Agricultural and Woody Biomass:

Contrasts and Comparisons

This Webinar is brought to you by:

Biomass Thermal Energy Council (BTEC)

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U.S. Forest Service
Wood Education Resource Center

1 PM ET, September 28, 2011

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Joseph Seymour - Moderator

- Executive Director- Biomass Thermal Energy Council (BTEC)

Quick notes

- Two Audio Options: Streaming Audio and Dial-In.
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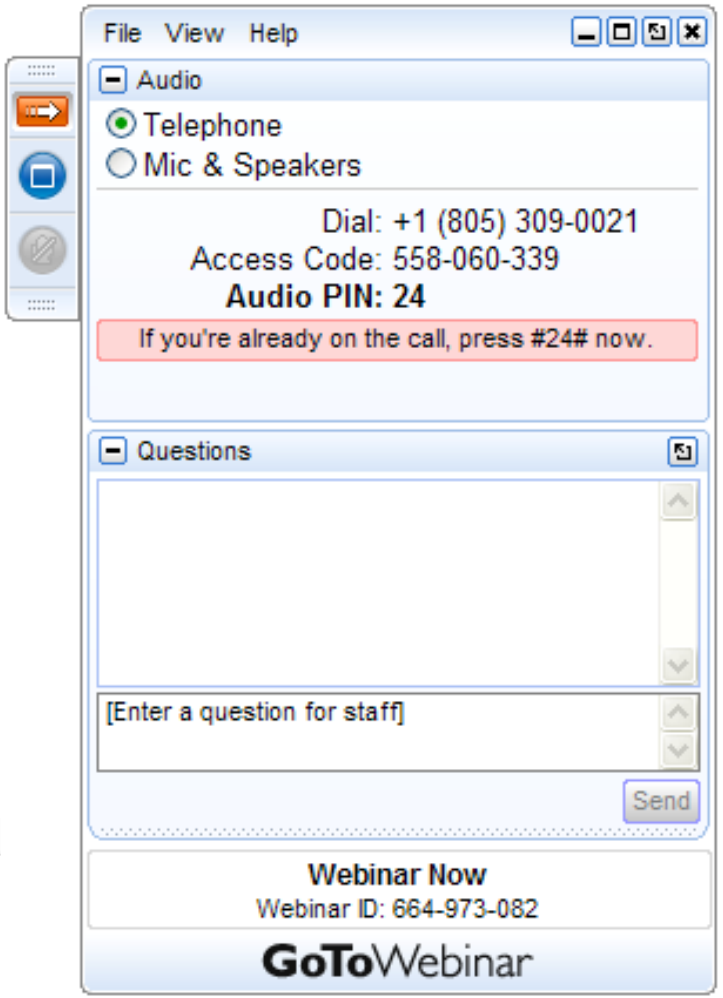


Speakers

- **John Bootle,** Founder, Renewable Energy Resources
- **Paul Cerosaletti,** Senior Educator, Cornell Cooperative Extension
- **Steve Flick,** Chairman of the Board, Show Me Energy Cooperative

Moderator

- **Joseph Seymour,** Executive Director, BTEC

Presentation Outline

I. **Introduction** – Joe Seymour
II. **Sourcing and Processing**– John Bootle
III. **Combustion Technology** – Paul Cerosaletti
IV. **New Market Opportunities** – Steve Flick
V. **Q & A, Next Events** – Joe Seymour

[Full presentation will be available online, www.biomassthermal.org/resource/webinars.asp]

Introduction to BTEC

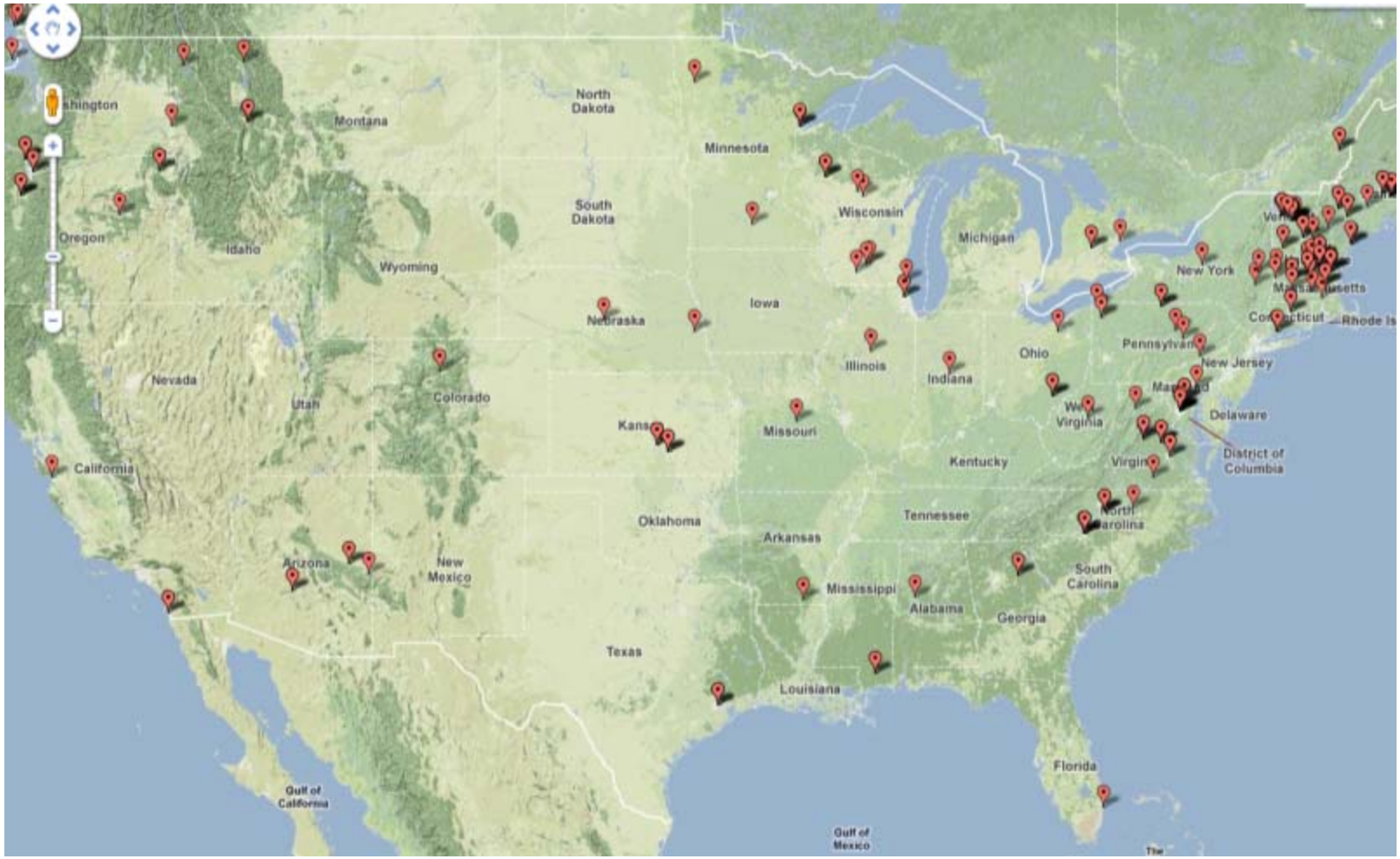
The Biomass Thermal Energy Council (BTEC) is the industry trade association dedicated to advancing the use of biomass for heat and other thermal energy applications.

Why was BTEC established?

1. To **advocate for and promote** the industry in the national energy policy debate
2. To **reach out** to and **educate** the public and decision makers on the benefits and advantages of using biomass for heat
3. To develop biomass energy **research and analysis** that enables sound investment and policy decisions

BTEC's membership*

* As of September 22, 2011



BTEC Membership

Abundant Power
ACT Bioenergy
Alliance for Green Heat
Alternative Energy Solutions International, Inc.
American Agriculture Movement
American Wood Fibers
APEX
Bear Mountain Forest Products
Beaver Wood Energy
Biomass Combustion Systems
Biomass Commodities Corporation
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Biomass Energy Works
Bionera Resources Inc.
Biowood Energy
Chip Energy
Clean Power Development
Comact Equipment
Confluence Energy
Continental Biomass Industries
Control Labs
Corinth Wood Pellet
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Ecostrat
Enviva LP
Ernst Biomass
Forest Energy Corporation
Froling Energy
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Fuel Pellet Technologies
FutureMetrics
Gavilon Group
Green Clean Heat
Indeck Ladysmith
Innovative Natural Resource Solutions
International Renewable Energy Technology Institute
International WoodFuels
Jesse E. Lyman Pellets
Krieg DeVault
Lignetics of Virginia
Maine Energy Systems
Maine Pellet Fuels Association
Marth
Missouri Corn Growers Association
Montana Community Development Corporation
National Network of Forest Practitioners
New England Wood Pellet
Northeast Mill Services
Oregon Forest Industries Council
PA Pellets
Pellet Technology USA
Pelletco
Plum Creek
Pratt & Whitney Power Systems - Turboden
Proe Power Systems
Public Policy Virginia
Rainforest Alliance
Ray Albrecht/The Fulton Companies
Renewable Energy Resources
Resource Professionals Group
Sandri Companies
Santa Energy Corporation
Sewall Company
Skanden Energy
State of Montana Department of Natural Resources and Conservation
State University of New York
Tarm Biomass
Twin Ports Testing
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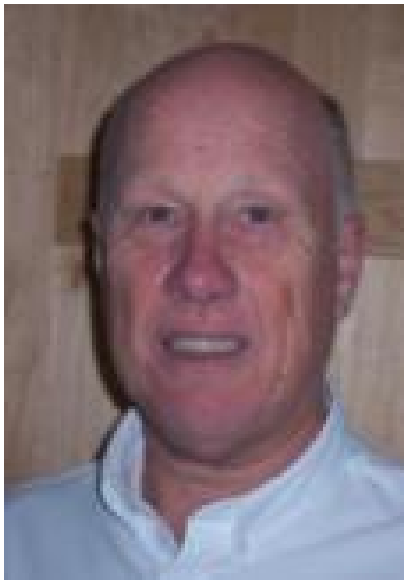
West Oregon Wood Products
Western Ag Enterprises
Westervelt Renewable Energy
Wilson Engineering Services
Wisconsin Energy Conservation Corporation
WoodFuels Virginia LLC
Woodmaster
WoodPellets.com
Zilkha Biomass Energy

Project made possible by the USDA FS WERC

- BTEC awarded a grant from the USDA Forest Service's Wood Education and Resource Center (WERC) in June 2010 to advance education and outreach on biomass thermal energy
- The Center's mission is to work with the forest products industry toward sustainable forest products production for the eastern hardwood forest region.
- Previous webinars available at: www.biomassthermal.org/resource.
- All questions and attendee feedback will help form future activities.

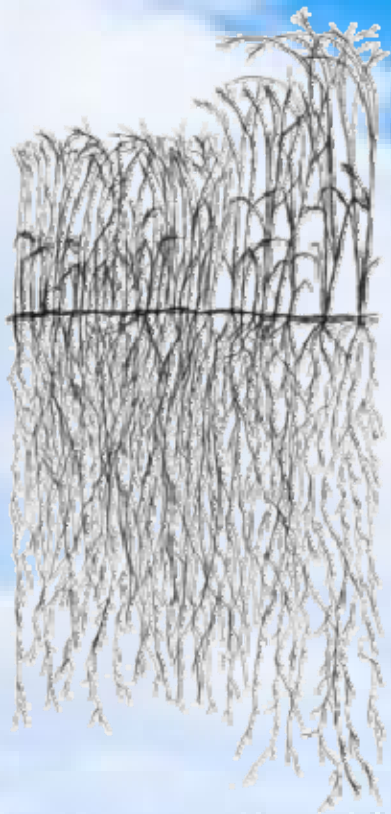
Remember to answer the survey at the webinar's conclusion!

John Bootle



- Founder,
  Renewable Energy Resources

Sourcing and Processing



Renewable Energy Resources

Biofuel from grassland
Sustainable and Local

"Field to Flue"

RER inspecting grass in field prior to harvest

Delivery for processing

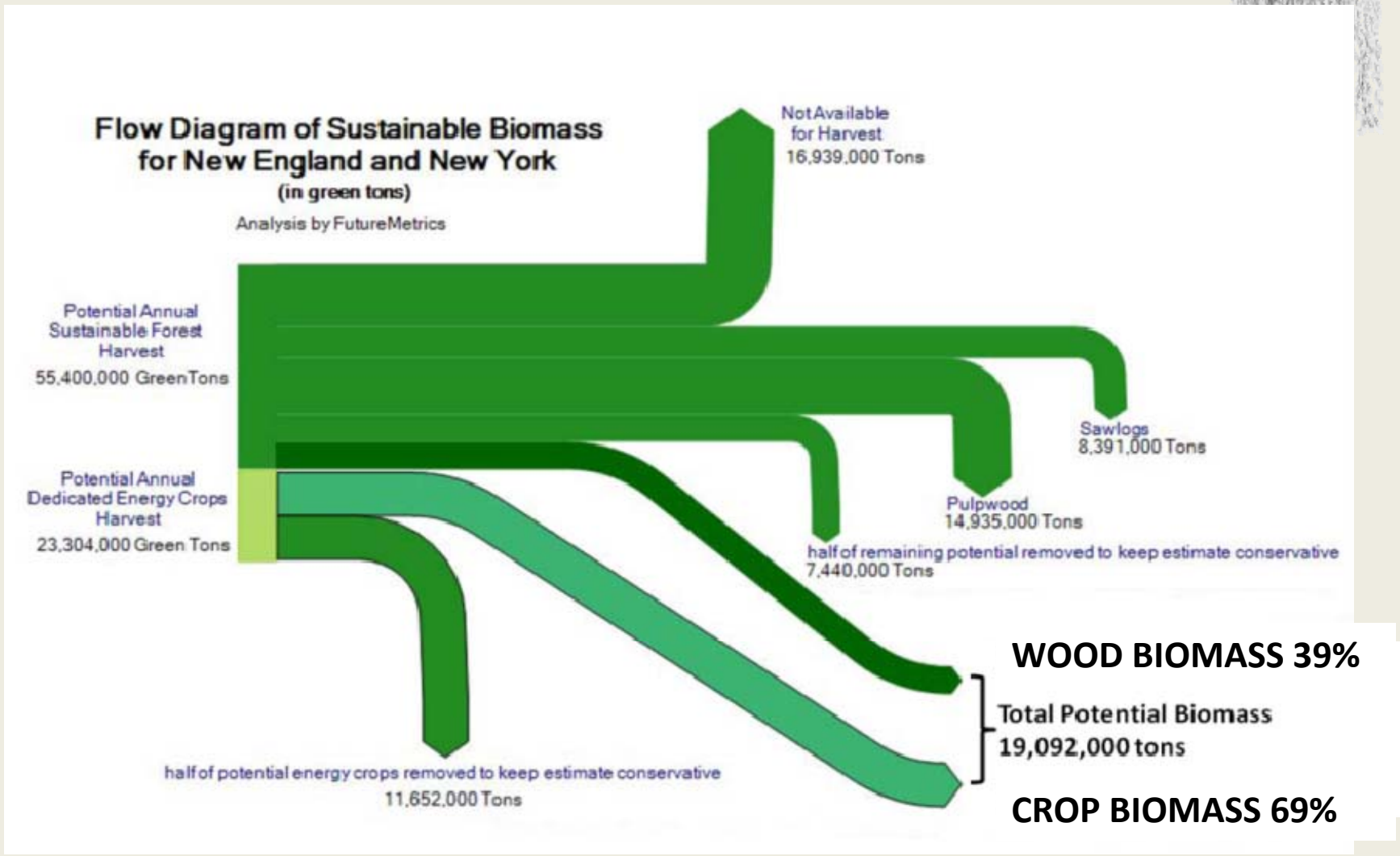
RER Compacting Switchgrass into Briquettes

Flue

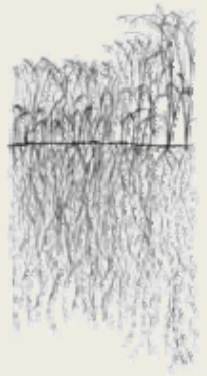
Boiler

Delivery to boiler

Crop Biomass– Why it is important

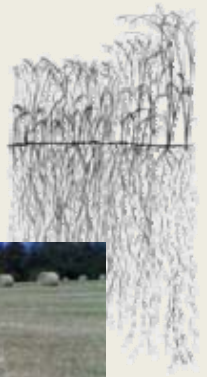


Benefits



- Highest efficiency – direct heating
  - Economic Benefits
    - Low cost and sustainable
    - Local production
      - $$ stay in local economy
    - Local fuel supply
      - Fuel security
    - Benefit to local community more important than $$ alone
    - Consistent with National objectives for energy use
  - Environmental benefits
    - Crop biomass is faster method to reduce carbon emissions than wood
    - Improved wild life/bird habitat
      - Late harvested after birds have bred
    - Deep roots
      - Improved soil quality
      - Improved water quality

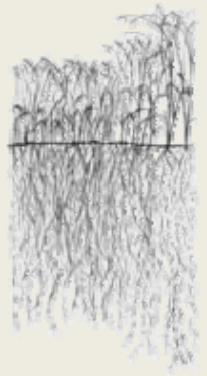
Crop Species



- Agricultural waste
  - Mulch hay
  - Corn stover
    - Low cost
- Specialist energy crops
  - Switchgrass, Miscanthus, Arundo, Etc
    - Higher yields
      - 3 ½ - 15+ ton/acre
    - Yields depend on length of growing season

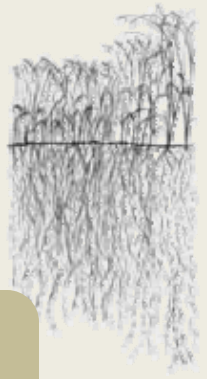
Miscanthus trial on an INRA test field. Credit: INRA/S Cadoux

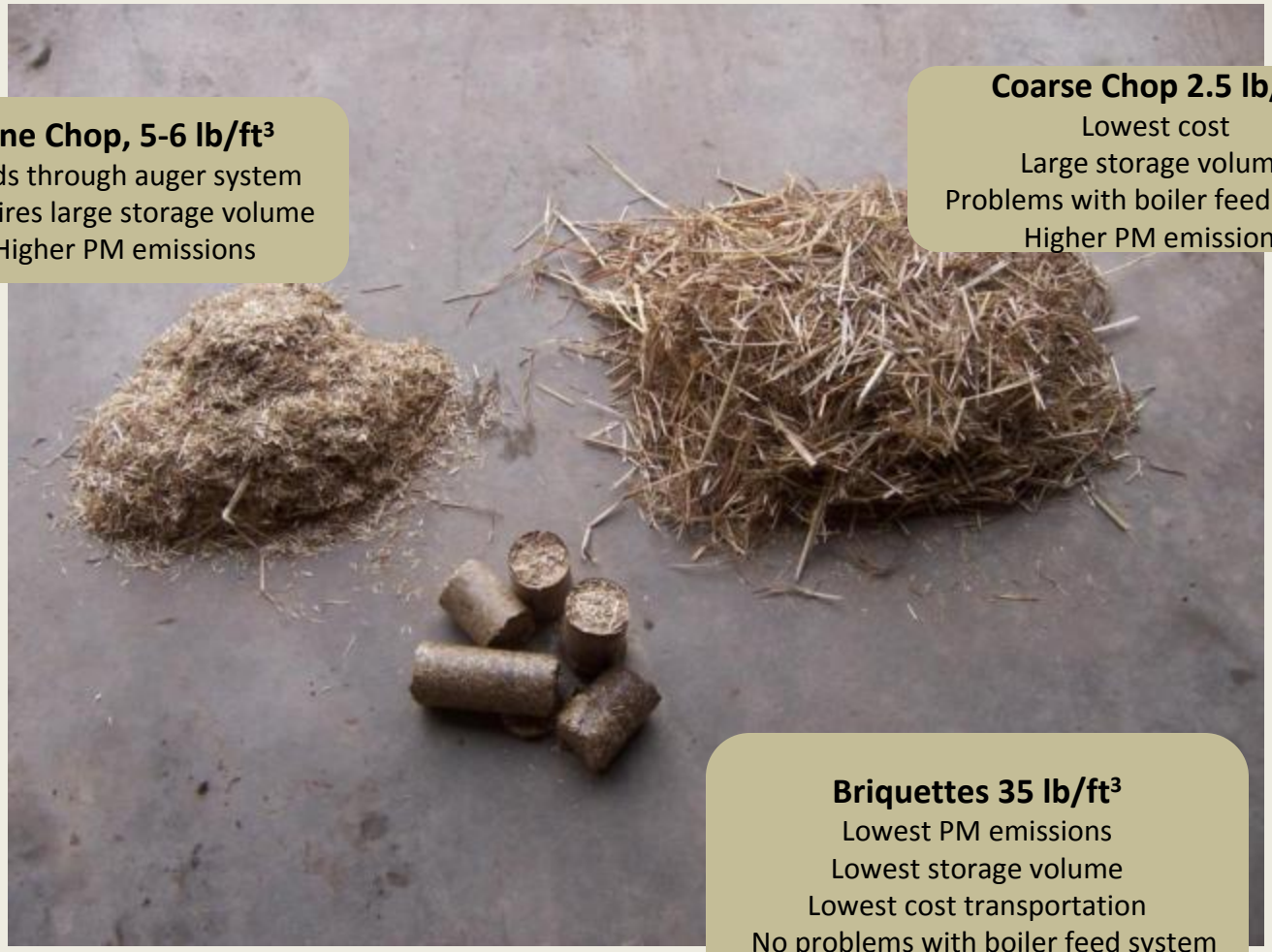
Energy Content



- All grasses have about the same energy content
  - ≈ 16 MBTU/dry ton
    - Grasses have different mineral contents,
      - % of leaves
        - » Ash content
        - » Slagging & Fouling
        - » Corrosion
        - » Emissions
      - Experience demonstrates that all issues associates with high mineral content can be effectively eliminated with correct combustion and harvesting
- Test results show
  - Switchgrass burns cleaner than some other grasses

Grass Biomass Fuels



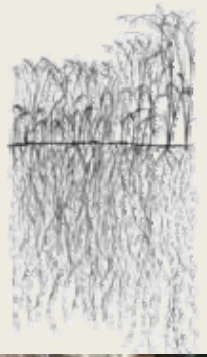


Fine Chop, 5-6 lb/ft³
Feeds through auger system
Requires large storage volume
Higher PM emissions

Coarse Chop 2.5 lb/ft³
Lowest cost
Large storage volume
Problems with boiler feed system
Higher PM emissions

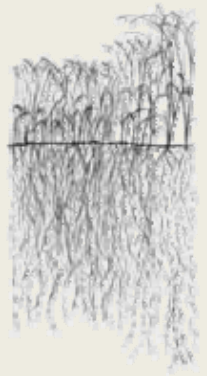
Briquettes 35 lb/ft³
Lowest PM emissions
Lowest storage volume
Lowest cost transportation
No problems with boiler feed system

Material Handling to Boiler



- Grass briquettes are dumped into storage pit
  - On-site storage- 3-5 days supply at peak load
- Fuel is feed by auger from storage pit to boiler
  - Multi-fuel handling capability able to handle and burn either wood chip or grass biomass

Boiler System



- Crop Biomass is reliable and well proven
  - Hospitals, schools, colleges, etc.
  - Examples
    - Benton, PA, Burkeville: VA, Schools: MD & NY, Ski area and hotels, Power plants, Mid-west, Europe
- Many boiler manufacturers
  - Challenger, Skanden, Messersmith, Hurst, Viessmann, Chiptech, Etc.
    - Not all are multi-fuel
- **Recommendation**
  - True multi-fuel boiler system
    - Capable of burning any biomass –Wood or Crop
      - Automatic computer controlled fuel feed systems
      - Automatic ash removal system
      - Remote monitoring
  - Greater fuel security can burn any biomass fuel
    - Results in high reliability & great security

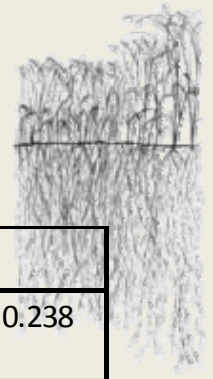
Typical Boiler Systems

- 45 yr old biomass boiler
  - 220 HP
- 10 tons/day
  - Chopped switchgrass
  - Chopped miscanthus
- Fixed grate
- Clear ash by hand
  - 1 time per day
- No slagging or fouling issues

- 2 yr old biomass boiler
  - 225 HP
- 3.5 tons/day
  - Briquetted switchgrass
    - Cleanest burn
  - Chopped switchgrass
- Firing on demand
- Automatic ash removal augers
- No slagging or fouling issues

Grass biomass burns efficiently in commercial boilers

Emissions

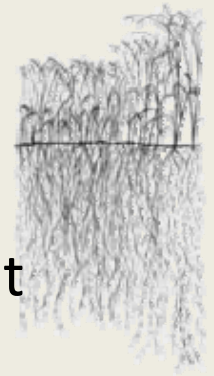


- States have different Clean Air permitting requirements
  - So check local requirements
- EPA regulations
  - Particulate matter limited to 0.07 lb/MMBTU
  - To comply with regulations
    - Systems will require multi-cyclone and bag-house to achieve new EPA levels
  - Monitor CO to ensure clean burn

Emissions		
Filterable Particulate	LB/MBTU	0.238
Nitrogen Oxides	LB/MBTU	0.289
Carbon Monoxide	LB/MBTU	0.130
Switchgrass Consumed	LB/HR	420

Fuel analysis				
		Moisture & Ash Free	Mositue Free	As Received
Moisture Total	%			13.58
Ash	%		3.25	2.81
Volatile Matter	%	86.89	84.07	72.65
Fixed Carbon	%	13.11	12.68	10.96
Gross Heating Value	BTU/lb	8432	8158	7050
Sulfur	%	0.3	0.29	0.25
Carbon	%	49.98	48.36	41.79
Hydrogen	%	6.06	5.88	6.6
Nitrogen	%	0.38	0.37	0.32
Oxygen	%	43.26	41.85	48.23

Lessons

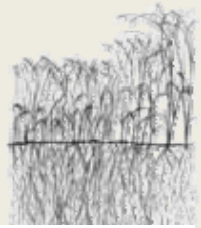


- How and when Grass- biomass is harvested is important
  - Grass for biomass is different than grass to feed cows
  - Biomass standards are necessary
  - Time of harvest is important if grass harvested early results in higher emissions
- Benefits of Briquettes
  - Briquettes are more dense than chopped grass
  - Lower transport costs
  - Less frequent fuel deliveries
  - Burns better
  - Reduced PM
  - Easier to manage boiler

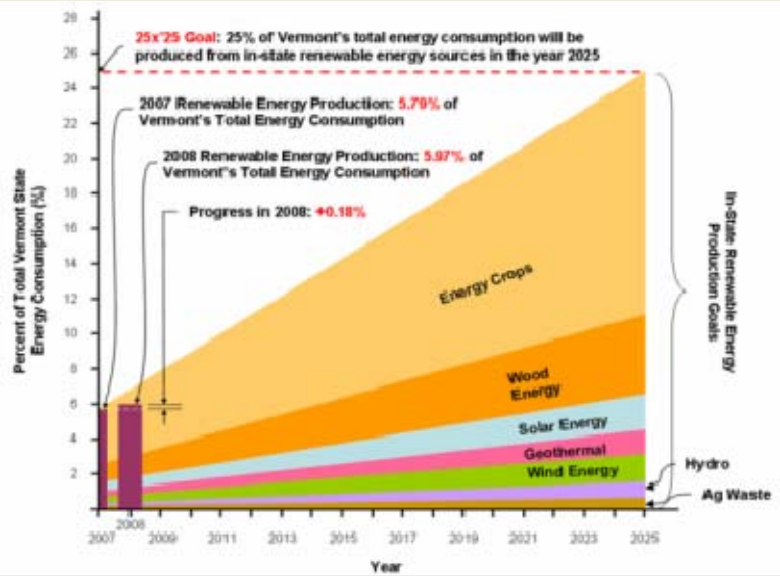
Standards

- Standards are important to produce a consistent high quality product with low emissions
- RER are preparing a general standard that will include
  - Species
    - Switchgrass
    - Big Blue Stem
    - Indian Grass
    - Wild Flowers & Legumes
  - Harvest time
    - Moisture content
    - Mineral content
  - Cutter height
    - Avoid stones
  - Bale
    - Size – shape and size for ease handling and processing
    - Sisal – natural fiber

Summary

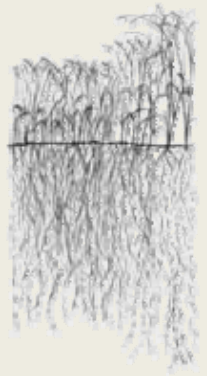


Oil	Traditional	Limited Unstable?	Highest
Wood chips	Popular in NE USA	Competition Out of state	Lowest short term
Grass biomass	Widespread in Europe	Local 30 mile radius	Lowest project life



- **Benefits of grassy biomass**
  - Fuel security
  - Grown within 30 mile radius
  - $$$ stay in local economy
  - Lowest long term cost
  - Consistent with State objectives for energy use
  - Fastest method to reduce carbon footprint
  - More information
    - John Bootle
    - Renewable Energy resources
    - JohnBootle@Switchgrass-RER.com
    - 802-379-8553

Additional information



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Combustion Technology

The Catskill Grass Bio-Energy Project:

Perspectives on Ag and Woody Biomass Combustion

Paul Cerosaletti

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Delaware County: *Home to…..*

Nearly 2 Million acres of haycrop harvested annually in NYS……..

……There are nearly 1.5 million acres of unused or under utliized ag land in NYS.

The Catskill Grass Bio-Energy Project

- A Production to Consumption Research and Demonstration Project:
  - Grass biomass production and processing
  - Demonstrate combustion residential and small business applications
    - 9 demonstration sites
  - Educate public on grass biomass thermal bioenergy

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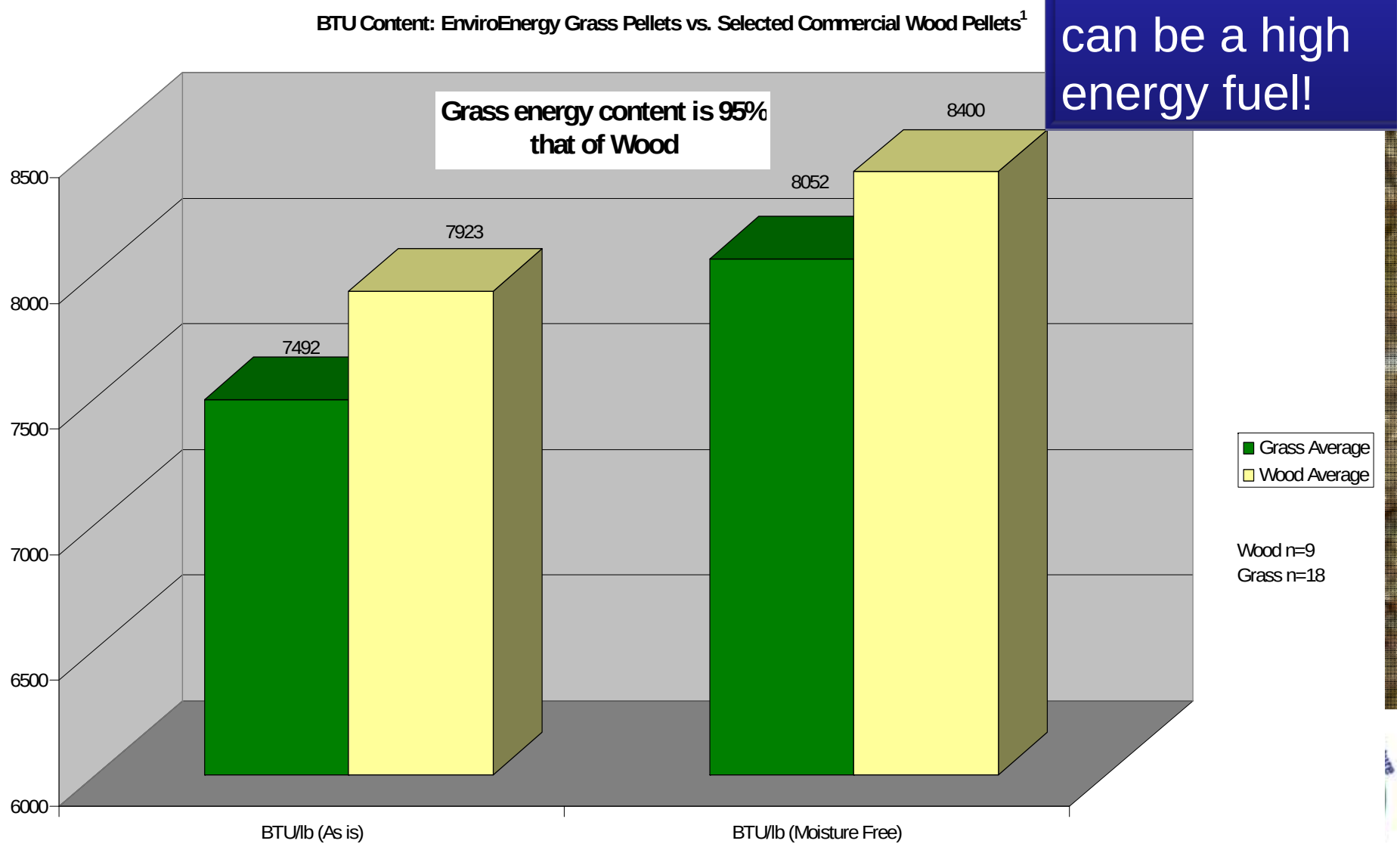
Grass Biomass as a Fuel

Grass biomass can be a high energy fuel!



Ag and Wood Biomass: Comparisons and Contrasts

Combustion

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Contrasts and Comparisons: Combustion

1. Functionality
2. Emissions

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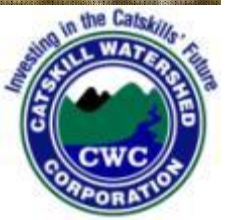

Combustion technology

- Most combustion units on the market have been developed for, and work well with wood pellets.
- Some units are marketed for corn
- A few are now developed for “biomass”

What’s the difference? – What are the issues?

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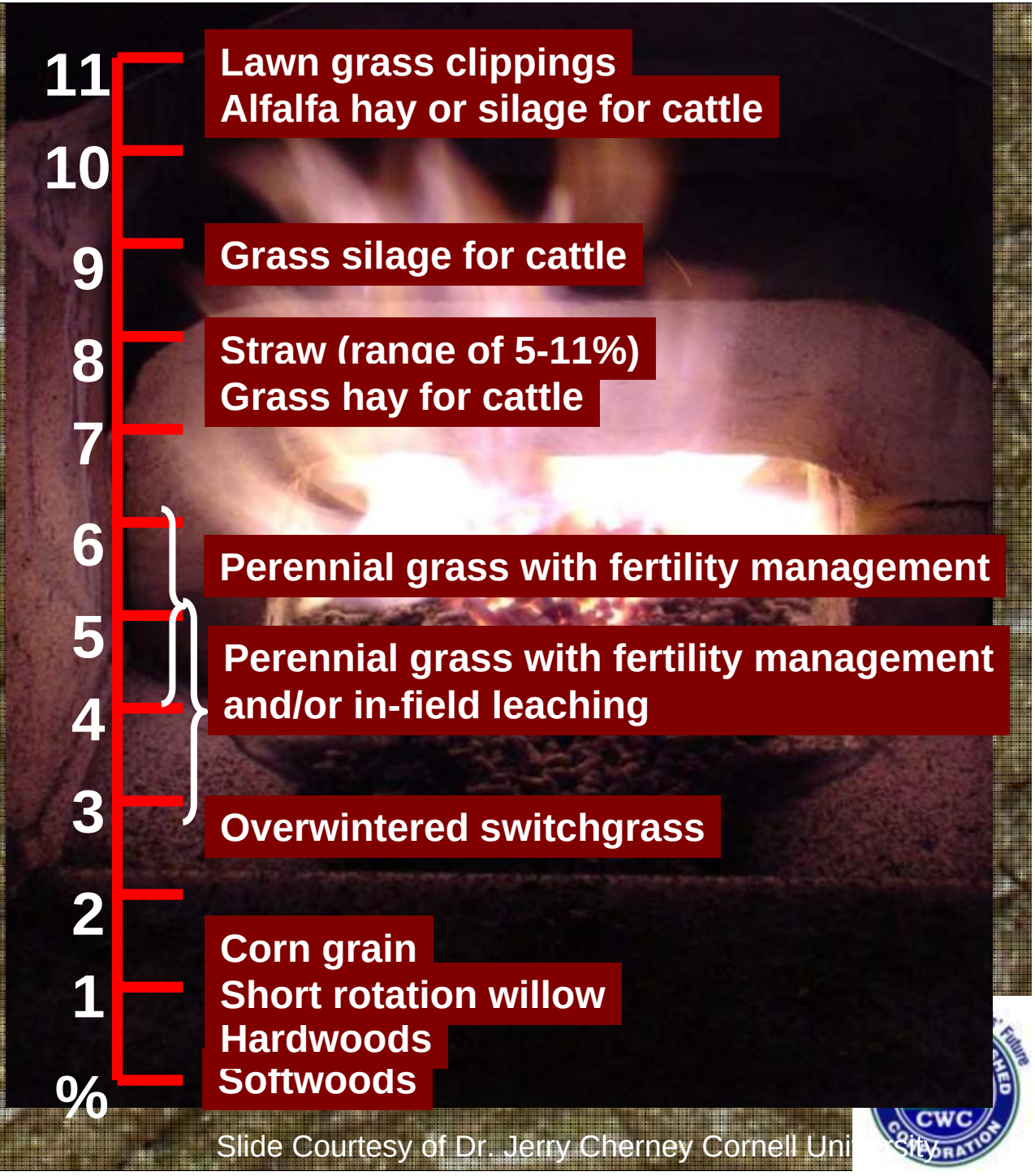
Potential issues with grass combustion

1. Clinkering (melting of ash)
2. Corrosion potential
3. Convenience
4. Emissions

Slide Courtesy of Dr. Jerry Cherney Cornell University

Ash Content of biomass



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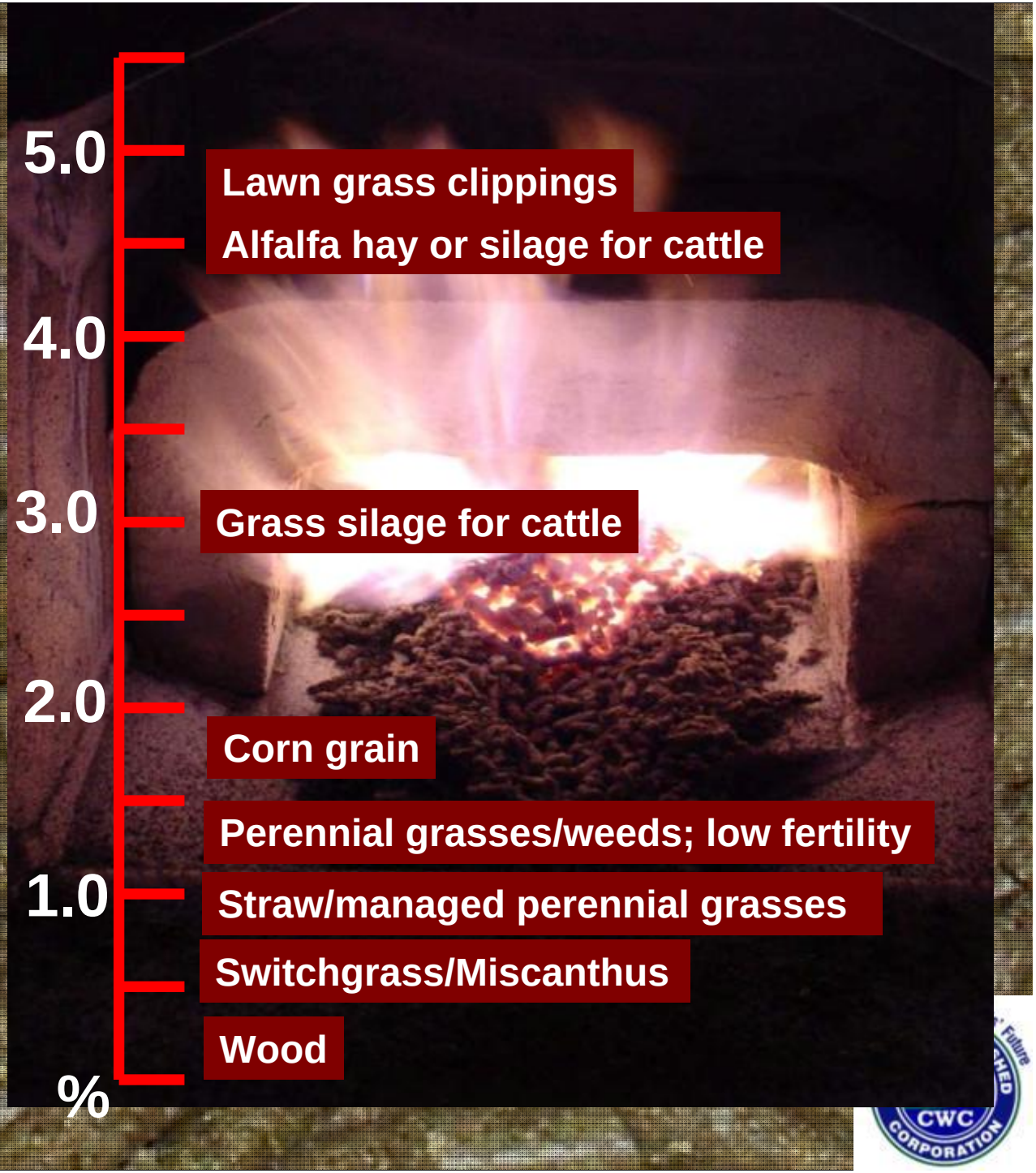
Slide Courtesy of Dr. Jerry Cherney Cornell University

Nitrogen Content of biomass



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Biomass Combustion Issues

Nitrogen

- Possibility of NOx emissions.

Potassium

- Contributes to corrosion and buildup.
- Contributes to particulate emissions.

Chlorine

- Catalyzes corrosion and buildup.
- Contributes to particulate emissions.
- Possibility of dioxins and other toxics.

Sulfur

- Contributes to particulate emissions.
- Contributes to sulfate deposits.

For Grass: Minimize through fertilization & leaching.

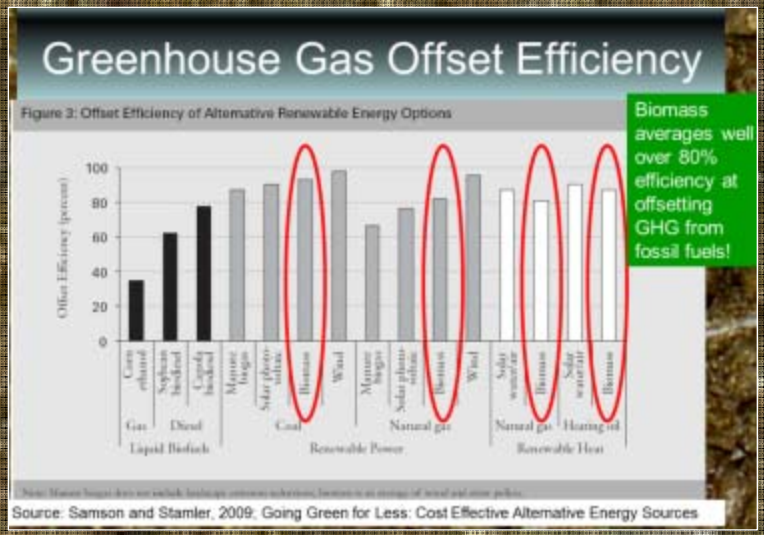
Slide Courtesy of Dr. Jerry Cherney Cornell University

Contrasts and Comparisons: Combustion

- Emissions:
  - Ag biomass higher in Nitrogen content
    - = higher NOx emissions
  - Grass similar (or lower) in CO and SO_2 emissions.
  - Particulate emissions - Grass maybe lower

Contrasts and Comparisons: Combustion

- Thermal Biomass Common Ground:
  - When having the emissions discussion we need to be also talking about "*Life Cycle" Greenhouse Gas Production.*
  - Thermal biomass wins this argument



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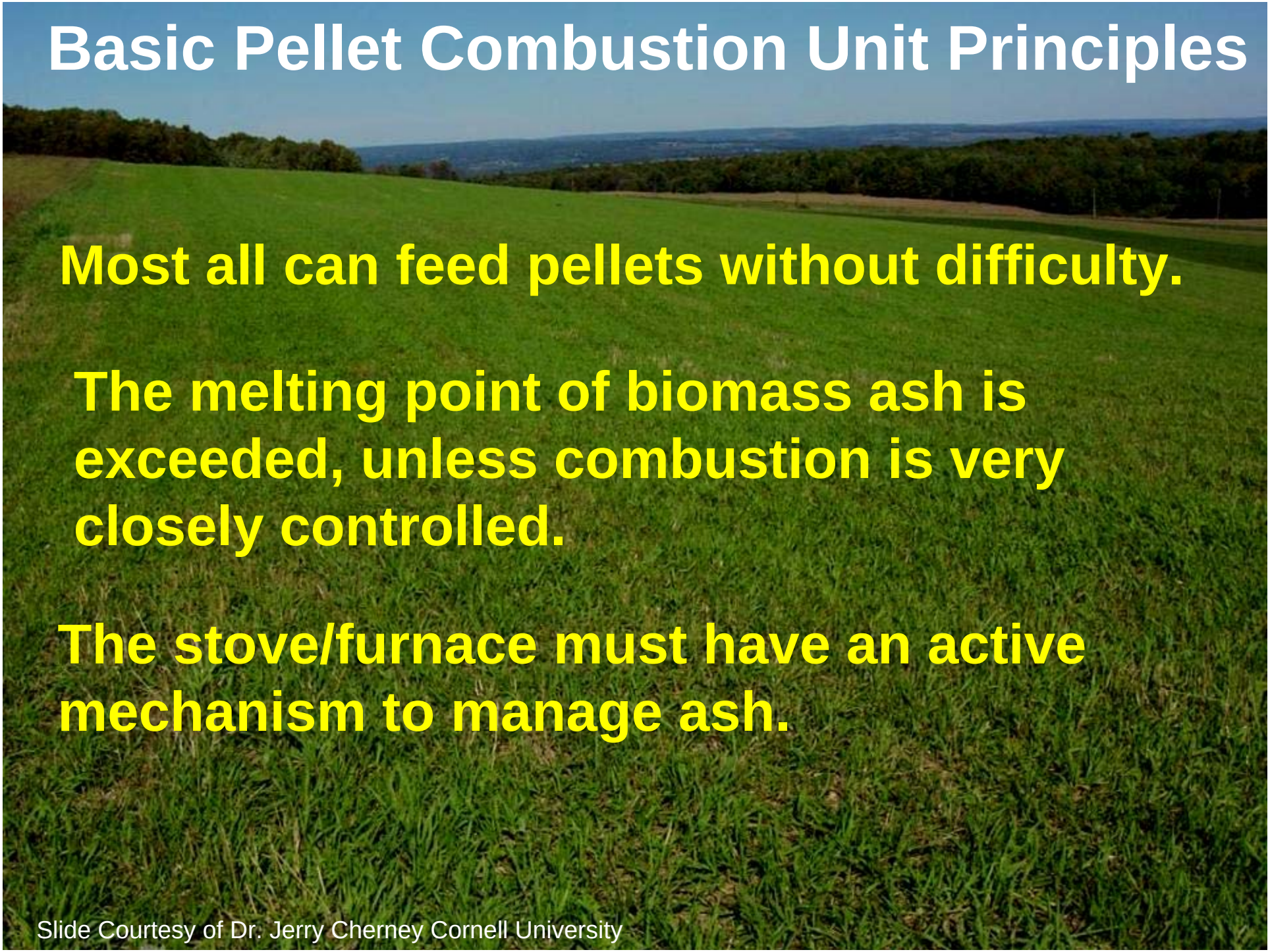
Basic Pellet Combustion Unit Principles



Most all can feed pellets without difficulty.

The melting point of biomass ash is exceeded, unless combustion is very closely controlled.

The stove/furnace must have an active mechanism to manage ash.

Slide Courtesy of Dr. Jerry Cherney Cornell University

Grass Combustion Successes

- Have found units that will work with grass biomass
- Have burned 97 tons of grass pellets to date in project.
- Little clinkering under normal burn.
- Have realized significant fuel savings.

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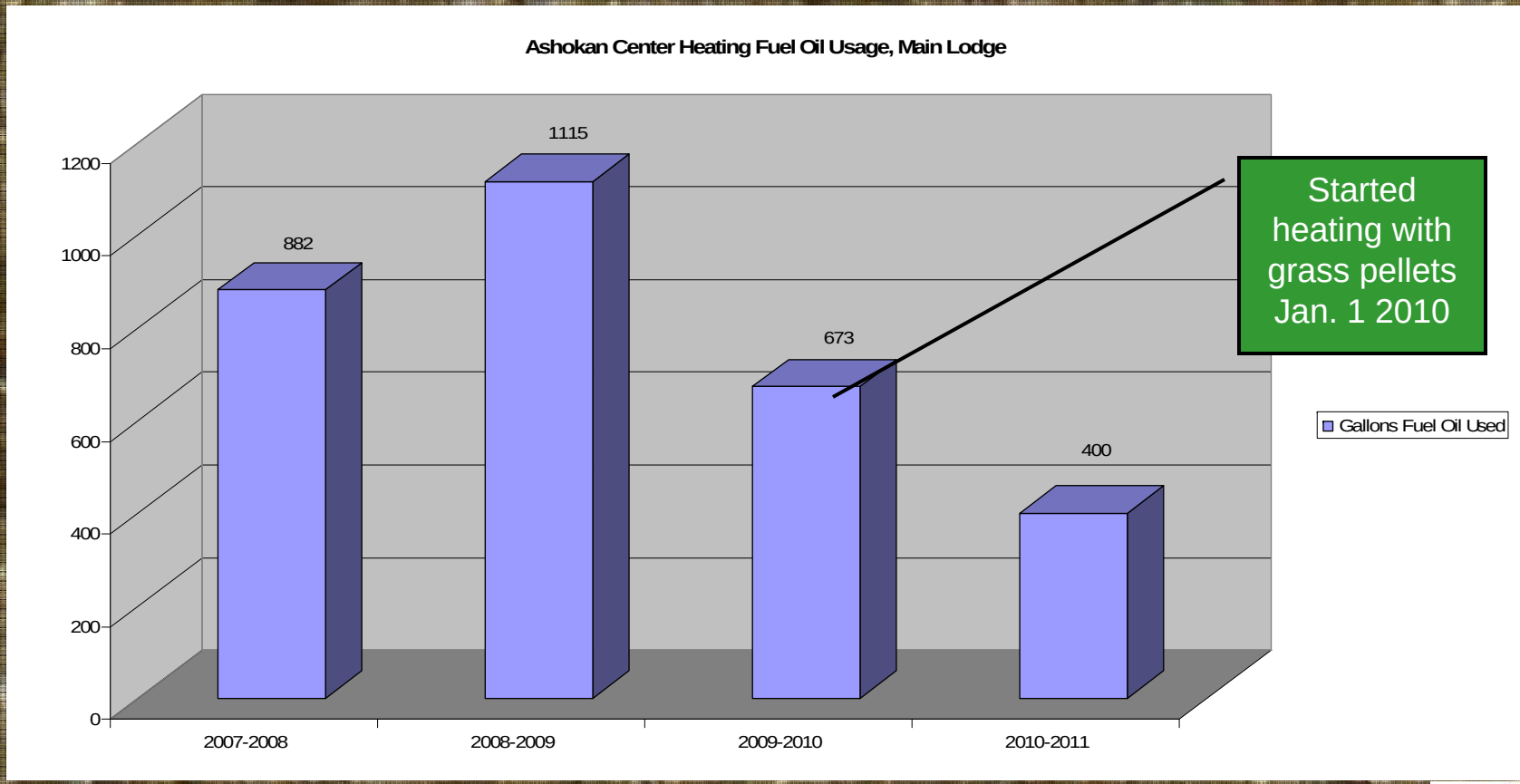
Ashokan Center Fuel Oil Usage



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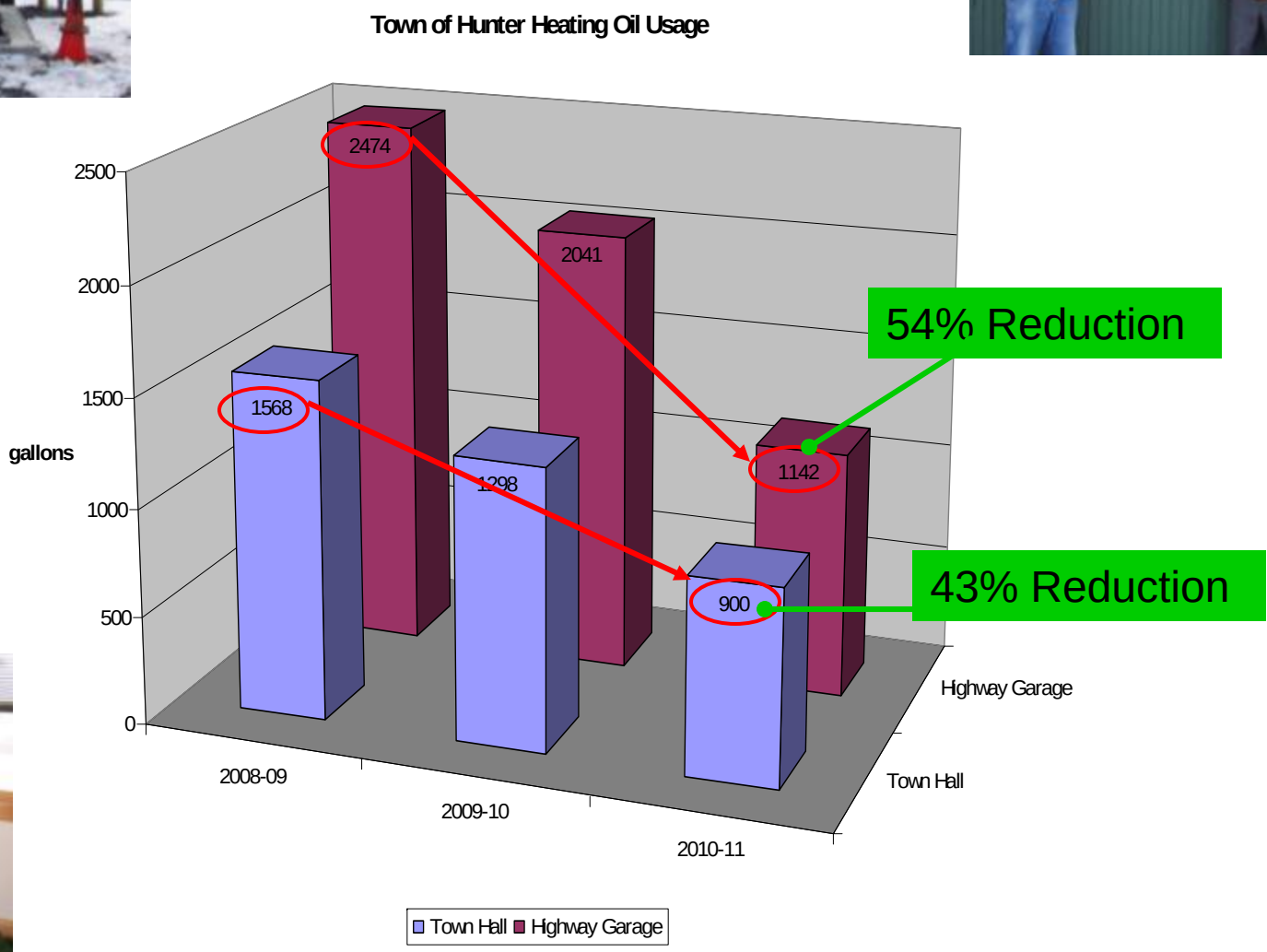
Town of Hunter



e Extension
re County

Combustion Experience

- Insufficient support from manufacturers for their products – particularly home/business scale heaters.
  - Dealer networks don't emphasize service.
  - Mechanical issues not entirely resolved.
    - This is not fluid mechanics
  - Need recognition of ag biomass and develop technology accordingly.

Ag Biomass Compatible Biomass Hydronic Pellet Furnaces Examples

Verner - Czech

Reka – Danish

Brandelle – Canadian

Bio-Burner – USA

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Ag Biomass Compatible Indoor Biomass Stoves Examples

Harman P series

Quadrafire Mt. Vernon

Paromax Europa

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Ag Biomass:
Challenges/Opportunities for
the Future

A Vision for Ag Biomass

- Eat Local ***- Heat Local!***
  - A large population of people that want to be energy independent and support local agriculture and the local economy
  - We need to capitalize on this
    - Educational Campaign with Public re. Biomass!!
      - Biomass in general/ Ag Biomass
      - Local biomass

A Vision for Ag Biomass

- "Build It and They Will Come"
  - Need for large "anchor users" (municipal scale) to support development of industry.
- "Don't Stay Off the Grass"
  - Opportunity for appliance industry to develop units that work with wide range of biomass types.

A Vision for Ag Biomass

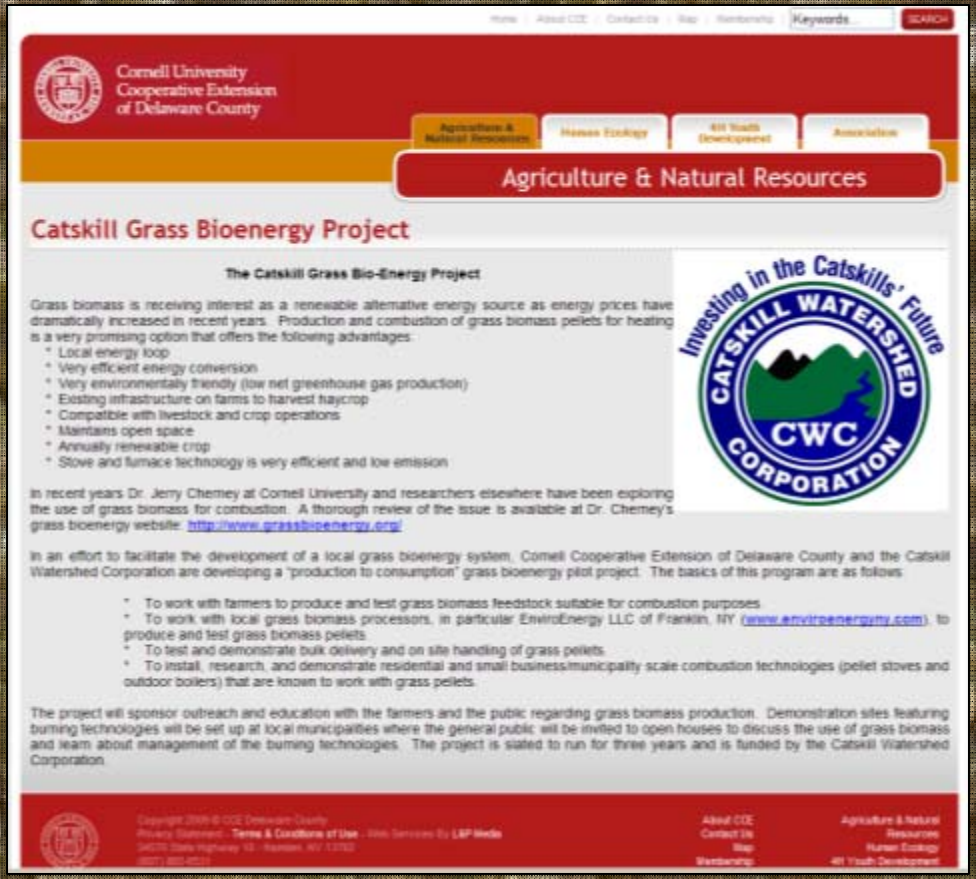
- "Biomass for the Masses"
  - Need technology that is affordable.
  - Range of users
  - Small stove technology works – and there are a lot of people that want to use grass biomass and deal with its issues.
  - Mid scale technology (<1,000,000 BTU) - "Opportunity area".

A Vision for Ag Biomass

- Local Biomass Feed Stock development and management.
- Continued Ag Biomass research.
- Address regulations.
  - Certify Ag Biomass types as approved fuels;
- Get more examples of heating with biomass out there.
- Build this industry from the ground up – do it right.

Visit us on the Web!

www.ccedelaware.org



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Agriculture & Natural Resources

Catskill Grass Bioenergy Project

The Catskill Grass Bio-Energy Project

Grass biomass is receiving interest as a renewable alternative energy source as energy prices have dramatically increased in recent years. Production and combustion of grass biomass pellets for heating is a very promising option that offers the following advantages:

* Local energy loop
* Very efficient energy conversion
* Very environmentally friendly (low net greenhouse gas production)
* Existing infrastructure on farms to harvest haycrop
* Compatible with livestock and crop operations
* Maintains open space
* Annually renewable crop
* Stove and furnace technology is very efficient and low emission

In recent years Dr. Jerry Cherney at Cornell University and researchers elsewhere have been exploring the use of grass biomass for combustion. A thorough review of the issue is available at Dr. Cherney's grass bioenergy website: http://www.grassbioenergy.org/

In an effort to facilitate the development of a local grass bioenergy system, Cornell Cooperative Extension of Delaware County and the Catskill Watershed Corporation are developing a "production to consumption" grass bioenergy pilot project. The basics of this program are as follows:

* To work with farmers to produce and test grass biomass feedstock suitable for combustion purposes.
* To work with local grass biomass processors, in particular EnviroEnergy LLC of Franklin, NY (www.enviroenergyny.com), to produce and test grass biomass pellets.
* To test and demonstrate bulk delivery and on site handling of grass pellets.
* To install, research, and demonstrate residential and small business/municipality scale combustion technologies (pellet stoves and outdoor boilers) that are known to work with grass pellets.

The project will sponsor outreach and education with the farmers and the public regarding grass biomass production. Demonstration sites featuring burning technologies will be set up at local municipalities where the general public will be invited to open houses to discuss the use of grass biomass and learn about management of the burning technologies. The project is slated to run for three years and is funded by the Catskill Watershed Corporation.

Investing in the Catskills' Future
CATSKILL WATERSHED
CWC
CORPORATION

Steve Flick

- Chairman of the Board, Show Me Energy Cooperative
- **New Markets**

Show Me Energy Cooperative Developing Energy Today for America's Tomorrow

Developing Partnerships

SMEC Vision

- Show Me Energy Cooperative has as its guiding vision a commitment to establish an **innovative**, **profitable**, **leading model** for production of **advanced biomass based fuels** which may be replicated across the country by small producer owned cooperatives that will provide a positive economic impact on the regions where they are located.

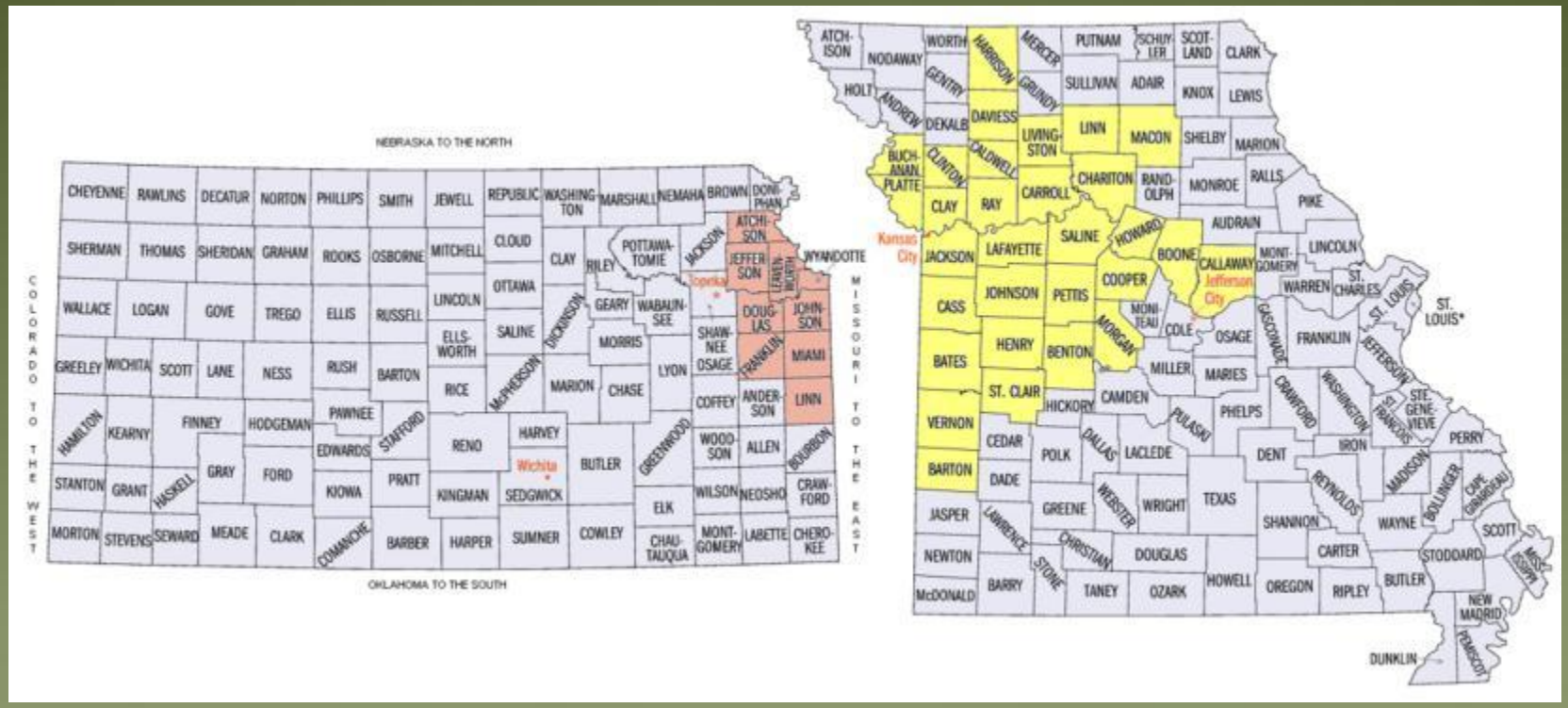
Objectives

- Innovation
- Creating Jobs
- Economic Development

Where is Centerview, Missouri?

BCAP = Biomass Crop Assistance Program

- 20,000 acres signed up in 7 weeks!



Dedicated Energy Crops

Polycultures – Native Grass

BCAP Approved Mixes

Mix # 1-Spring Seeded Upland	**Cost per acre $98.41**
Pure Live Seed (PLS) Rates for seed drilled into residue or a tilled field:	
Big Bluestem, Roundtree	3.0 pounds/acre x $7.80 =$23.40
Indiangrass, Rumsy	3.0 pounds/acre x $7.90 = $23.70
*Switchgrass, Blackwell	1.8 pounds/acre x $6.90 =$12.51
Illinois Bundleflower, Native	0.9 pounds/acre x $22.00 = $19.80
Purple Prairie Clover, Native	1.0 pounds/acre x $19.00 = $19.00
Mix # 2-Fall Seeded Upland	**Cost per acre $148.58**
Pure Live Seed (PLS) Rates for seed broadcast and then rolled:	
Big Bluestem, Roundtree	4.5 pounds/acre x $7.80 = $35.10
Indiangrass, Rumsy	4.5 pounds/acre x $7.90 = 35.55
*Switchgrass, Blackwell	2.7 pounds/acre x $6.90 = $18.63
Illinois Bundleflower, Native	1.4 pounds/acre x $22.00 = $30.80
Purple Prairie Clover, Native	1.5 pounds/acre x $19.00 = $28.50
Mix # 3 Spring Seeded Lowland	**Cost per acre $114.83**
Pure Live Seed (PLS) Rates for seed drilled into residue/tilled field in lowland sites:	
Canada./Virginia Wild Rye	8.2 pounds/acre x $7.00 = $57.40
*Switchgrass, Blackwell	2.7 pounds/acre x $6.90 = $18.63
Illinois Bundleflower, Native	0.9 pounds/acre x $22.00 = $19.80
Purple Prairie Clover, Native	1.0 pounds/acre x $19.00 = $19.00
Mix # 4-Fall Seeded Lowland	**Cost per acre $164.19**
Pure Live Seed (PLS) Rates for Seed Broadcast and then rolled:	
Canada/Virginia Wild Rye	12.3 pounds/acre x $7.00 = $86.10
*Switchgrass, Blackwell	4.1 pounds/acre x $6.90 = $28.29
Illinois Bundleflower, Native	1.4 pounds/acre x $22.00 = $30.80
Purple Prairie Clover, Native	1.0 pounds/acre x $19.00 = $19.00

***Add $7.00 per pound for Kanlow and /or Alamo Switchgrass**

Discounts:
If you order and pay for before Oct 1, 2011 you get 5% off

If you order more than 20 acres you get 5% off

Delivery of Biomass to Centerview

Weight, Moisture, BTU, and Sugars

Biomass Energy Pellets

Show Me Energy Coop has developed an Advanced Biofuel Recognized by USDA

Show Me Energy Cooperative Repeatable Model

Cattle Feed

Bio-Refinery

Biomass

Liquid Fuels

Drop In Fuel

Residue

Gasificatio n

Syngas

Turbine Technology

Electricity

Heat

Aquatic Agriculture

Produce

Protein

Residue

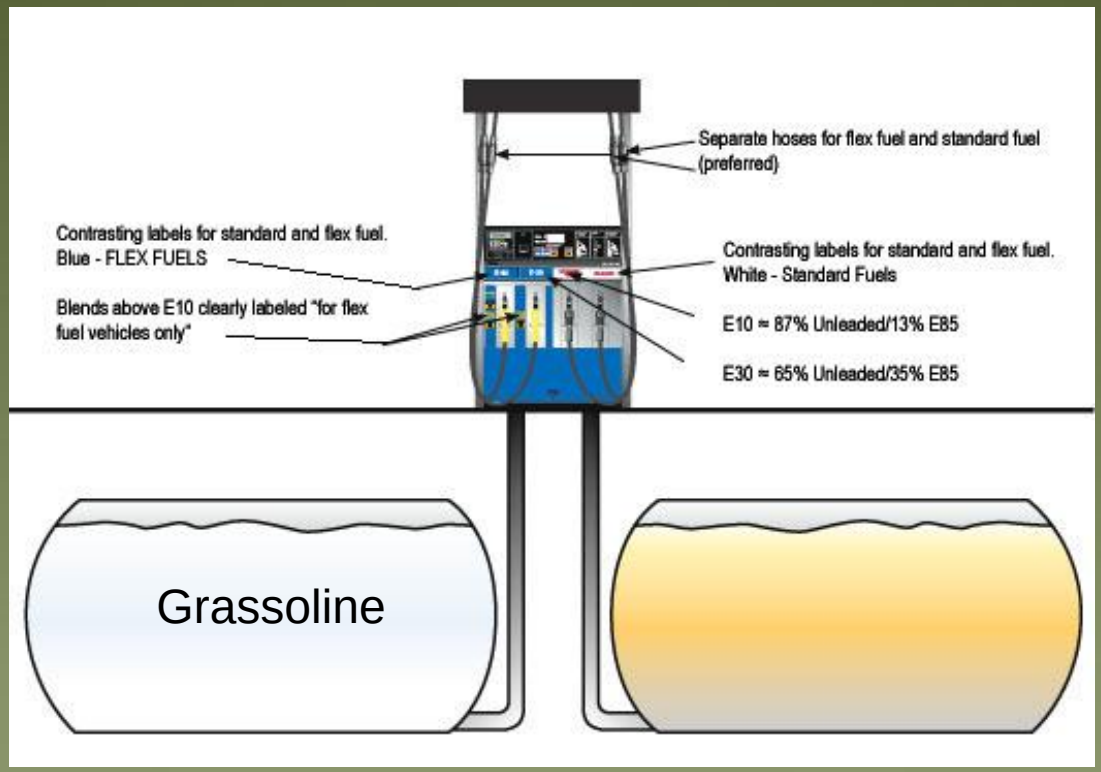
Rural America

Fertilizer

SHOW ME ENERGY CO-OP

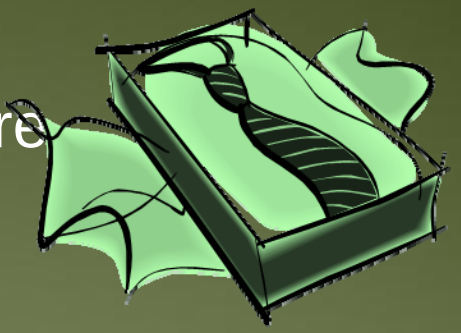
CENTERVIEW MISSOURI

DOE Approved Technology



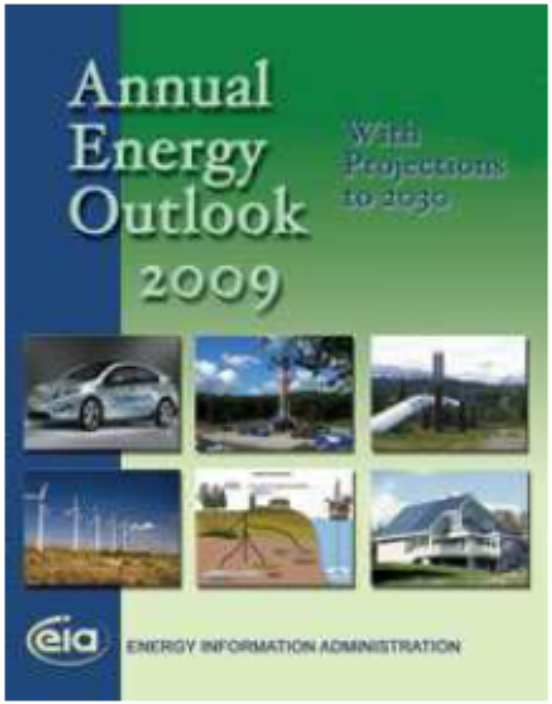
Benefits to the State of MO

- Farmers' Income
  - Increase Value Added Income Per Acre
- Rural Community Development
  - Job Creation – Green Collar Jobs
- Renewable Energy Use through Utility Companies
  - Urban and Rural Utilities Benefit
- Cleaner Water with Renewable Energy Crop Growth
- Energy Production Without Effecting the Feedstock Supply for Animals or Humans



Benefits to the United States

This presentation relies upon the USDOE EIA 2009 AEO Reference Case data …



U.S. Department of Energy (DOE) regularly publishes energy forecasts

The Challenge

U.S. Electricity Supply Challenge

How big is the effort to add by 2030 200,000 MW to U.S. electric power generating capacity?

The Reality

… and, if the growth were satisfied with coal-fired projects …

- 200,000 MW
- $500 billion @ $2,500 / kW
- 500 MW average plant size
- 400 projects
- Commission a ***new 500 MW plant every 3 weeks*** until 2030

Diverse Portfolio Needed

… or, if the growth were satisfied with wind turbine projects

- 200,000 MW
- $400 billion @ $2,000 / kW
- 1.5 MW wind turbines
- 133,000 projects
- BUT, wind turbines operate only 40% of the time
- $1,000 billion
- 333,000 projects
- Commission ***40 new 1.5 MW wind turbines every day*** until 2030

Questions?

Contact Information

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Q & A

Ask questions using the **Questions Panel** on the right side of your screen.

All questions and comments will be recorded and incorporated in the webinar summary report.

Also, please take a few moments to answer the survey questions.

Other Resources

- **biomassthermal.org/resources**
  - Podcasts

  - Interviews with key industry leaders (10+, also on iTunes Podcasts)
  - Factsheets (biomass background, job data, technology, etc.)
  - Presentation (comprehensive program information)

Upcoming Events

- Northeast Biomass Show
  - October 11-13, Pittsburgh

More Information

- **This Webinar will be available** by Monday, Oct. 3.
- **Sign up** to receive BTEC news at on our website.
- **Join BTEC for:**
  -- Frequent and timely regulatory, policy and market intelligence updates

  -- Business Development opportunities and networking with other biomass leaders

  -- Visibility as a supporter of the market's growth

  -- Discounts to nearly all major biomass industry events in the U.S.

For more info or to join, go to: www.biomassthermal.org/membership

Thank you!

If you want to learn more about the biomass thermal industry, BTEC, or membership, visit www.biomassthermal.org