Reducing environmental pollution while creating novel value propositions for livestock manure management

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Project overview

Aims:

- Provide dairy manure management solutions to small-to-mid sized dairy farms using standard, pre-fabricated systems
- Reduce the environmental pollution caused by dairy manure (primarily GHG and excess nutrients)
- Improve farm economics for manure management

Manure dewatering and pyrolysis units installed at farms initially in Vermont and Connecticut.
Current challenges in dairy manure management

1. Livestock manure management = 1.3% of total GHG emissions in the U.S.

2. Potential watershed nutrient pollution caused by excess nutrient leaching

3. Anaerobic digesters: limited application at small farms

4. Dewatering manure:
   - Up to 40% reduction in GHG emissions
   - Bulky material with no clear market
Proposed solution: dewatered manure pyrolysis
Screw press separator
Dewatered manure
The Biogenic Refinery

01 | Decentralised small-scale pyrolysis system
02 | Experience treating human faecal sludge, similar characteristics to dairy manure
03 | Integrated air emissions control technology
04 | Remote monitoring capabilities
Data collection and remote monitoring

Sensors

- Temperature (air and water)
- Oxygen levels
- Flow rates
- Power usage

Database and kelv°n

- MySQL relational cloud database
- Real-time data access
- Web and mobile app, kelv°n: [https://kelvinapp.io/](https://kelvinapp.io/)
200 cow dairy farm: Carbon and Phosphorus balance

- **200-cow farm**: 8,000 lbs P/yr, 800 t CO₂ eq/yr
- **Screw press separator**: 15% P-removal, 40% CO₂ eq removal, 6,800 lbs P/yr, 450 t CO₂ eq/year to storage pit
- **Pyrolysis unit**: 1,200 lbs P/yr, 350 t CO₂ eq/year
  - Bedding: 15% P-removal, 4 t CO₂ eq. per cow per year
  - Potential for biochar sequestration: 100 t CO₂ eq/yr

Quantified GHG reductions = project financing through carbon trading mechanisms
Expected benefits and challenges

1. Positive environmental impact:
   - Reduction in GHG emissions in dairy farms using well understood equipment and recognized carbon protocol
   - Potential reductions of excess nutrients at farms
   - Air emissions control from pyrolysis unit

2. Produce valuable products:
   - Biochar: low volume, can potentially be used on the farm
   - Dewatered solids for bedding
   - Potential excess heat

3. Carbon financing as an enabling mechanism for an aggregated program of small-scale GHG reduction projects

4. Site-specific scoping and preparation required
Long term vision

01 | Expansion to other regions of small dairy farms (about 50,000 small dairies in U.S.)

02 | Application in similar sectors (e.g. hog farm manure management)

03 | Additional revenue for farms in the challenging milk market (recent 6.8% drop in number of dairy farmers in the U.S.)

04 | Standardization to bring long term costs down

05 | Potential for carbon validation/verification relating to carbon sequestration of biochar, and resulting increased carbon market value of project
Thank you!
200 cow dairy farm example: mass flow

- 200 cows × 30 gallons/cow/day = 6,000 gallons/day
- 7.5% TS = 3780 lbs/day DM, 91.5% MC
- 40% TS removal
  - 1512 lbs/day DM, 6.3 CY/day, 65% MC
- 1512 lbs/day DM, 6.1 CY/day, 35% MC
- 5900 gal/day
  - 2268 lbs/day DM, 95% MC

DM: Dry Matter
MC: Moisture Content
TS: Total Solids