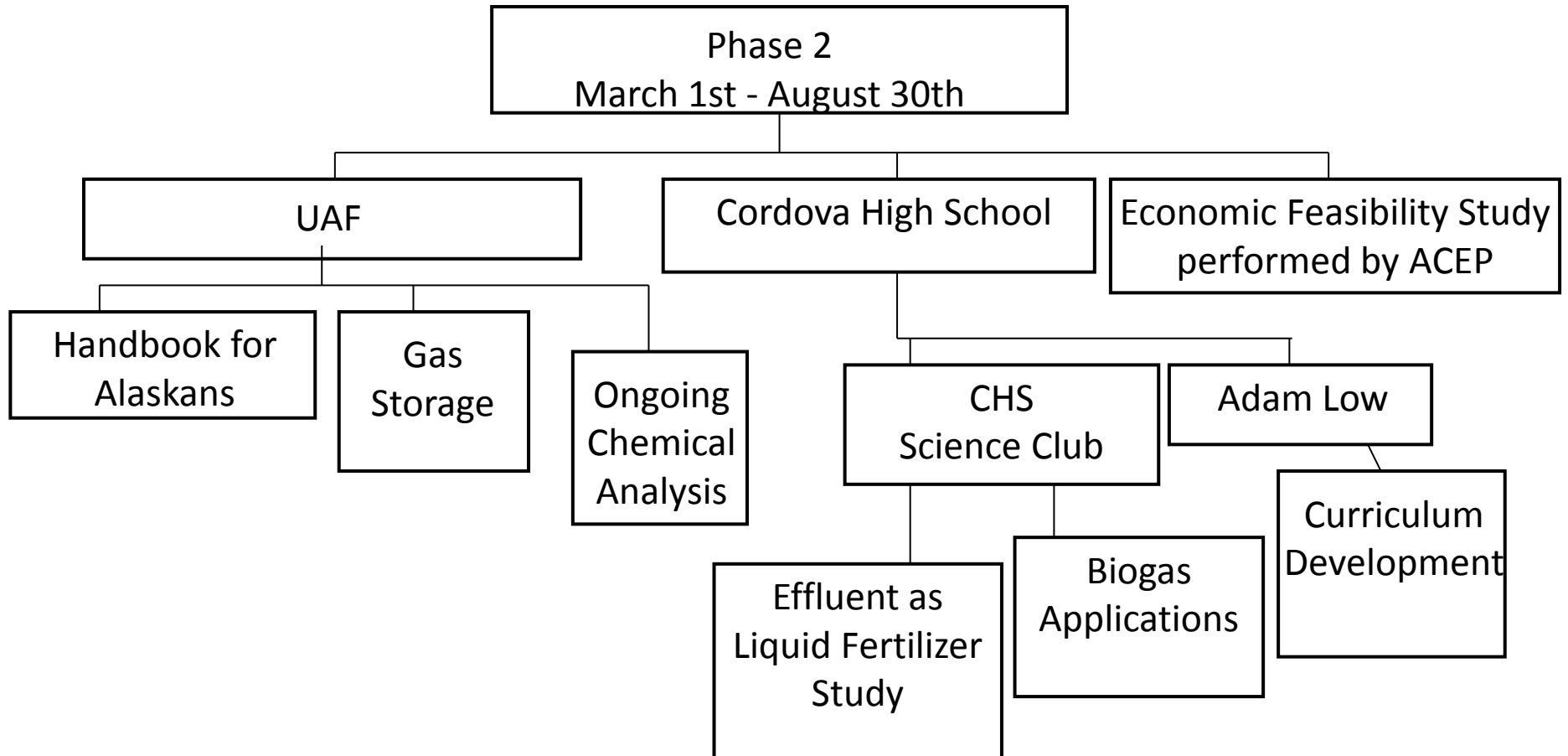
# Phase 1 - Challenges

- ❖ Temperature Control
  - Greatest influence on metabolic rate
- ❖ System Design
  - Reactor and gas-storage containers must be robust
  - Water gas-collection systems freeze in Alaskan climate
- ❖ pH Concerns
  - At low temperatures, the anerobic digestion process can become imbalanced.
  - Acedogen production outpaces methanogen production.
  - Favorable pH for methanogenesis is 6.5-7.5

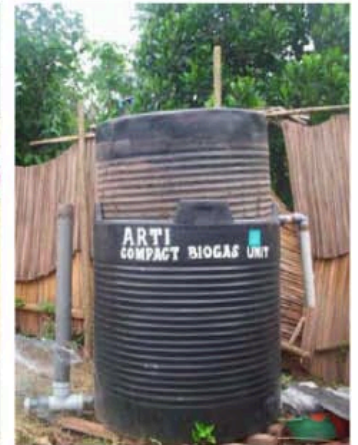
Gerardi, M. 2003 *The Microbiology of Anaerobic Digesters*. 23-45



# Tasks & Timeline: Phase 2

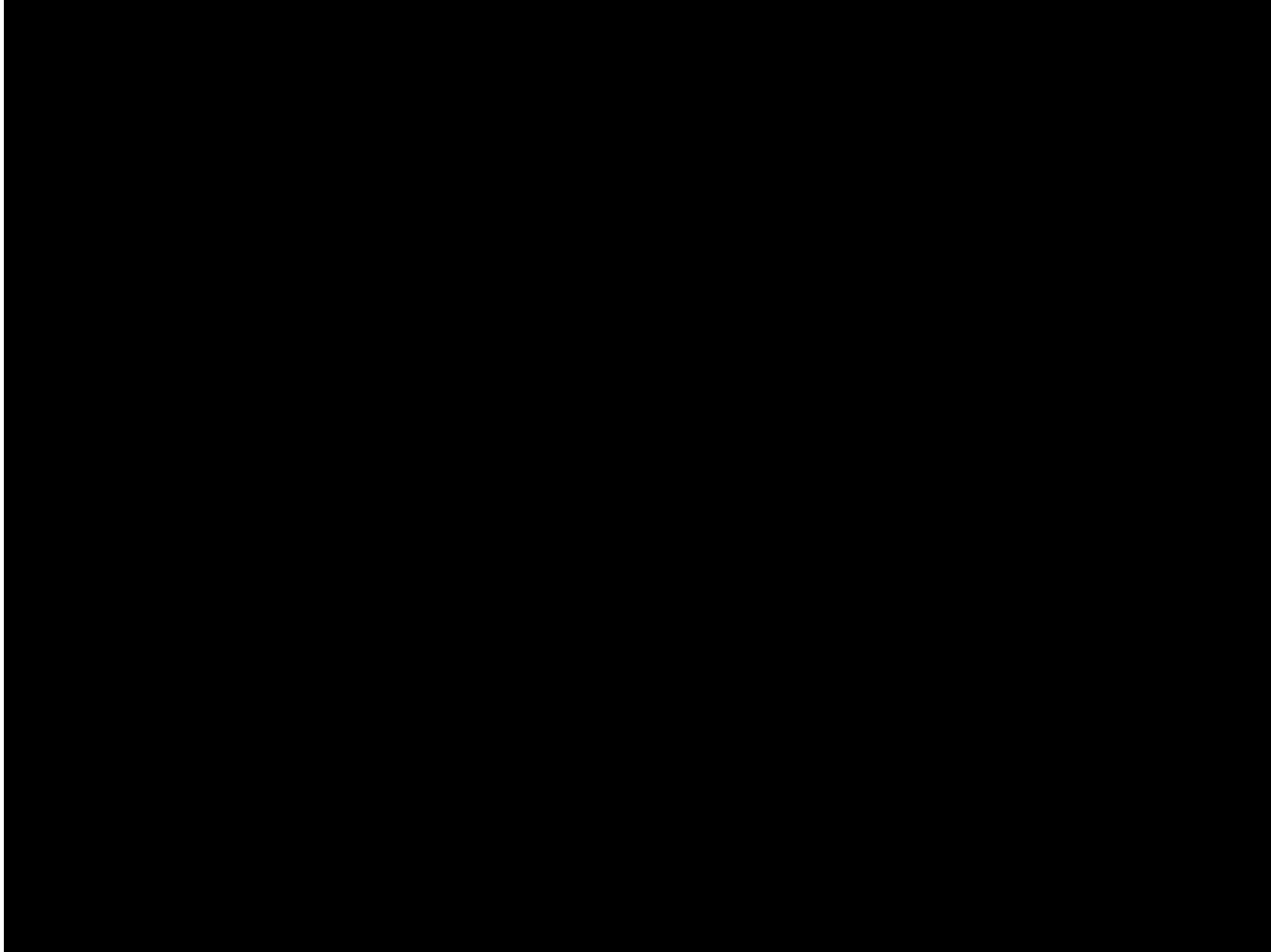


# Project Status



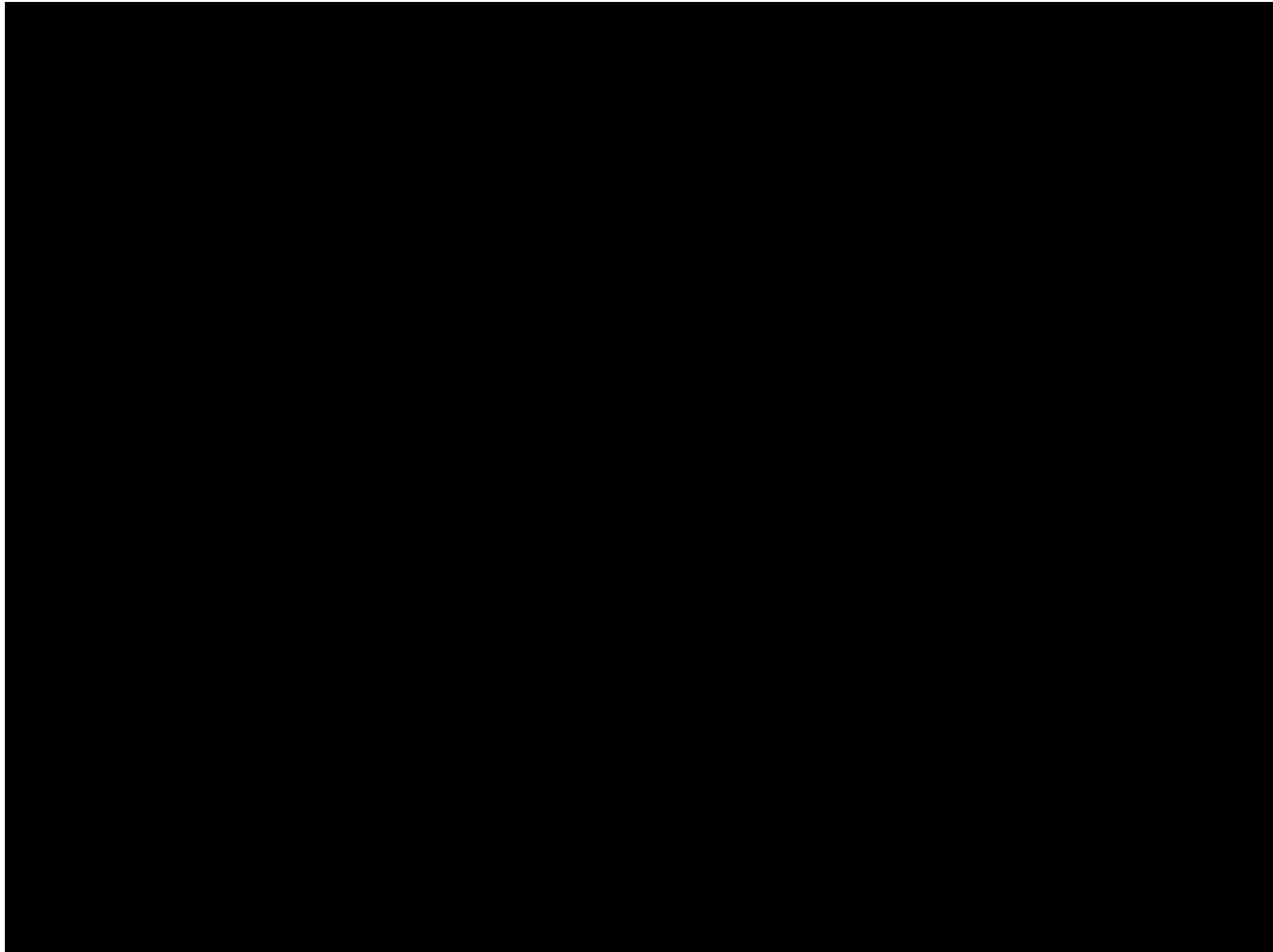
Collection

# Project Status



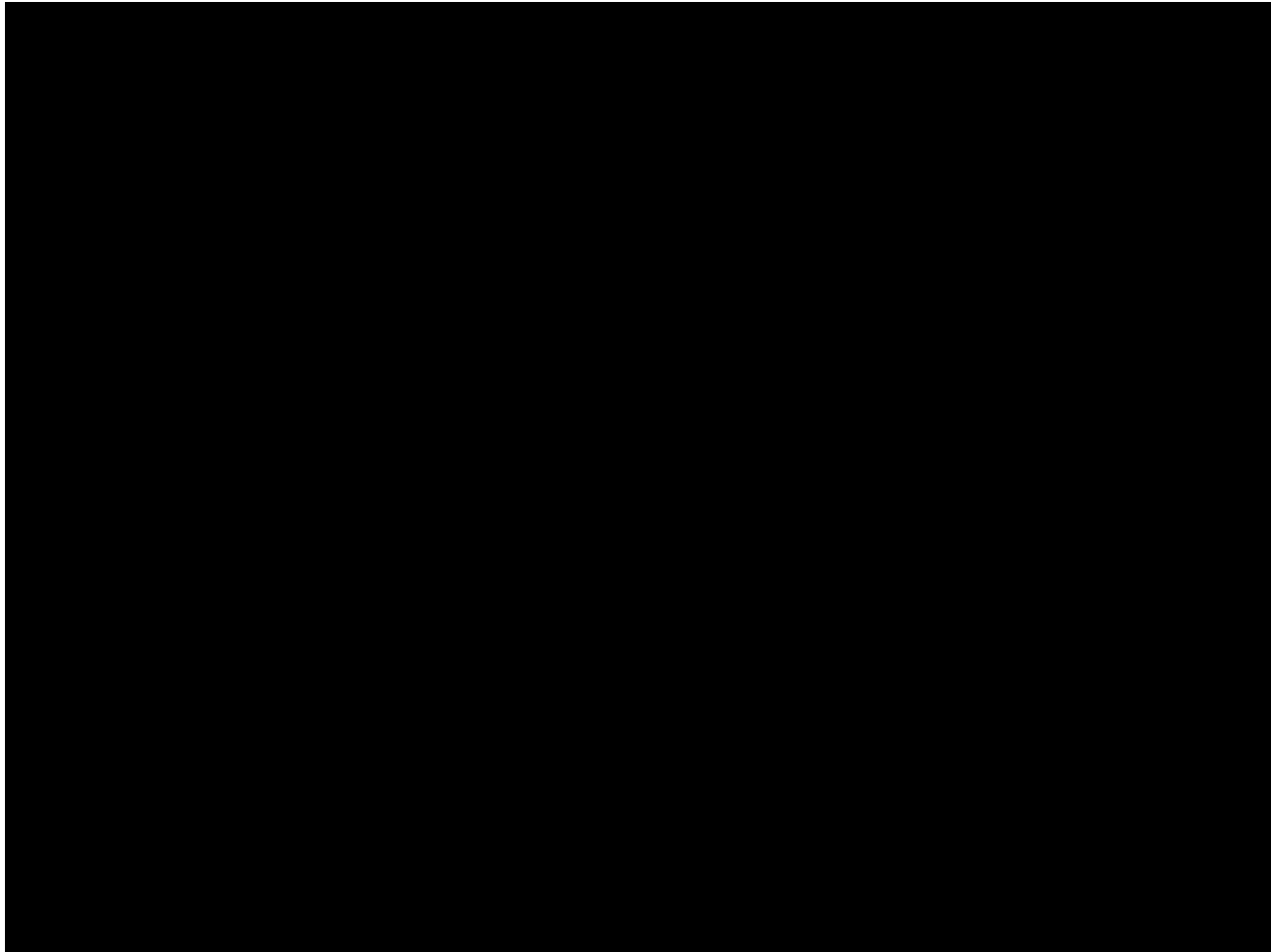
Greenhouse

# Project Status



Application

# Project Status



Application

# Questions?



[www.cordovaenergycenter.org](http://www.cordovaenergycenter.org)

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- [http://www.manuremanager.com/index.php?option=com\\_content&task=view&id=3446&Itemid=138](http://www.manuremanager.com/index.php?option=com_content&task=view&id=3446&Itemid=138)
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