Conference Summary

Northeast Sun Grant Regional Feedstock Summit

November 11-13, 2007- Statler Hotel, Cornell University, Ithaca, New York

Organized by
The Northeast Sun Grant Institute of Excellence
Cornell University, Ithaca, New York
Conference Chair, Professor Larry P. Walker

Sponsored by
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Cornell University College of Agriculture and Life Sciences,
Pennsylvania State University,
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We thank all of the speakers, working group facilitators and recorders for their excellent, informative presentations and contributions. All speakers have generously made their presentations available online at the Northeast Sun Grant Site at: http://www.nesungrant.cornell.edu

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Northeast Sun Grant Regional Feedstock Summit

INTRODUCTION

Biomass energy experts from the Northeast Sun Grant region gathered to exchange ideas, research, and business expertise at the Northeast Sun Grant Regional Feedstock Summit, held on the Cornell University campus at the Statler Hotel in Ithaca, New York, November 11-13, 2007. The meeting was attended by more than 100 participants from the Northeast region. In addition to hearing the latest research and business concepts through conference presentations, meeting participants also participated in working group breakout sessions to exchange ideas for potential competitive grant team concepts and to provide feedback to federal partners on the Northeast region's current biomass industry capacity and future biomass potential.

The conference included information on using Geographical Information Systems (**GIS**) in assessing biomass potential and economic assessments. The Summit provided a platform for sharing insights and data between the Northeast Sun Grant Region land grant institutes and the expanding network of researchers, educators, government representatives and stakeholders essential to building the Northeast bio-economy.

Keynote Speakers and Presentations

The Northeast Sun Grant Regional Feedstock Summit featured four Keynote presentations.

The opening Keynote Address by William Chernicoff, Sun Grant Program Manager, US Department of Transportation, entitled "**Biofuels and Transportation: Perspectives on Sustainability and Pathways Forward,**" touched on a number of important vision and research investment concepts for consideration in a biofuels research program. National infrastructure investments, such as road and rail transportation systems, are long-term (50 year) investments while technology development is a near-term (1-5 years) investment. Fitting long-term infrastructure investments to address the predicted needs of emerging industries, such as biomass energy and fuel production systems, is a challenging task.

The lunch program Keynote Address by Thomas Fretz, Dean Emeritus University of Maryland and Chair of the NE Sun Grant Competitive Grants Program Steering Committee, entitled, "**Extending Sun Grant Research and Outreach Competitiveness through the NESGI Competitive Grants Process**", reviewed the Sun Grant portfolio of awarded 2007 projects and explained changes for improvement to the 2008 competition. The 2008 Request for Applications was distributed to attendees following the presentation. Other members of the Steering Committee were introduced for the audience and questions were invited.

The dinner program Keynote Address by Nathanael Greene, Natural Resources Defense Council, entitled, "**The Politics and Policy of Getting Biofuels Right**" provided an overview of the key issues for the transition to biofuels in an environmentally responsible and economically feasible way. The key issues for today include being technology neutral and performance driven; establishing lifecycle emissions standards for biofuels; using incentives to encourage best management practices; and establishing a global biofuels labeling system that quantifies warming pollution, renewability of the biomass, and reports the feedstock management practices.

The closing day Keynote Address by Jason Hill, University of Minnesota Departments of Applied Economics and Ecology, Evolution and Behavior, entitled, "**Sustainable Biofuels from Sustainable Mixtures of Native Prairie Plants**" described a study published in Science magazine[1] showing increased yields from mixed grasses over monoculture grass plots.

The four keynote speakers also served as panel moderators for sessions on Geographical Information Systems (GIS), Energy crop development, Environmental sustainability, and Economic sustainability.

Regional Feedstock Partnership Presentations

A description of the Regional Feedstock Partnership was presented by John Ferrell, Feedstock Platform Manager, United States Department of Energy, Office of the Biomass Program, Energy Efficiency and Renewable Energy, in a presentation entitled, **"Regional Feedstock Partnership – DOE Perspective."** The Partnership's DOE Milestones include biomass feedstock development, assessment and education.

A background of "*The Billion Ton Report*"[2] was provided by Mark Downing, Oak Ridge National Laboratory (ORNL), and directions given to the working groups in a presentation entitled, "**The Data Management and Research Path Forward**." The types of spatially-specific data sets needed were described in three categories: yield, environmental and crop production management data. ORNL's work in this area focuses on biomass feedstock resource analysis and logistics engineering modeling and support. In developing a national biomass resource map, ORNL is asking for feedback on the "Billion Ton Report" and for regional input on potential biomass feedstocks and quantities. Current data sets are needed for the national map. What portion of the "billion-ton annual supply" can the northeast region deliver for energy markets?

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[1] Tilman, David, Jason Hill and Clarence Lehman, (2006) Carbon-negative biofuels from low-input, high-diversity grassland biomass, *Science*, 8 December 2006; Vol 314, no. 5805, pp. 1598-1600.

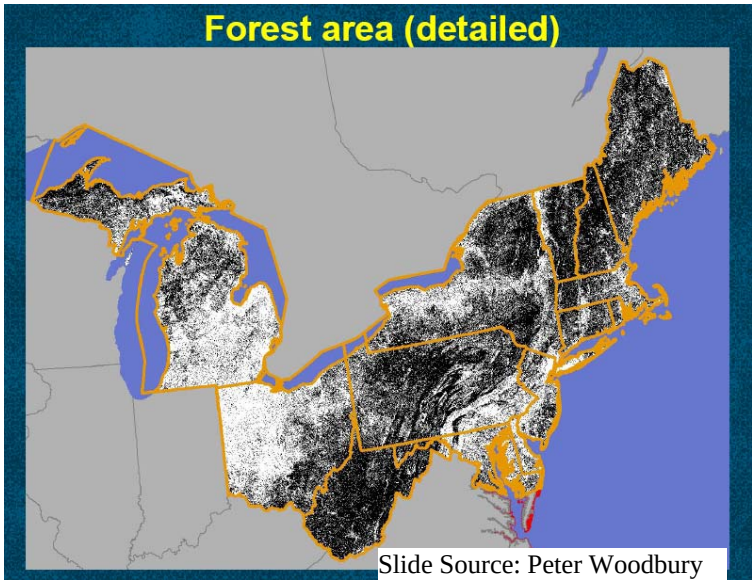
[2] USDOE-USDA Report (2005) Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a One-Billion Ton Annual Supply, http://feedstockreview.ornl.gov/pdf/billion_ton_vision.pdf

Working Group Lightning Reports

Working groups met and discussed biomass feedstock issues for the northeast. The following day the group facilitators provided a series of "lightning reports" summarizing their working group's discussions.

GIS as a Tool for Biomass Resource Assessment

Facilitator: Peter Woodbury
Recorder: Richard Klotz
Participants: Peter Woodbury, Richard Klotz, Tris West, Mike Hoffmann, Chuck Ray, Alison Goss, Mark Downing, Chris Recchia, Jeff Keller



Slide Source: Peter Woodbury

We spent most of our time discussing forest biomass issues due to our interests and our perception that in the Northeast forests are a very important resource. We discussed the state of data on forest biomass resources. For productive forests, there are very good data at the regional and state scale and reasonable data at the county scale on the biomass actually in forests from the US Forest Service Forest Inventory and Analysis (FIA) database. However, data on actual removal of biomass from forests, including harvests, is not as strong, because it is based on surveys of wood processing facilities. Data on wood byproducts is even weaker, and we need to know more about how byproducts are currently being used. Also, the forest industry is changing rapidly in the Northeast US, and it's hard for databases to keep up with such rapid changes.

This leads to a knowledge gap. We need a GIS layer of wood-consuming facilities, including the type and amount of wood used. For example, many pulp mills have been closing. But knowing where these facilities are (or were) located is important because these facilities already demonstrated that harvest and transport of wood to the facility is feasible. Closed mills could be important for jump-starting a wood-based bioenergy industry.

We have data on forest biomass and yield from survey plots, and we can model yield for other locations based on historical data and biophysical factors that affect yield. But a real knowledge gap is understanding the rapidly-changing landowner attitudes and management choices. The trend in forest ownership is towards smaller parcels, and harvesting is not the main reason most people give for buying forest land. What price would be required to get owners to harvest their forests? What percentage of owners would even consider harvesting for any purpose? What is the social capacity – are there qualified foresters and others available? How will these factors change during coming decades? Work is being done to answer these questions in PA, NY, WVA, and by the US Forest Service.

For dedicated energy crops, we have some data from research studies and we know how to characterize agricultural systems focused on crop productivity. However, much biomass will be a byproduct of another activity. How do we analyze byproducts? Do we need to model the main enterprise, either agricultural or other? We discussed that DOE is using the POLYSYS model to address these questions.

We agreed that GIS can serve as a good integration tool with other modeling tools. In conjunction with other modeling tools, it can be used to show what we know, and also to quantify knowledge gaps. We discussed the need for sub-county spatial resolution. Such detailed spatial information may be needed for facility siting. Such information is also needed for accurate estimation of environmental impacts such as erosion and nutrient loading to surface waters. For forests, much higher resolution data on forest cover are available from remote sensing. But information on species, growth rates etc are not available at such high resolution. Such data are collected in the FIA on individual plots, but the plot location data are not available in order to protect privacy. The same issue occurs with agricultural statistical data, thus county level data are commonly the finest resolution commonly available.


Slide Source:Margaret Brennan

Agricultural Residues, Food Wastes and Municipal Solid Wastes

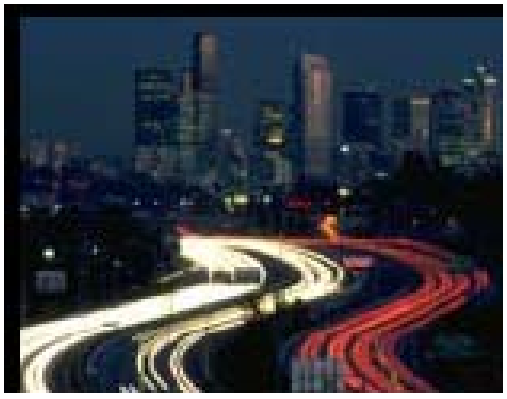
Facilitators: Priscilla Hayes and Norm Scott
Recorders: Navaneetha Santhanam and Linelle Fontenelle
Participants: David Specca, Priscilla Hayes, Abby Webb, Tom Wilson, Pegi Ficken, Manuel Villa-Garcia, Zhongtang Yu, Fred Michel, Norman Scott, Darek Letkiewicz, Navaneetha Santhanam, Linelle Fontenelle

The participants in the Agricultural residues working group merged with the Food Wastes and MSW working group because of shared interests and goals. The combined working group discussed the current best feedstocks in the northeast for this category and suggested the top four are:

- Animal manure
- Food waste
- Paper waste
- Agricultural residues

In reviewing the current northeast region databases for quantities and locations of these resources, four existing databases were noted that could be combined into a regional database: Norm Scott's data for New York State, Pricilla Hayes and David Specca's New Jersey data, Abbie Webb's data for New York, and Fred Hitzhusen biomass feedstock data for Ohio. The group noted that even in a combined regional database, constant updates must be made.

The group consensus is that the top three most significant challenges that must be addressed to develop an inventory are:
1) accurate quantity data
2) accurate categorization
3) improved and updated regulations.



Infrastructure and Policy

Facilitator: William Chernicoff
Recorder: Ben Heavner
Participants: William Chernicoff, Dan Conable, Ben Heavner, Tom Richard, Kevin Stone, John Stouffer

The group consensus regarding the most significant policy and infrastructure challenges that must be addressed to bring the biomass products to the energy market included:

a) leveling the playing field for cellulosic ethanol;
b) focusing on underutilized resources (not just land);
c) insuring positive environmental outcomes during production and use of biofuels and bioenergy.

Regarding the northeast region's physical Infrastructure, the region should emphasize preserving and improving rail infrastructure for distributed resources and also address improving bridges and storage capacity. We need to understand what infrastructure changes it might take to double or

triple rural material flows. We should do this especially paying attention to medium and smaller scale volumes.

We need to remember that Agricultural development is infrastructure building not just jobs creation. We need to quickly build the knowledge with effective Research & Development, and analysis before implementing policy that is not fully informed or there may be unintended consequences that do not achieve the true societal goals. If there's anything our northeast region legislators can do that would be really helpful, it's to consider whether the scale assumption of any national policies are applicable to the Northeast. For example, for northeast region biofuels: feedstocks (must be mixed) and feedstocks should be considered in moderate scales, otherwise we're not talking about the northeast.


Slide Source:Chuck Ray

Forest Residues

Facilitator: Jingxin Wang
Recorder: Amy Welch
Participants: Jingxin Wang , Amy Welch, Jude Liu, Tony Nekut (Forest Owner Biomass Coop.)

The Forest Residues working group discussed the current best feedstocks in this category currently available in the northeastern US. These feedstocks can be divided into three categories: Primary (logging residues, fuel treatments, tree trimming), Secondary (mill residues and pulping liquors) and Tertiary (urban wood residues). The group consensus was that the best sources of information for determining quantities of these feedstocks are State agencies that focus on Energy or Forestry and Universities (especially forestry or natural resources related departments). There also are state-level inventories. For example, West Virginia - state wide inventory on logging and mill residue is available at county level. In addition, spatial analysis tools are available and detailed.

Biomass uses and opportunities in West Virginia are summarized and available online at: www.wdsc.caf.wvu.edu/biomatctr. The West Virginia analysis began as a DOE initiative, with funding to State level Department of Energy and they have a working relationship with the biomass center at West Virginia University (the first few years was seed money). There also is a new database for New Jersey that was presented at this conference and available at www.njeas.rutgers.edu/bioenergy. The group did not have information on the rest of northeast, and was not sure how close the level of data is between the various sources.

How do other states compare to West Virginia's residue assessment?— West Virginia used detailed information from state and did not rely exclusively on

the USDA Forest Service – Forest Inventory and Analysis (FIA) data, used state, National Agricultural Statistical Service (NASS), West Virginia state level information not via FIA for logging residue assessment. Typically, FIA is the primary source for non-residue. However, there are limitations to the FIA data at scales finer than counties and (new data since 2001) limited point source data at the sub-county level.

The typical hauling distance is at least 90 miles, and 10 to 15 miles is not adequate to capture enough resource. Fifty (50) miles is the most economical distance because of scalability of production, but might not capture enough resource for mid-sized projects (~100 million g/yr).

The group discussed smaller scale, distributed ethanol production. Forestry is not able to scale down as readily as food grease or even farm level residues because of distribution of resources.

There are approximately 5 million green tons of residue across the state of West Virginia (smaller area than other NE States though 80% forested—300 miles n/south, 200 miles East West (less 2.4 million dry tons at 15% moisture content) Maine has highest % forested land, Vermont #2, West Virginia #3.

Construction and Demolition (CandD) materials as a resource is bigger in West Virginia than general Municipal Solid Waste (MSW), (used population data—waste per capita from national study to characterize MSW production) however they do not have any other information source for that part of the inventory.

Managing for NPP? Stand structure? The consensus was that there is not a lot of activity in northeast to increase yield in forests—most yield work related to genomics--Hybrid poplar-much activity to increase yield, research into applications for strip mining reclamation, among other species being tested.

Harvesting equipment. West Virginia is engaged in a study of 7 regions terrain species for harvesting equipment by species—NE two major types: feller-buncher, grapple scale. Harvester forward not used in WV and NE in general due to species and terrain limitations—more popular in MI and lake states. It also is used in NY and looks like lower impact—feller-buncher and grapple is ½ of capital cost of this equipment.

On-site chipping. Many years of whole tree chipping—specific activity depends on what you want to do with resource. Cost is a big driver of how resource is handled-- nobody brings a whole tree to mill. Dr. Wang believes whole tree chipping will be used with biofuels—chipping could provide greater density if the technology to compact on site is produced or could keep transportation costs lower as a function of density.

Nutrient cycling? How much do you have to leave? 80% of the nutrients are located in the tree tops (left behind at harvest). Harvest time also can influence nutrient location. Collecting trees after leaves fall though is a controversial issue. Reapplication of ash occurs in some European systems.


Slide Source:Hilary Mayton

Lignocellulosic and Herbaceous Perennial Crops

Facilitator: Gary Bergstrom
Recorders: Brian King, Mary Wrege
Participants: Ben Dawson-Andoh, Gary Bergstrom, Suleiman Bughrara, Jim Doolittle, John Ferrell, Zane Helsel, Brian King, Yi Li, Thomas Lindberg, Hilary Mayton, Frederick Michel, Om Parkesh, Sarah Pollicove, Paul Salon, Matt Sanderson, Daniela Sciaky, Michael Speer, Anthony Turhollow, Mary Wrege

The group discussed the current best lignocellulosic and herbaceous perennial feedstocks in the Northeast. Promising options include existing low quality forage on underutilized hay and pasture acres, conservation reserve program (CRP) acres, mining reclamation sites, and fallowed land due to lack of economic incentives for land owners (e.g., tax breaks and expanded agricultural value assessments). Other promising lignocellulosic and herbaceous perennial feedstocks in the Northeast are:

- Switchgrass and other warm-season grasses in monoculture and mixed stands
- Reed canary grass and other cool season grasses in 2-cut systems, mixed stands with perennial legumes
- Tall wheat grass (as in Hungary)
- Winter cover crops for early spring harvest
- Sorghum and tropical corn
- Miscanthus

In reviewing existing inventories, databases and information on land for existing and potential perennial feedstocks, one method to come to an estimate would be:

> NASS acreage **minus** CRP acreage **minus** forested acreage **minus** urban and suburban **=** available acreage for Ligno-Cellulosic Biomass (LCB) production

As a rough estimate: Land in hay 20 years ago minus land in hay today = available acreage for LCB production (e.g., 2 million acres in NY). The USDA-NRCS conducts natural resource inventories every 5 years.

The top 3 most significant gaps that must be addressed before making a reasonable assessment of perennial feedstock potential in Northeast are:

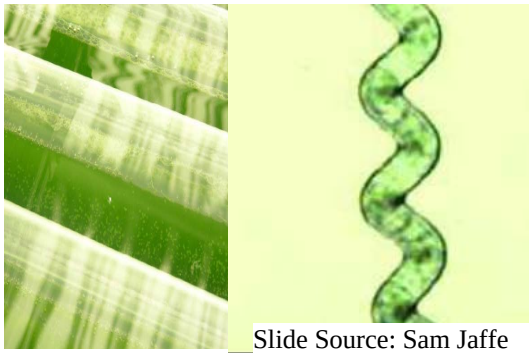
- How much agricultural land is there and how much of it is available for energy/fuel feedstock production?
- Who owns/manages it and what is on it now?
- Agronomic adaptation inventories needed for numerous species on a range of land types and ecological zones (including yield, perennial adaptation, edaphic factors, climatic factors, pests, nutrient, phenological traits)

What would be the cost to adequately address the identified gaps?

- Average 3-year research investment of $1 million per state for 3 years, plus indirect and cost-share

Other constraints/needs?

- Lack of organized feedstocks associations
- Low energy density feedstock (transport, storage, siting)
- Lack of public knowledge of benefits of bioenergy and of technology (myths and realities)
- Need for greater conservation and lifestyle changes
- Realistic perception of feedstock prices to growers



Slide Source: Sam Jaffe

Other Potential Northeast Feedstocks and Resources

Facilitator: Sam Jaffe
Recorder: Jose Moran-Mirabal
Participants: Ed Evans, Jose Moran-Mirabal, Nirav Patel, Sam Jaffe, Paula Marie Ward, Kyle Arvin

The working group considered algae and other potential feedstocks for the region.

Other potential feedstocks for the northeastern region are:

- Source-separated Waste (i.e. industrial waste) for liquid fuels
- Algae (high-oil content varieties) in controlled environment production
- Ethanol plant wastes (turn dried distillers' grains with soluables (DDGS) and other wastes from plant into an energy source that replaces the natural gas or coal that otherwise runs the plant)
- Fruit orchard wastes
- Municipal green waste (leaves, grass clippings, tree prunings)
- Unnecessary or outdated industrial solvents and pollutants are employed in processing, which end up in industrial feedstock streams, such as VOCs and PCBs. This example can be applied to a lot of industrial waste streams by working with the waste generators and

applying creative substitutes that might otherwise devalue the waste as a bio-energy feedstock.
- Industrial process/manufacturing co-products (e.g., heat, compost, distillates, low-cost fertilizers, clean water)

There may be databases on the quantities of these materials through SWANA (Solid Waste Association of North America), Local and municipal waste and environmental agencies, and individual factories. However, there is a knowledge conundrum: little is known about volume, composition, variability, etc., because it's not in the interests of the waste producers or the waste haulers to track, categorize, or reveal their waste stream data.

The top 3 most significant challenges that must be addressed to bring these feedstocks to the energy market are:

1) Knowledge void—we need better, more precise data;

2) Once an individual waste stream has been identified and categorized, optimization of correct technology is needed (e.g., Anaerobic Digestion? Fermentation? Gasification? Pyrolysis?) for specific waste stream is a fractured and diverse process;

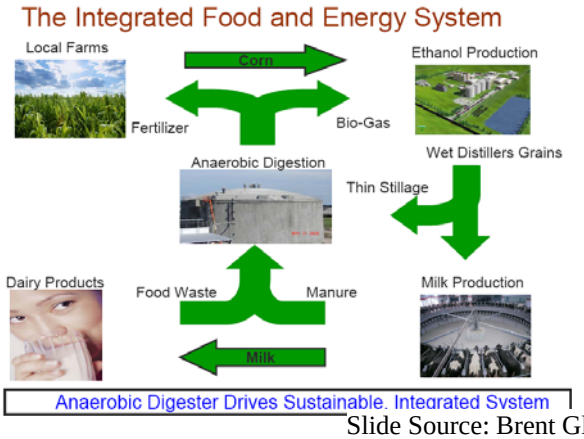
3) The solution will always be local—because the cost of transporting waste eliminates huge centralized energy production. However, the solutions to these challenges can be and should be market-driven, so public funds aren't necessarily required.

The potential benefits of adopting these waste-stream and other potential feedstocks include:
- Regional job growth
- Reduction of landfill space
- Elimination of otherwise hazardous wastes
- Carbon recycling
- Decrease in transportation energy used in trash hauling

Virtuous Cycle Suggestion
- Establishing a program for manufacturers to keep account of their waste and ensure that it ends up in an energy recycling program will provide an incentive for them to start keeping those data.
- Rather than establish regulations to force them to do this, create public/private program in the form of carbon credits or an "Energy Star"-like certification program that would drive the motivation to participate in the system.
- Once such a system is in place, it creates an infrastructure for a company to start making process decisions based on the value of their waste stream (like the restaurant owners who start using citrus cleaners instead of toxic solvents).

Vision – one last idea

- Create a program that standardizes the process for creating an onsite biofuel plant at a factory site for those plants large enough to do this profitably.
- Make it easy to have a contractor run these modular plants, so that factory-owner doesn't have to get into the energy business.
- For smaller factories, create power-sharing agreement templates between waste producers and utilities so that centralized waste plant can sell into the grid, and waste producer can claim a renewable energy credit for the energy produced by their waste stream.



Slide Source: Brent Gloy

Resource Economics and Systems Analysis

Facilitator: Antonio Bento
Recorder: Joel R. Landry
Participants: Joel R. Landry, Margaret Brennan, Jonathan Rubin, Paul Adler, Matt McArdle, Stephane Corgie, Mark Downing

What is the time-line? Given the public policy goal of bio-energy adoption of greenhouse gas reduction, what are the cheapest ways to achieve greenhouse gas emissions, via electricity generation or fuel production? Fuel production does not achieve that goal today (cellulosic may in the future). However, combined heat and power (CHP) does achieve that goal today. Fischer Drake diesel using wood does as well. Federal policy may be necessary to create demand.

What are the economic models currently available? And what data exist to feed into those models? These models should take prices into account to look at commodity displacement, changes in land-use patterns and greenhouse gas (GHG) displacement, and impacts on oil imports. Many land-use models ignore endogenous plant decision-making and do not include markets on renewable energy. We need a general equilibrium model that takes into account renewable energy. In examining such a model, we should ask the following questions: 1) What are the data needs for the model? 2) What outputs is it going to produce? 3) Will it tell us how to deal with the four F's (food, feed, fiber, and fuel)? 4) We will need to address issues with trade. 5) Can the model be general or does it need to be state-specific or site specific, or both? At the regional level, we need to aggregate up across the various models. *6) We* need life-cycle analysis of GHG impacts for other feedstock types; e.g. forest residue. 7) We need a Computable General Equilibrium model (CGE) that deals with lifecycles of several feedstocks. 8) What is the smallest distance unit that we need to work at: 25 miles, 50 miles? Distance

depends on cost, and available infrastructure which varies by state and subregion.

What Data? County level data would be useful to acquire. Maine, New Jersey, Pennsylvania and New York have county-level data (all regions represented in the working group). However, the region as a whole has poor data sharing currently. There is a lack of information on local feedstock availability. Is the Billion Ton Report (BTR) accurate? We need price data, costs of production data, transportation costs, and infrastructure costs. What are the actual costs of production, extraction of forest resources, etc?

Pertinent Questions/Discussion:
The question we need to be asking is: *What feedstocks are available at what price*?, not, *What feedstocks are available*? What are the pathways for putting the technology in place and combining technologies to make them viable for energy production? Do we need flexible biorefineries that allow for multiple feedstocks given various price levels of input commodities? The large scale bio-refinery concept does not make sense for all areas, but rather, region specific, e.g. Maine with pre-established paper, wood industry, it may make sense. We need to understand the assumptions that determine the economically viable distance for biorefinery location. We need to know the end-use of the feedstock. Conversion pathways will dictate which feedstock is optimal. The feedstock cost is different for different areas. For NJ, municipal solid waste (MSW) presently makes sense via co-firing. Costs are different depending on the way in which waste enters the waste stream. Can one get Americans to self-separate waste at the beginning of the waste stream? Is an educational program possible to deal with the issue and lower costs to industry? How does one link the paper industry with the infrastructure for bioenergy production? How will diversion to bioenergy impact the prices of other wood and paper products?

From a resource perspective we (the Northeast Sun Grant States) are not the same region. There are various feedstocks and a heterogeneous infrastructure, varied costs of production, etc. A regional solution will probably need to be sub-state specific.

We need policies to offset risk. Insurance mechanisms are needed to make biomass feasible for farmers and for industry. There is a role for state governments in insurance and information sharing (informing farmers on profits from switching to bio-fuel feedstock from food production, etc.). We need state/local policies to address the issue. Should incentives be on plant location or on biomass production?


Photo source: ARS Image Gallery, Scott Bauer, soybean

Starch and Oil Seed Commodities

Facilitator: Steve St. Martin
Recorder: Deborah Sills
Participants: Steve St. Martin, Thomas Kilcer, Greg Roth, Deborah Sills, Alan Taylor

The region is very diverse, and our crops and products must be diverse, too. A biorefinery should use more than one feedstock and produce more than one product. Important starch crops are corn (especially for OH and MI) and potato (ME). Cellulosic crops are potentially more important than starch crops for much of the Northeast.

What "new" feedstocks can be produced and in what quantities?

Among oilseeds, we think canola, crambe, castor and soybean can contribute. Some of these lend themselves to cold pressing, which implies they may be suitable for small or medium-scale operations. Some offer possibilities as feedstocks for bioproducts.

Where are the most significant voids that must be addressed before making a reasonable assessment of feedstock inventories?

- Agronomic research on production practices, rotations, fertility, weed control, cover crops, etc., to enhance production efficiencies (as in Greg Roth's presentation)

- Building teams of researchers for a full systems approach. Teams must include engineers, agronomists, economists, logistics experts (Matt McArdle).

What are the process co-products (plus associated value) and/or cost?
Meal is a co-product of oilseeds and will need to find a use (feed, fertilizer, or bio-product)

What are the potential benefits of feedstock production?
Rural development, i.e., useful products and jobs for the underutilized lands of the region.


Slide source: Ray Miller

Woody Crop Development

Facilitator: Ray Miller
Recorder: Marie Donnelly
Participants: James Higgins, Sal Giallombardo, Janet Hawkes, Yi Li, Ed White, Abdelali Barakat, Joe Sullivan, Larry Abrahamson, Marie Donnelly, Ray Miller

Current best feedstocks in this category in the northeast and best source(s) of information for determining quantities are

- Unused annual growth and mortality in natural forests (USFS FIA) [34 million dry tons]
- Urban forestry trimmings, removals, and mortality (availability usually based on models).
- Energy Plantations on abandoned or marginal farmland (Census of Agriculture)

Top 3 most significant challenges to bring forest feedstocks to the energy market?

1. Establishing estimates of feedstock costs and availability that address:
    A. Physical access costs and restrictions
    B. Public attitudes and policy limitations
    C. Competing demand for the feedstock
    D. Landowner awareness and capability
2. Establish 1st generation (heat) markets quickly to avoid losing forest management infrastructure.
3. Integrate biofeedstocks into existing forest products supply chain.

Energy Plantation Issues

- Extend the range of energy species.
    - Many more regional species and variety trials of willows and poplars are needed.
    - Breeding centers can produce new materials for testing by cooperators throughout the region.
- Increase yield and pest resistance through both traditional breeding and genetic engineering.
- Reduce plantation establishment, maintenance, and harvesting costs.

What would be the cost (dollars, equipment, full time equivalent positions, time, etc.,) to adequately address the identified roadblocks?

Overcoming the problems identified will require funding for people much more than for things.

- Inventories and surveys

    - Public outreach and landowner education
    - Geneticists, silviculturists, process engineers
- This suggests that recurring funding rather than lump-sum granting is needed.

Final Thoughts – Woody Crop Development

- First concentrate on using the vast surplus feedstocks in the Northeast's natural forests – but don't expect them to be "free."
- Rapidly employ existing technology like CHP or District Heat systems.
- This stops the loss of infrastructure and buys desperately needed time for 2nd generation feedstocks and fuel technologies to emerge.
- This postpones making ethanol until tomorrow but it offsets petroleum and natural gas consumption for heat and electricity today.

Panel Presentations – Activities in our Region

The 2007 Northeast Sun Grant Regional Feedstock Summit featured six panels highlighting research, education and economic development activities occurring in the Northeast Sun Grant Region. The Summit organizers (NESGI Institute of Excellence, Department of Transportation, ORNL and Department of Energy) focused a portion of the conference on using Geographical Information Systems (GIS) as a biomass industry tool. Two panel sessions focused on GIS research already underway in the Northeast region. There also were two panels on northeast region bioenergy crop development and two panels on different aspects of NE region biomass Sustainability (Environmental and Economic). GIS is an important tool for visualizing and predicting biomass quantity, but also can be used in conjuction with other tools and databases to assess environmental impacts, socio-economic impacts, existing roads and processing facilities, etc. GIS also can be used as a predictive decision tool for planning (future processing plant location, crop yield predictions, future infrastructure needs, etc.). Multiple layers of spatially-specific data (i.e., data located on a map) can be used to predict crop yield or environmental impacts. For example, soil type mapped data can be over-layed with watershed data, roads, existing land use, population concentrations, allowing predictions and optimized planning for future land use or policy impacts in a given area.

GIS Presentations

Tristam West from Oak Ridge National Laboratory is the DOE/Sun Grant lead for the GIS Biomass Atlas project and Tris opened the GIS discussion through a presentation entitled, "**Organization, use, and distribution of spatial data for estimating the current and potential bioenergy feedstock supply.**" The goal of the national project is to ultimately

provide data and analysis capabilities to the northeast and all regions of the country. The plan for this work is to first collect point data on feedstock yields and environmental data, then analyze the data to develop models of the relationships between yields, composition and environmental factors. Finally, after collecting spatial data to aid in mapping, a national map will be made from the 5 Sun Grant Regional maps to be produced through the project. A Beta-version of the national GIS Atlas is expected in late 2008.

Peter Woodbury, Cornell University, provided a presentation with a strong Northeast region focus entitled "**Geospatial analysis of strengths, weaknesses, opportunities, and threats for biomass feedstock production in the NE Sun Grant Region**." Sustainable feedstock production in the northeast region must account for high local and regional variability in soil characteristics (slope, drainage, texture), land use (agricultural, forest, urban), agricultural systems in place (dairy, field crops, silage) and environmental vulnerability (erosion, surface waters, etc). In a New York case study, it was determined 1.5 million acres of underutilized farmland could produce a variety of biomass crops.

Charles Ray, Pennsylvania State University, discussed northeast region forest biomass in his presentation "**GIS for documenting current forest biomass inventory and future development of forest biomass crops**." Several already-existing state-level biomass databases were shown. Dr. Ray explained that current state-based tools have 'border effect' limitations and that GIS and data limitations appear to be the single largest constraint on the progress of biomass utilization efforts. We need *dynamic* regional biomass utilization and flow databases for project planning, economic and infrastructure development and landowner assistance.

John Mackenzie, University of Delaware, addressed a number of critical issues to the northeast region in his presentation "**GIS tools for assessing nutrient cycling, water quality and biomass potential**." Dr. Mackenzie described the power of mapping in an exciting example – looking back in time to1854 and the cholera plague that hit London. Mapping was used to show that 66% of cholera deaths in London could be traced to a single pump on Broad street in London, disproving the "Miasma theory." Today, using GIS, Dr. Mackenzie teaches students to "think like a pixel" to predict water and nutrient flows across the landscape in Delaware. In addition to water and nutrient flows in the talk, Dr. Mackenzie described several economic and social issues and the need to analyze 'gravity effects' (sinks and sources) in spatially-dispersed energy markets.

Christopher Recchia from the Biomass Energy Resource Center (BERC) in Montpelier, VT, presented a Vermont Study, entitled, "**Vermont Wood Fuel Supply Study: A new model for analysis of the Billion Ton Report**." The presentation included estimates of excess wood from Vermont forests, described as "Net Available Low-grade Growth" (NALG). A conservative estimate based on 2005 data of NALG from Vermont is an annual 1.1 million green tons, and as much as 5.3 million green tons in a more aggressive scenario. The BERC is a national not-for-profit organization promoting responsible use of biomass for energy.

Energy Crop Development Presentations

Steve St. Martin from The Ohio State University, presented a talk entitled, "**Breeding the next generation of oil crops**." Dr. St. Martin reviewed current soybean oil production and challenges for breeding increased productivity. Future yield gains are possible and it is estimated that we are not even half-way to full potential currently. The Billion Ton report[3] calls for a 2:1 ratio of residue:grain in soybeans. But maximizing grain yield requires optimum harvest index, i.e., is probably closer to 1:1. Transgenic methods hold the potential for new traits, however this is a long, expensive regulatory process and public acceptance is slow. These are exciting times for agriculture! We have lots to do!

Hilary Mayton from Cornell University, described recent grass cultivar evaluation field trials in a presentation entitled, "**Breeding bioenergy grasses for the Northeast**." The trials assess yield and quality in diverse regions, determine best management practices, collect data on disease incidence and severity, collect economic data, and calculate production costs. The studies include both warm and cool season grasses in replicated plot trials. The evaluations also included seed treatment trials and germplasm selection for winter hardiness.

Yi Li from the University of Connecticut, presented his work in the Department of Plant Science in a presentation entitled, "**Two new tools for genetic improvement of cellulosic energy crops: the 'gene-deletor' and 'growth promoting' technologies**." We need to improve yield and cellulosic bioenergy crops so that we use less land and reduce the cost of feedstock production and therefore

[3] USDOE-USDA Report (2005) Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a One-Billion Ton Annual Supply, http://feedstockreview.ornl.gov/pdf/billion_ton_vision.pdf

reduce the biofuel price. The strategy in Dr. Li's laboratory is to improve cellulosic crop yield through genetic manipulation of plant hormones. They are also working on bio-based technologies for transgene containment through the 'gene-deletor' technology.

Sam Jaffe, Business Development from Copea Energy, discussed an alternative feedstock in a presentation entitled, "**Development of algae as a potential biofuels feedstock**." Laboratory scale results are promising and extrapolation of scaled up data suggest that is may be possible to produce 170,000 lb biomass/acre/year. The current engineering challenges include reducing the space, labor, energy and capital costs involved in algae feedstock production.

Margaret Brennan and David Specca of the Rutgers New Jersey Agricultural Experiment Station presented an important study and an exciting new assessment tool in their presentation entitled, **"Assessment of Biomass Energy Potential in New Jersey."** A project to evaluate the state's bioenergy potential was described. Four major goals of the NJ project were to: 1) Assess the characteristics and quantity of NJ biomass resources; 2) Perform a technology assessment (commercially or near commercially available); 3) Develop a statewide map of waste/biomass resources and bioenergy potential; 4) Develop policy recommendations for NJ. The research yielded six major findings about NJ biomass resources. 1) NJ produces an estimated 8.2 million dry tons of biomass annually; 2) Approximately 65% of NJ biomass could be available to produce bioenergy;3) Nearly 75% of NJ biomass resources are produced by the state's population (e.g., municipal waste); Agriculture and forestry management account for the majority of the remainder. NJ estimated recoverable biomass resource (5.5 MDT) could deliver up to 1,124 MW of power. 6) This large proportion of waste-based biomass supports the recommendation that NJ pursue development of a waste-to-energy industry. The group also has developed a unique bioenergy calculator that yields projected biopower and biofuel estimates for more than 40 biomass resources in each county in New Jersey.

Rick Handley, Regional Energy Programs CONEG Policy Research Center Inc. and Northeast Regional Biomass Program presented a set of concepts for northeast biomass industry in a presentation entitled, "**Building demand for new energy crops.**" The northeastern states are not very well suited to large-scale production of a single biomass feedstock. Most northeast region biomass applications will need to accommodate heterogeneous feedstocks. Biomass combined heat and power (CHP) offers an interesting opportunity for northeastern biomass. Biomass fuels compete well with propane and fuel oil ($40-$70 per ton) at a price that may encourage farm and forest owners to expand land management activities. The size of distributed CHP facilities (in contrast to

electric generation plants) is better suited to the heterogeneous and local nature of northeast region biomass feedstock supply. CHP is a good initial strategy for creating market demand for biomass in the northeast.

Environmental Sustainability Presentations

Jonathan Rubin, from the University of Maine, described three exciting opportunities in Maine in a presentation entitled, "**Maine forest biorefinery research initiative and green chemistry: opportunities for bioproducts**." The projects are 1) Potatoes-to-Plastics The potatoes-to-plastics project predicts 17.3 million pounds of polylactic acid (PLA) yield is possible in Maine with new acreage. 2) The Forest Biorefinery Research Initiative (FBRI) core research areas are a) Promote forest health for a sustainable bioeconomy; b) Understand and separate wood components, and c) create and commercialize new bioproducts. and 3) Forest credits under the Regional Greenhouse Gas Initiative (RGGI -pronounced "ReGGIe") is a cooperative effort by 9 Northeast and Mid-Atlantic states to discuss the design of a regional cap-and-trade program initially covering carbon dioxide emissions from power plants in the region.

Greg Roth from the Pennsylvania State University discussed a creative approach to optimizing northeastern sunlight during the winter months in a presentation entitled "**Integration of energy crops into agricultural systems: winter cover crops**." Winter cover crops are an integral component of cropping system intensification efforts in the northeast. Increased production, diversity, nutrient cycling, soil quality and reduced erosion are potential benefits. Winter cover crops in the northeast also are potential feedstock for bioenergy and biofuel systems.

Lawrence Smart from the State University of New York College of Environmental Science and Forestry (SUNY-ESF) discussed woody crop development in a presentation entitled "**Genetic improvement of shrub willow as a bioenergy crop**." In the 1890's willow stems were harvested in this region for basketry. The center of the basket willow industry is now a center for growth of shrub willow energy crops. In the willow breeding program, more than 600 accessions have been collected and more than 600 crosses made since the mid 1990's. New varieties produced through traditional breeding generate higher yields than existing varieties and are being deployed commercially in the US today.

Economic Sustainability Panel Presentations

Brent Gloy from Cornell University described economic perspectives on and benefits of an integrated food and energy system in a presentation entitled "**Economics of an integrated bioenergy system**." In a case study of ethanol and livestock production, it was shown that an anaerobic digester can drive a sustainable, integrated food and energy system. There are substantial benefits to developing a more integrated bio-energy system. Relative prices (of other fuels and of co-products) are key to determining the economic opportunity. Systems thinking about food and fuel is required to maximize economic efficiency.

Matt McArdle of MESA Reduction Engineering described the role his company plays in collecting biomass, material handling, and consulting/engineering in a presentation entitled "**Biomass feedstock aggregation –The Missing Link - from the field into the facility**." Biomass aggregation is often the overlooked part of the supply chain. Unlike proven reserves in the fossil fuels market, an aggregation system is dealing with variable reserves in the biomass world. MESA has examined storage and moisture trials to study the impact on biomass degradation and seeks to optimize each step in the process for the lowest delivered cost and best biomass properties for food, feed, fiber and fuel.

David Kay from Cornell University demystified 'job creation estimates' and explained the basic methods used in economic reports estimating such things as dollars to local economy, jobs created, tax revenues, etc. by planned biomass processing facilities in a presentation entitled "**Input output analysis as a tool for modeling economic impact of regional biomass feedstock production**." Impact analysis models and software packages are available off the shelf (e.g., MIG/Implan, RIMS, Policy Insight, TranSight, GTAP) and allow evaluation of the consequences of an issue/policy change. Input-Output models such as these also can be used with GIS to develop spatially-explicit land use/economic impact predictions.

Gerald Stack of Hiscock and Barclay LLP, was our lunch speaker and provided insights into regional tax laws regarding biomass and alternative fuels in a presentation entitled "**Federal and New York Tax Incentives for Alternative Fuels**." There are several Federal incentive programs including loans and loan guarantees from DOE, USDA, and State programs, government grants and tax incentives. There are two types of tax incentives: one type to stimulate use of ethanol, and another to stimulate production of ethanol.

Appendix A – List of Poster Displays

Engineering *Crambe abyssinica* and switchgrass (*Panicum virgatum*) for enhanced biomass via heavy metal tolerance and increased nutrient uptake Om Parkash (Dhankher), Bibin Paulose, Asma Zulfiqar, Anirudha Dixit, Graham Burhart and Denise Debrito, Department of Plant, Soil, and Insect Sciences University of Massachusetts Amherst, MA 01003 Contact: parkash@psis.umass.edu
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Fuels for Schools and Beyond Tom Richard, Director, Penn State Biomass Energy Center, Pennsylvania State University, University Park, PA 16802 Contact: trichard@psu.edu
Biofuels, Bioproducts and Bioenergy From Woody Biomass Feedstocks Ed White, Director Biomass Energy, SUNY-ESF, The Syracuse Center Of Excellence In Environmental And Energy Systems, Syracuse, NY 13210 Contact: ehwhite@esf.edu
Mitigation of greenhouse gas emissions with cellulosic and grain bioenergy crops Paul Adler, United States Department of Agriculture - Agricultural Research Service, (USDA-ARS), University Park, PA 16802 Contact: paul.adler@ars.usda.gov
The Molecular Basis of Reduced Biomass Accumulation in Hybrid Poplar in Response to Herbivory and Air Pollution Abdelali Barakat, Pennsylvania State University, Department of Biology, University Park, PA 16802 Contact: aub14@psu.edu
Cornell Biofuels Game: Race to the pump! Stephane Corgie, Corinne Rutzke and Sarah Munroe, Northeast Sun Grant Institute of Excellence, Ithaca, NY 14853 Contact: cfj4@cornelll.edu
Establishing Switchgrass for Biomass Production Dr. Paul Salon, Research Agronomist, United States Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS), Plant Materials Center, Corning, NY 14830 Contact: paul.salon@ny.usda.gov
Laying the foundation for an integrated sustainable plant biofuels research initiative at Cornell University Prof. Jocelyn Rose, Department of Plant Biology, Cornell University, Ithaca, NY 14853 Contact: jr286@cornell.edu
Ensilage: A biological platform for biomass pretreatment Michael Speer, Agricultural and Biological Engineering, Pennsylvania State University, State College, PA 16803 Contact: mas853@psu.edu
Bio-energy research initiatives at University of Connecticut Professor Xiusheng Yang, Department of Natural Resources M and E, University of Connecticut, Storrs, CT 06269 Contact: xiusheng.yang@uconn.edu

Appendix B – Attendees List

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Appendix C – CONFERENCE AGENDA

Sunday November 11, Biotechnology Building Atrium

4:00-6:00 p Registration, welcome reception, and poster session
5:00-5:05 p **Opening remarks,** ***Larry Walker,*** NE Sun Grant Institute of Excellence
6:30-8:30 p **Speakers' dinner meeting,** *Statler Hotel, Taylor Room*

Monday November 12, Statler Hotel, Carrier Ballroom

7:00-8:00 a Registration and continental breakfast
8:00-8:15 a **Welcome and Introduction,** ***Michael Hoffmann,*** CUAES
8:15-8:40 a **Opening Keynote and Panel Moderator:*William Chernicoff,*** US DOT, Biofuels & Transportation: perspectives on sustainability and pathways forward
8:40-8:50 a ***John Ferrel,*** US DOE, Office of the Biomass Program, Energy Efficiency and Renewable Energy, US Department of Energy, Regional Feedstock Partnership -- DOE Perspective

GEOGRAPHICAL INFORMATION SYSTEM (GIS, PANEL A)

8:50-9:10 a ***Tristam West,*** Oak Ridge National Laboratory, GIS: Organization, use, and distribution of spatial data for estimating the current and potential bioenergy feedstock supply
9:10-9:30 a ***Peter Woodbury,*** Cornell University, Geospatial analysis of strengths, weaknesses, opportunities, and threats for biomass feedstock production in the NE SunGrant Region
9:30-9:45 a Questions and Discussion
9:45-10:00 a **Break**

GEOGRAPHICAL INFORMATION SYSTEM (GIS, PANEL B)

10:00-10:20 a ***Charles Ray,*** Pennsylvania State University, GIS for documenting current forest biomass inventory and future development of forest biomass crops
10:20-10:40 a ***John Mackenzie,*** University of Delaware, GIS tools for assessing nutrient cycling, water quality and biomass potential
10:40-11:00 a ***Christopher Recchia,*** Biomass Energy Resource Center, Montpelier, VT, A new model for analysis of the Billion Ton Report
11:00-11:15 a Questions and Discussion

ENERGY CROP DEVELOPMENT (PANEL A)

11:15-11:35 a ***Steve St. Martin,*** The Ohio State University, Breeding the next generation of oil crops
11:35-11:55 a ***Hilary Mayton,*** Cornell University, Breeding bioenergy grasses for the Northeast

11:55-12:15 p **Yi Li,** University of Connecticut, Two new tools for genetic improvement of cellulosic energy crops: the 'gene-deletor' and 'growth promoting' technologies

12:15-12:30 p Questions and Discussion

12:30-1:30 p **Lunch Keynote and Panel Moderator:** ***Thomas Fretz,*** Dean Emeritus, University of Maryland, Extending Sun Grant Research and Outreach Competitiveness through the NESGI Competitive Grants Process,

ENERGY CROP DEVELOPMENT (PANEL B)

1:30-1:50 p ***Sam Jaffe,*** Business Development, Copea Energy, Development of algae as a potential biofuels feedstock

1:50-2:10 p ***Margaret Brennan & David Specca,*** New Jersey Agricultural Experiment Station, Rutgers University, Assessment of Biomass Energy Potential in New Jersey

2:10-2:30 p ***Rick Handley,*** Regional Energy Programs CONEG Policy Research Center Inc. and Northeast Regional Biomass Program, "Building demand for new energy crops"

2:30-2:45p Questions and Discussion

2:45-3:00p ***Mark Downing,*** Oak Ridge National Laboratory, Billion Ton report background

–Directions for breakout sessions (break refreshments on way to working group sessions)

3:00-5:00 p ***WORKING GROUPS– BREAKOUT SESSIONS***

-Agricultural residues and food waste: **Ballroom** (Norm Scott)
-Lignocellulosic and herbaceous perennials: **Amphitheatre** (Gary Bergstrom)
-Forestry residues and mill waste: **Duffield Hall Room 350** (Jingxin Wang)
-Woody crop development: **Taylor Room A** (Ray Miller)
-Economics and Systems analysis: **Harvard Room** (Antonio Bento)
-Infrastructure and Policy: **Rowe Room** (William Chernicoff)
-Starch and oil seed crops: **Biotech Building, Room 130** (Steve St. Martin)
-Municipal solid waste to energy: **Ballroom** (David Specca)
-Other potential feedstocks: **Brown Room** (Sam Jaffe)
-GIS as tool for biomass industry: **Taylor Room B** (Peter Woodbury)

5:30-6:30 p **Cocktails and Hors d'oeuvres Reception,** *Statler Hotel, The Terrace Restaurant and Lounge*

6:30-8:30 p **Dinner,** *Statler Hotel, The Terrace Restaurant and Lounge*
Keynote and Panel Moderator: ***Nathanael Greene,*** NRDC, The politics and policy of getting biofuels right