Herbaceous Biomass for Heat
US Energy Policy

$4.00
Means “Energy Crisis”

Means “No worries”

$3.99
Non-traditional Use of Perennial Forages

Mixed or Pure Species

(Consistency)
Pure Species

(Fiber)
Processed Products

Baled or Densified

(Any Composition)
Any Species

Yield & Composition

Feedstock may be densified or not, but unprocessed.

Yield

Biofuels
Plastics
Paper
Organic composite board

Absorbants
Bedding
Compost
Mulch

Biogas
Bioheat
Biochar
NY and New England = 80% of the nation’s heating oil demand.

Over ½ of the liquid fossil fuel in the Northeast is used for heating. New York has more tons of ‘old’ grass available for heating than wood. Grass has slightly less BTUs/lb than premium wood pellets.
Bioheat - Composition does matter for combustion.

Chlorine, Potassium, & Nitrogen
Biomass Yield & Quality in Northern NY

Switchgrass, Tall fescue, Reed canarygrass

Clay soil site and Sandy soil site
Chloride %, 3 years and 2 locations

('CSG' = cool-season grasses)
Chlorine content of grasses

Grass cut and sampled in Summer (CSG) or Fall (WSG)

0.07% to 1.36% Chloride.

Switchgrass baled in Fall:

0.03% Cl

Switchgrass baled in Spring:

0.01% Cl

Premium wood pellets ≤ 0.03% Chloride
What happens to overwintered switchgrass?

Yield components after overwintering standing in the field:

- **Blade**: 15% Ash, 4.2% (7200 BTU per dry pound)
- **Sheath**: 19% Ash, 2.7% (7600 BTU per dry pound)
- **Stem**: 64% Ash, 0.8% (8000 BTU per dry pound)
- **Head**: 2% Ash, 4.4% (8400 BTU per dry pound)
Overwintering Switchgrass in windrows vs. standing. Yield loss depends on the winter.

Three Year Averages – two fields

Overwintered windrow vs. Fall-baled switchgrass
- 25% yield

Spring mowed & baled vs. Fall-baled switchgrass
- 35% yield

Up to 50% loss in spring-mowed grass.
We are evaluating mulch hay in NYS.

Soil contamination of hay may be significant.
Biomass transport is problematic.
Global biomass volumes required to achieve a 50% reduction in greenhouse gas emissions by 2050.

Local closed-loop biomass system solves this problem!
Mobile biomass densification
### EN 14961-6:2012 European Standard
Non-woody, non-industrial pellet standards

#### What about K?

<table>
<thead>
<tr>
<th></th>
<th>Miscanthus</th>
<th>Reed canary</th>
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<tbody>
<tr>
<td>Moisture, %</td>
<td>&lt;10</td>
<td>&lt;12</td>
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<tr>
<td>Ash, %</td>
<td>&lt;4</td>
<td>&lt;8</td>
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<tr>
<td>N, %</td>
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<tr>
<td>S, %</td>
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<tr>
<td>Cl, %</td>
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<tr>
<td>BTU State</td>
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<tr>
<td>minimum value</td>
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</table>
Chlorine content = soil fertility + management

0.08%
Small Square, round and large square bale boilers from Europe.
We are in the process of testing pellet stoves and boilers for emissions. (NYSERDA)

Paromax Europa Gasifier stove
Danish Reka boiler
Currently over 20 demonstrations in the N.E.
LEI Bioburner
burning wood pellets

Mean = 190 ppm

LEI Bioburner
burning grass pellets

Mean = 36 ppm
LEI Bioburner
burning wood pellets
Max. combustion temp. at 1350° F

LEI Bioburner
burning grass pellets
Max. combustion temp. at 1350° F
Sampling train for very thorough emissions analysis

Cornell Mechanical & Aeronautical Eng.
Is grass combustion up in smoke?

High grain prices

Shortage of forage

Co-fire switchgrass or grow mushrooms?

Federal policy rewards pre-ordained technologies, rather than rewarding desired outcomes. Combustion is Mature!
Biomass is not energy dense. It requires credit for environmental benefits. Grass composition is controlled by species, so soil fertility, and harvest management.

Grass pellet composition will be variable and needs to be described and/or controlled. Appliances exist that can sufficiently control emissions from grass pellets.

Grass combustion may smolder until 2022.
Herbaceous Biomass for Heat is not a “mature” technology

Best option is probably CHP

The End