

# Energy Solutions for New York State: The Role of Biofuels

Dr. Amanda Lavigne  
Assistant Professor,  
Environmental Studies

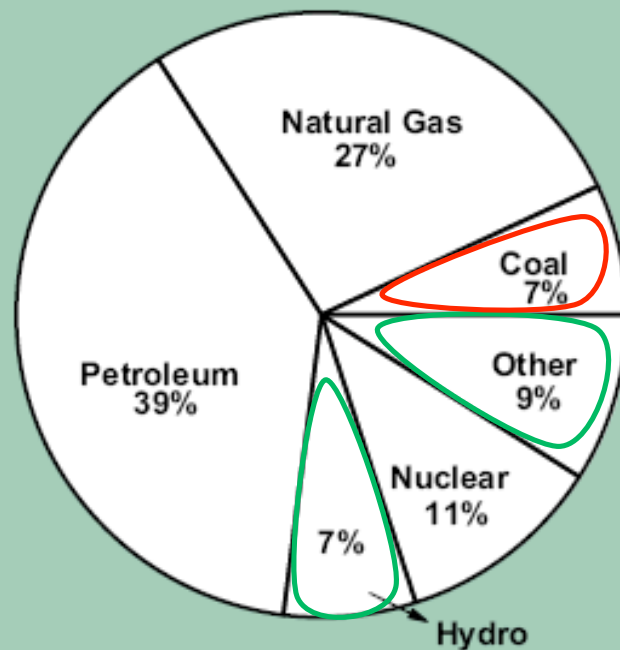
ST. LAWRENCE UNIVERSITY 

# Overview

- State of the State – current energy use
- Specific energy sector requirements
- Emerging alternative & technologies
- Trade-offs
- A recent example (time dependant)
- Questions & discussion

# New York State – Current Energy

Primary Consumption by Fuel Type, 2006



New York State

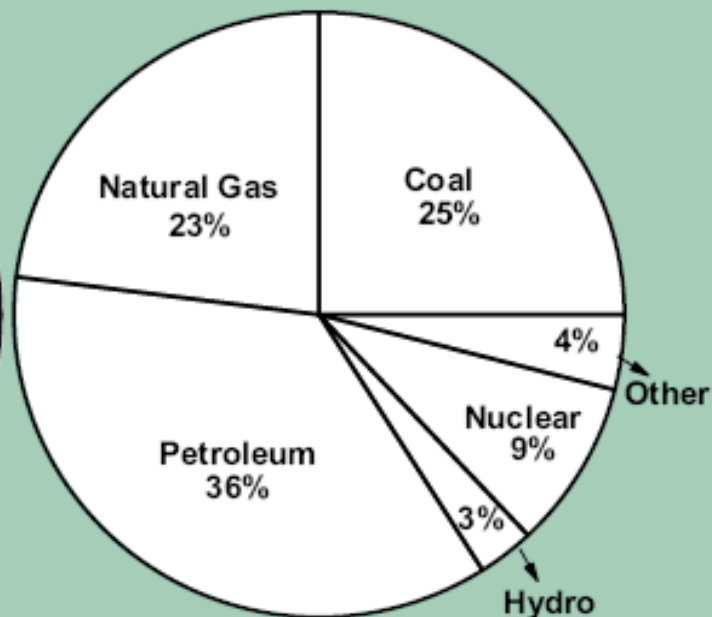
~ 4.1 Quad

~ 4,100,000,000,000,000 BTU

~ 32.8 Trillion Gallons Gasoline

~ 267 Million Air Dry Cords Fuel

Wood



United States

~ 100 Quad

# New York State – Current Energy Use

- 4<sup>th</sup> largest energy consuming state
- 4.1% of the US total primary energy consumption
  - 6.4% of population
- 2<sup>nd</sup> most energy-efficient state (per-capita)
- 4.1% reduction in total primary energy consumption from 2005
- Reliance on foreign oil as a proportion of total petroleum:
  - New York 89%



# New York State – Current Energy Use

	<u>Residential</u> TBtu	<u>Commercial</u> TBtu	<u>Industrial</u> TBtu	<u>Transportation</u> TBtu	<u>Net</u> <u>Consumption</u> TBtu	<u>Electric</u> <u>Generation</u> <sup>1</sup> TBtu	<u>Primary</u> <u>Consumption</u> TBtu
Coal	0.4	3.5	37.9	0.0	41.8	231.1	272.8
Natural Gas	361.7	264.4	80.6	10.3	717.0	399.2	1,116.2
Petroleum Products:	185.8	148.2	39.2	1,142.0	1,515.2	69.2	1,584.4
Distillate	160.2	93.5	20.9	166.9	441.5	2.6	444.1
Residual	0.0	50.0	8.2	41.1	99.3	66.6	165.9
Kerosene	10.2	2.0	2.4	0.0	14.6	0.0	14.6
LPG	15.4	2.7	7.7	0.3	26.1	0.0	26.1
Gasoline	0.0	0.0	0.0	719.5	719.5	0.0	719.5
Jet Fuel	0.0	0.0	0.0	214.3	214.3	0.0	214.3
Biofuels	58.8	14.0	15.8	37.0	125.6	46.8	172.3
Electric Sales	166.8	264.2	68.6	11.7	511.3		
Net Consumption	773.5	694.2	242.0	1,201.0	2,910.8		
				Hydro Electricity		290.0	290.0
				Nuclear Electricity		440.3	440.3
				Net Imported Electricity		189.4	189.4
				Wind Electricity		5.4	5.4
				Primary Consumption		1,671.4	4,070.9

# New York State – Current Energy Production

- 13% primary energy requirements met from in-state resources
  - 7% from hydropower
  - **4% from biofuels**
    - Wood for residential/commercial home heating
    - Industrial heat & power applications
- 100% of refined petroleum products from external sources - no in-state refineries



# New York State – Current Energy Production

## So...

Increasing fossil fuel prices +  
Decreasing fossil fuel availability? +  
Increasing environmental concerns  
– (Global warming & others)

---

= **DEVELOPMENT OF ALTERNATIVE  
ENERGY SOURCES**

- “Cheap” **and** “Green”
- **Existing** applications / infrastructure
- Greater **independence**? (define local / regional sources)

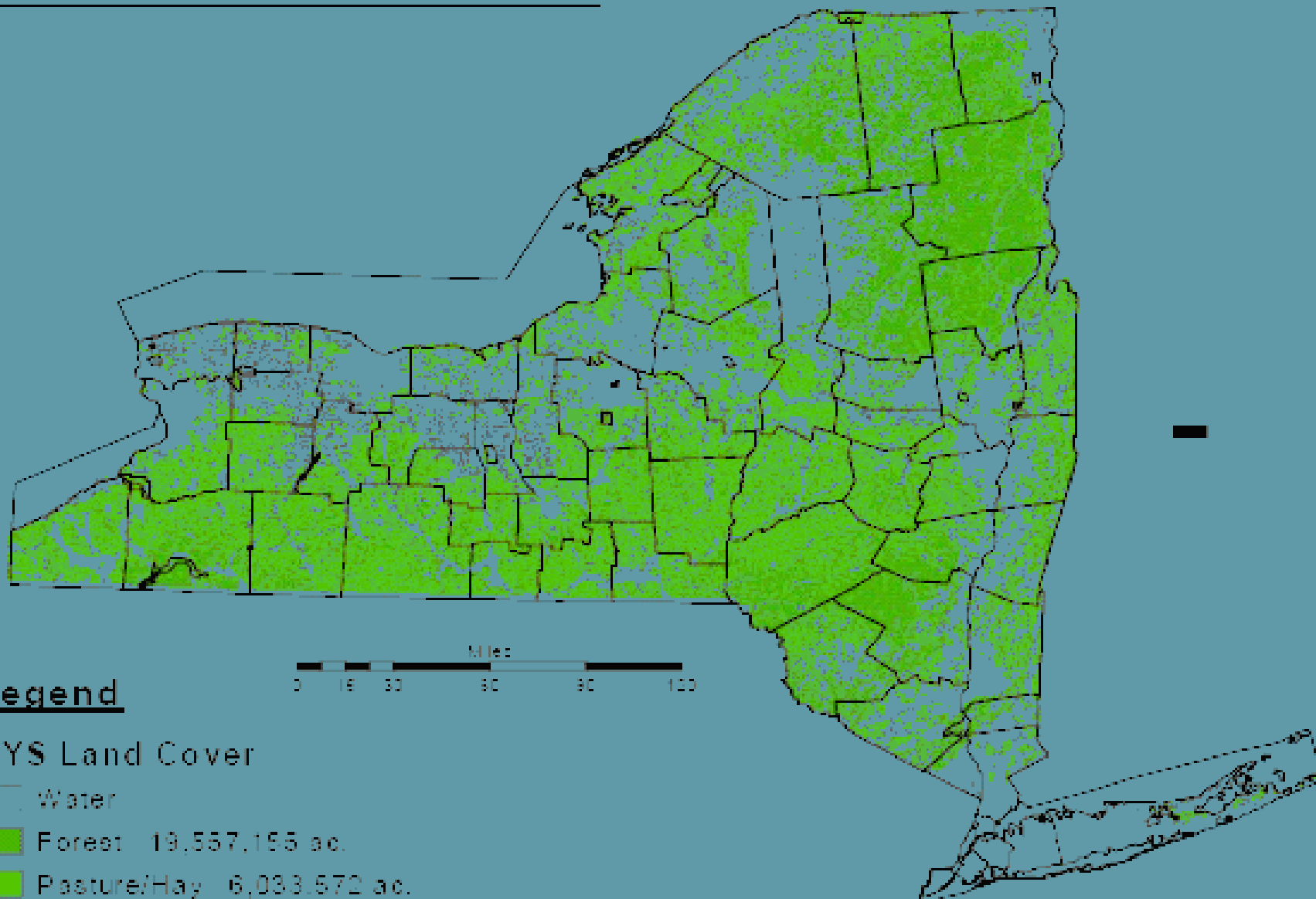
# Critical Energy Sectors

- **Heat**
  - High percentage of residential costs
  - Solid / Liquid / Gas / Electric sources
- **Transportation**
  - Imported refined products
  - Liquid infrastructure / I.C.E. technology base
- **Power**
  - Large generation facilities
  - Industrial on-site generation / co-generation

Are biofuels **part of** the  
answer?

If so, **what part?**

## New York State Land Cover



### Legend

#### NYS Land Cover

- Water
- Forest 19,557,155 ac.
- Pasture/Hay 6,033,572 ac.
- Row Crops 1,694,229 ac.

Map Created for the Willow Biomass Project  
Date: June 14, 2005

## "Liquidating" all available biomass in NYS...

28,200,000,000	Cubic feet <sup>1</sup>
128	Cubic feet per cord <sup>2</sup>
220312500	Cords
2400	lbs per cord <sup>2</sup>
5.2875E+11	lbs
6400	BTU/lb air dry <sup>2</sup>
3,384,000,000,000,000	BTU
2.6	Quads
264375000	Tons
85	Gals ETOH per ton <sup>3</sup>
22,471,875,000	Gals ETOH
15,056,156,250	Gal/Gal equivalent (67%)
<u>Plus other "annual"</u>	<u>Years</u>
<u>feedstocks...</u> <sup>4</sup>	
1750000	Forest Residue
1275000	Mill Residue
130000	Agricultural Residue
3400000	Dedicated crops
1900000	Urban Wood Waste
8,455,000	TOTAL
718,675,000	Gal ETOH
481512250	Gal/Gal Equiv
0.1	Year
12%	Annual gasoline consumption

<sup>1</sup>Northeast Forest Inventory Analysis, 2004 Statistical Tables, Net volume of all live trees and salvable dead trees on timberland by class of timber and softwood/hardwood categories, New York, <http://www.fs.fed.us/ne/fia/states/ny/index.html>

<sup>2</sup>Oak Ridge Nat'l Lab [http://bioenergy.ornl.gov/papers/misc/energy\\_conv.html](http://bioenergy.ornl.gov/papers/misc/energy_conv.html)

<sup>3</sup> ETOH yield estimate based on various literature sources, GREET model, Argonne Nat'l Lab, 2006

<sup>4</sup>Biomass Feedstock Availability in the United States: 1999 State Level Analysis, Walsh et al., 2000



# What part of the answer?

## Biofuels can supplement & help transition:

- Local/Regional (other NE states, Canada)
  - Less transportation
  - Reduced reliance on (hostile) foreign imports
- Existing infrastructure
  - Liquid transportation fuel
  - Combustible heating source

## Can biofuels **alleviate economic pressure on consumers**, as well

as mitigate CO<sub>2</sub> emissions

# Home Heating

- Current economic pressures driving changes
- Not always consistent with environmental goals
  - i.e. Coal is cheap!
  - Residential areas intensify human health considerations
- Demand outweighing supply for alternatives?
  - Waiting lists due to rapidly increased demand for biomass and equipment

# Emerging Alternatives – Home Heating

## **Pellet stoves**

- Burn small biomass pellets (3/8–1 inch long)
- Automatic delivery system
- Convenience
- Higher combustion efficiency (78%–85%)
- Higher heating capacity (8,000 and 90,000 Btu per hour)
  - Produce very little air pollution
  - the cleanest of solid fuel-burning residential heating appliances.
- Exempt from EPA smoke-emission testing requirements
- Cheap installation:
  - direct-vented
  - do not need chimney / flue



# Emerging Alternatives – Home Heating

## Pellets

- Wood:
  - Virgin hardwood / softwood = different heating values
  - “Waste” materials: sawdust, recycled wood, lumber mill scraps
- Grasses
- Other “wastes”:  
agricultural residues  
i.e. corn stover



<http://www.home-energy.com/images/bioenv/pellets.jpg>

**ALBANY, New York, September 30, 2008**  
(ENS)

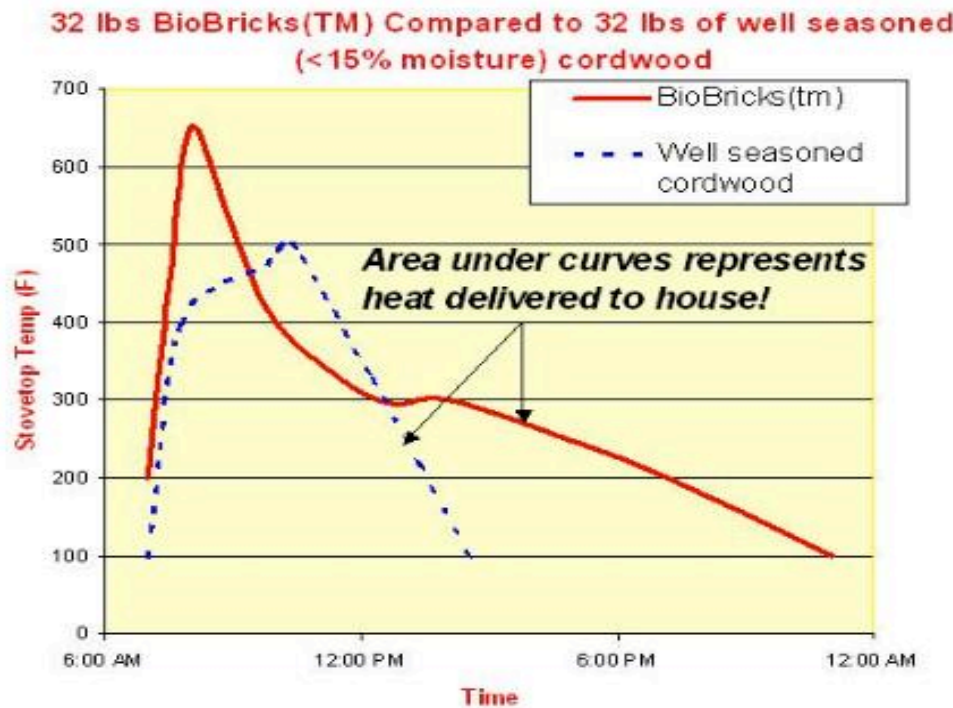
- NYSERDA announced NYS investing \$1.6 million to evaluate & improve wood-fired heating equipment
  - residential and commercial wood boilers,
  - pellet stoves, including emerging grass-pellet technologies
  - wood stoves.
- 9 projects that compare energy & emissions performance





## BioBricks

- Size, shape and density required for long, even output of heat
    - twice the density of cordwood , extending burn times > 2.5x .
  - Can be used in any wood burning appliance
  - No electricity requirement, like pellet stoves
- Burns 1/3 the time of cordwood with good cordwood



# Emerging Alternatives – Home Heating

## Outdoor wood furnaces/ boilers (OWBs)

- A freestanding combustion unit located outside the home or structure to be heated
- Firebox surrounded by a water reservoir
- Sales have more than tripled in NYS since 1999
- Among dirtiest & least efficient (~40%) modes
  - **especially when improperly used.**
- Even when used properly, OWBs emit:
  - 4 times as much fine particulate matter (PM) as traditional wood stoves
  - 12 x > EPA-certified wood stoves, 1000 x > oil furnaces, 1800 x > gas furnaces.
- ~~Currently, NO federal or NYS regulations address the proper use of, or limit the pollution from, OWBs.~~  
PM pollution = short-term & long-term health effects.
- Unlike indoor woodstoves & other heating devices, OWBs do not have to meet safety or performance standards. (NOT covered by EPA woodstove regs.)



Over 7,000 OWBs sold from 1999 to 2004.

# Emerging Alternatives – Home Heating

## Outdoor wood furnaces/ boilers

### • (QWBs) Pros

- Low economic cost for fuel
- Flexible fuel supply
- Self-harvest

### • Cons

- Incomplete combustion = inefficient use of fuel & poor emissions profile
- Flexible fuel supply – can burn ANYTHING!
- Self-harvest: unsustainable practices?





## Fuel Price Comparisons

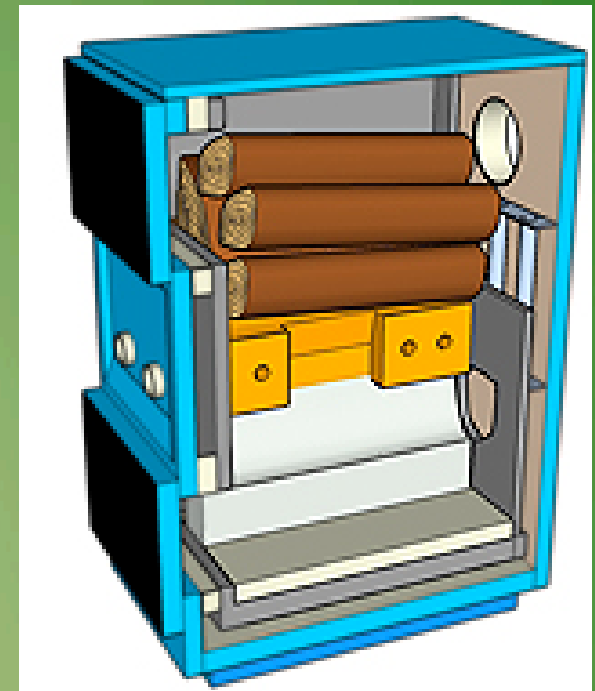
<u>Fuel Type</u>	<u>Unit</u>	<u>Price /Unit (\$)</u>	<u>Heat Content /Unit(Btu)</u>	<u>Price /Mbtu (\$)</u>
Wood	Cord	\$185.00	22,000,000	\$ 8.41
Natural Gas	Therm	\$1.51	100,000	\$15.13
Kerosene	Gallon	\$4.95	135,000	\$36.67
Fuel Oil No.2	Gallon	\$4.69	138,690	\$33.82
Propane	Gallon	\$3.26	91,333	\$35.58
Electricity	kWh	\$0.127	3,412	\$37.22

- \* Figures of the above tables determined using the Energy Information Administration
- online heat calculator.
- <http://www.eia.doe.gov/neic/experts/heatcalc.xls>

# Emerging Alternatives – Home Heating

## **GASIFICATION OWBs**

- fresh air blown downwards through wood burning in fire box
- Hot smoke and air mixture forced into combustion chamber & mixed with second jet of super-heated air.
- Results in torch-like combustion of retained gases > 1800 degrees.
- Almost all the gases burned, little residual soot /creosote
- Extra energy extracted transferred to full jacket heat exchanger = overall thermal efficiencies of 80 -



Alternative Fuel Boilers  
795 Deer Street  
PO Box 281  
Dunkirk, New York  
14048

## U.S. Environmental Protection Agency 2007 Outdoor Wood-Fired Hydronic Heater Program

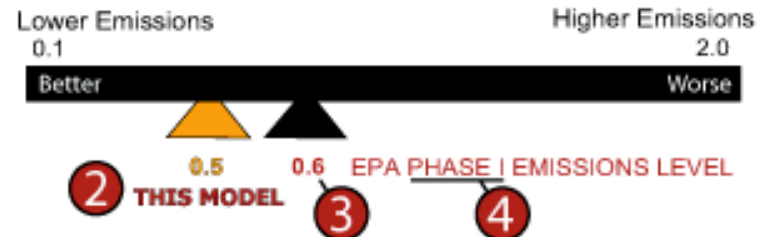
This Outdoor Wood-Fired Hydronic Heater has been tested and meets a certain air quality emissions level.\*

1

By meeting this level this model is cleaner and pollutes less than those models that have not met this emissions level. Exposure to wood smoke has been associated with respiratory illness and other health problems. Models that have lower smoke emissions may reduce your family's risk.

For more information go to [www.epa.gov/woodheaters](http://www.epa.gov/woodheaters)

### OUTDOOR WOOD-FIRED HYDRONIC HEATERS SMOKE EMISSIONS RANGE



Outdoor wood-fired hydronic heaters with lower emissions produce less smoke when installed and operated properly.

5 MANUFACTURER:

MODEL NO:

8-HOUR HEAT OUTPUT RATING:

EMISSIONS:

XXXXXXXXXXXX

XXXXXXXXXX

58,000 BTU/HR

XXX GRAMS/HR

0.5 LBS/MILLION BTU HEAT INPUT

XX GRAMS/HR / 10,000 BTU HEAT OUTPUT

\* - This model has been tested by an accredited independent laboratory according to EPA method 28 OW-H and meets the emissions level for U.S. EPA's Phase 1 Voluntary Program.

# **Transportation**

- No refinery capacity
- Strong public transportation in NYC
- Small-scale public transportation systems growing in popularity – not many
- Long travel distances in upstate region
- Many jobs rely on transportation
  - Commuting
  - Job description

# Emerging Technologies - Transportation

- Biofuels options.
  - Ethanol
    - Traditional = carbohydrate vs. Emerging = cellulosic
    - NOT ALL CREATED EQUAL!
    - Wastes!
    - Different emissions profile
    - Domestic/local supply?
    - Semi-compatible w/ infrastructure
    - Blending location / credit
  - Biodiesel
    - Oil crops: Canola, mustard seed
    - Waste Vegetable Oil
    - Semi-compatible w/ infrastructure
    - **Can also be blended with home heating oil!**

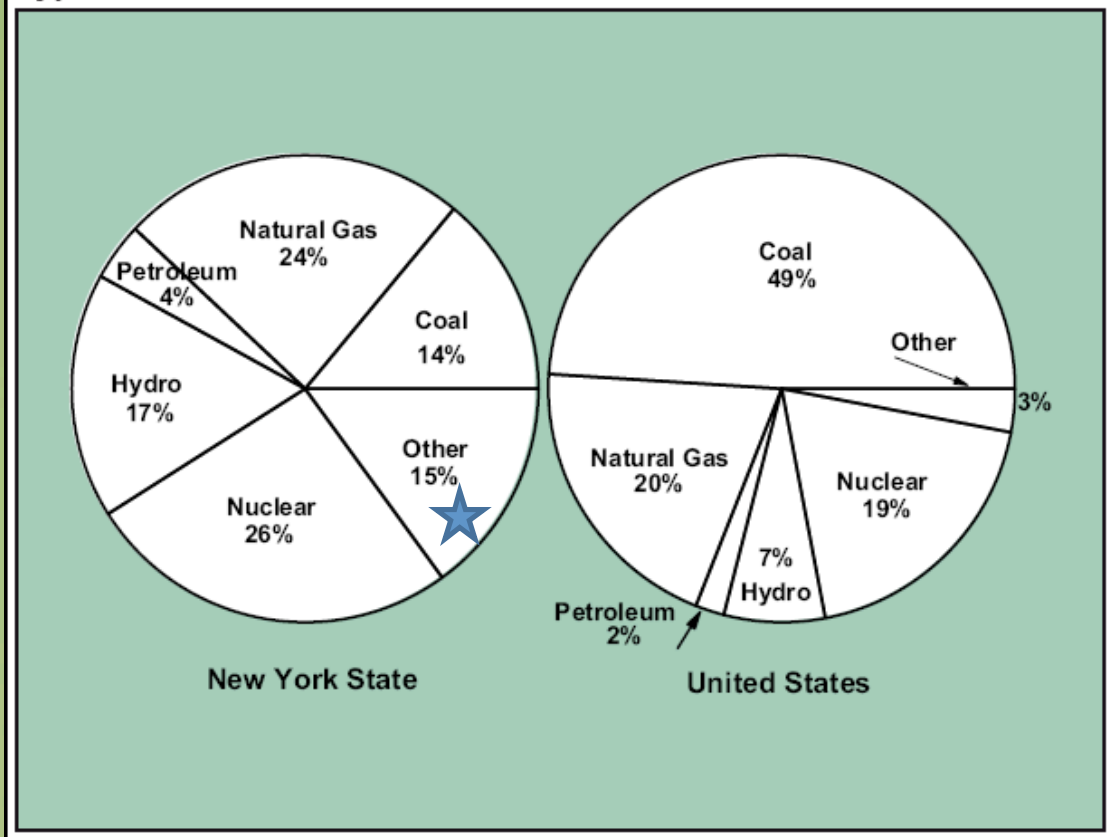
# Emerging Technologies - Transportation

- Ethanol Producers
  - Mascoma Corp, Rome NY
    - Cellulosic ethanol production
    - New processing technology: wood/grasses
    - Looking for local markets
  - Northeast Biomass, Fulton NY
  - Western New York energy LLC, Shelby NY
    - 50 MGY corn
  - Empire Biofuels, Romulus NY
    - 60 MGY corn
- Biodiesel Producers
  - Northern Biodiesel, Ontario NY
    - 7.5 MGY Canola

# Power Generation

- New York Power Authority (NYPA)
  - State agency
- Large % hydro power capacity
- Largest wind farm east of Mississippi – Maple Ridge
- Noble Wind
- Many impacts for increased capacity upstream – outside of state

Figure 1-10a Primary Consumption for Electric Generation by Fuel Type, 2006



# Emerging “Alternatives” – Power Generation

- Residential /Commercial generation
  - Digestion – methane from wastes
  - Added complexity to farms
  - Manure/biowastes must be dealt with anyway
- Co-generation of Heat &Power
  - (ex Finch Paper, Glens Falls)
  - CHP applications in industrial settings
    - Wood chips, sawdust, etc.
    - Lignin (co-product)
  - Greater efficiency with on-site generation
- Landfill methane capture



# Emerging Alternatives – Power Generation

## **Residential Co-Generation?\***

- Technologies available / under development for:
  - Residential = single-family (<10 kW) & multifamily(10 – 30 kW)
  - commercial (5 – 100 kW)
  - institutional (20 – 100 kW)
- Reciprocating internal combustion engine systems,
- Micro-turbine based systems,
- Fuel cell based systems,
- Reciprocating external combustion Stirling engine systems.

\* Knight et al., 2005 Annex 42 , International Energy Agency, Energy Conservation in Buildings and Community Systems Programme.

# Emerging Technologies – Power Generation

- ZeroPoint Clean Tech, Inc.
- Highly efficient biomass gasification process
- Capable of converting biomass into:
  - renewable synthesis gas,
  - electricity,
  - liquid fuels (Cellulosic Diesel™, ethanol, or methanol).
- Virgin and waste biomass
- Mesa Reduction Engineering, Inc.
  - Feedstock suppliers/research

# New York State

## **NYSERDA**

- Anaerobic Digester Gas-to-Electricity Rebate & Performance Incentive
- Solar, Wind & Biomass Energy Systems Exemption Last
- Energy Conservation Improvements Property Exemption

## **New York State Energy Program**

## **DEC**

- \$64,000 grant from USFS to  
explore woody biomass

**15% by 2015!**



**What applications should be incentivized**  
in NYS to help us fulfill our energy  
development goals?

# Trade-Offs – Biomass/Biofuels

- RENEWABLE~~✓~~ = SUSTAINABLE
- Land use
  - Impacts of change: FOOD vs. FUEL
  - Responsible practices / harvesting
- Carbon sequestration
- Agricultural inputs....WASTES!
- Low energy density
- Transportation distances
- Shift where impacts are incurred

# A Role for EMCs

- Education:
  - Available options: “Cheap” & “Green”
  - Sustainable practices
    - Harvesting
    - Appliance operation
- Adaptation :
  - Big picture:
    - Life cycle
    - Multi-media pollution prevention
  - Transition to new technologies
    - Existing business
    - Communicate w/ government - understand/push incentives

STAR TRIBUNE  
S&K



**Thank You...Questions and Comments?**