Renewable Fuels Roadmap and Sustainable Biomass Feedstock Supply for New York

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Abstract

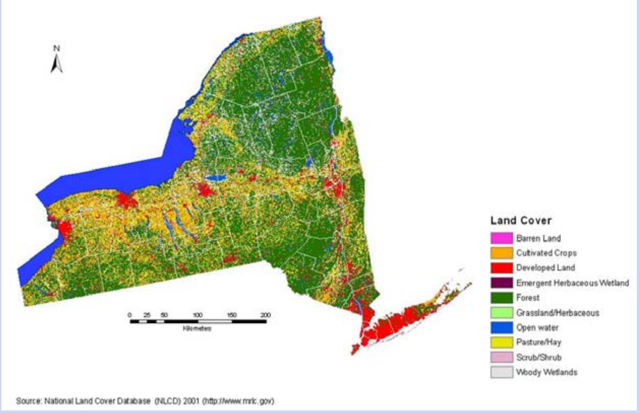
The need for a Renewable Fuels Roadmap was identified in the February 2008 Report of the Governor's Renewable Energy Task Force, which called for a Renewable Fuels Roadmap and Sustainable Biomass Feedstock Supply Study for New York.

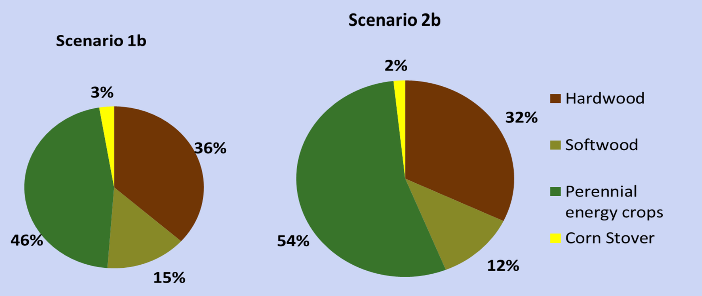
The Roadmap assesses the prospects for the expansion of biofuel production in New York State, focusing on resource availability and economic and environmental impacts. In addition, the Roadmap solicited input from New York stakeholders to identify the most important social, economic and environmental issues to make a renewable fuels industry socially, economically, and environmentally sustainable in the State.

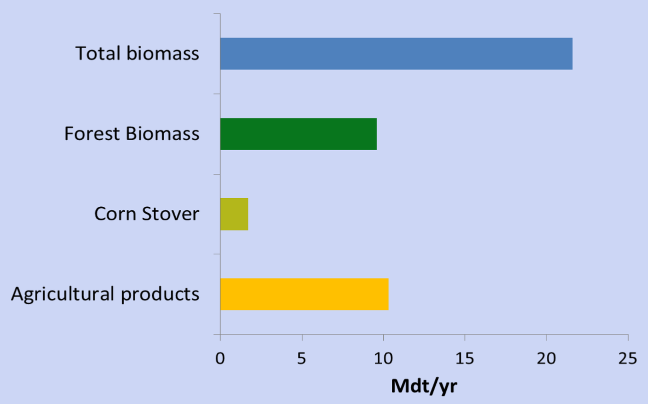
Assigned with the task of looking into the future for impacts from an industry that almost entirely does not exist at this writing, the Roadmap Team devised and implemented three scenario analyses. The scenario analyses were coordinated using an integrated set of computer models based on the best available data, combined with a set of expert judgments and assumptions where quantitative data were not available. These integrated computer models collectively provide feedstock, energy, economic, and environmental analyses of three Roadmap scenarios.

The Roadmap presents possibilities, identifies potential challenges, and outlines important technology and policy options that may be used to ensure that any expansion of a renewable fuels industry serves the social, economic, and environmental goals of New York.

New York State Land Availability and Biomass Capacity







The analysis of current land cover shows that forests cover more than half of the State, and nearly 25% of the State is in agricultural land cover, primarily hay and pastureland.

There is the potential for between 1 million and 1.68 million acres of non-forest land to be used for bioenergy feedstock production in New York. Of the State's forest lands, there are almost 18.5 million acres, of which nearly 15.8 million acres are capable of producing woody biomass (excluding the forest preserves in the Adirondacks and Catskills where harvesting is restricted).

Scenario Assumptions

Three scenarios are designed to test the bounds of the resource systems in New York and to evaluate impacts at these bounds. Each Scenario was analyzed at two price points: $3/gallon gas equivalent (gge) and $4/gge.

Scenario 1

"Big Step Forward"

- Emphasizes maintaining current NY food, feed, and forest production.
- Assumes rapid development of lignocellulosic feedstock resources on a portion of suitable and available rural lands (excluding lands currently in food production).
- Focuses on large (average 90 MGY) biofuel production plants.

Scenario 2

"Giant Leap Forward"

- In addition to land in Scenario 1, some cropland is used for biofuel feedstock production.
- Additional cropland estimated to become available due to increases in crop and milk yields.
- Focuses on large, second generation biorefinery clusters (average 354 MGY) operating in centralized loca-

Scenario 3

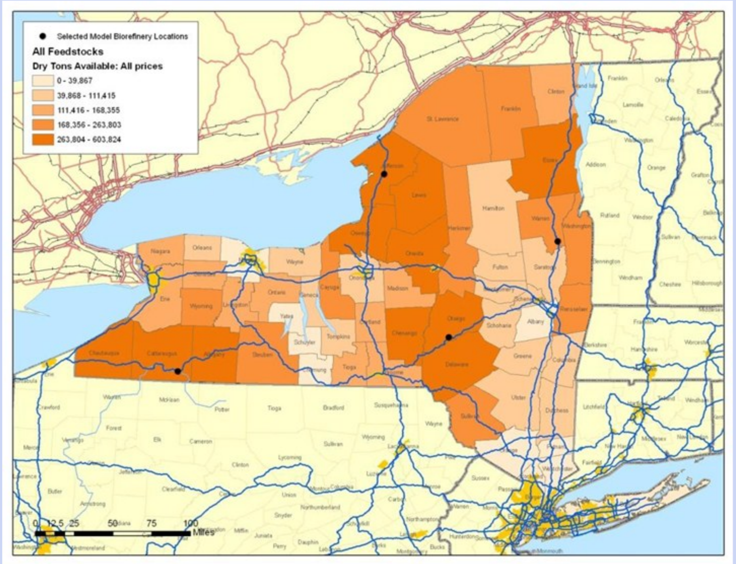
"Distributed Production"

- Assumes same feedstock production and conversion technology as Scenario 2.
- Focus on decentralized fuel production industry with no individual biorefinery exceeding 60 MGY capacity.

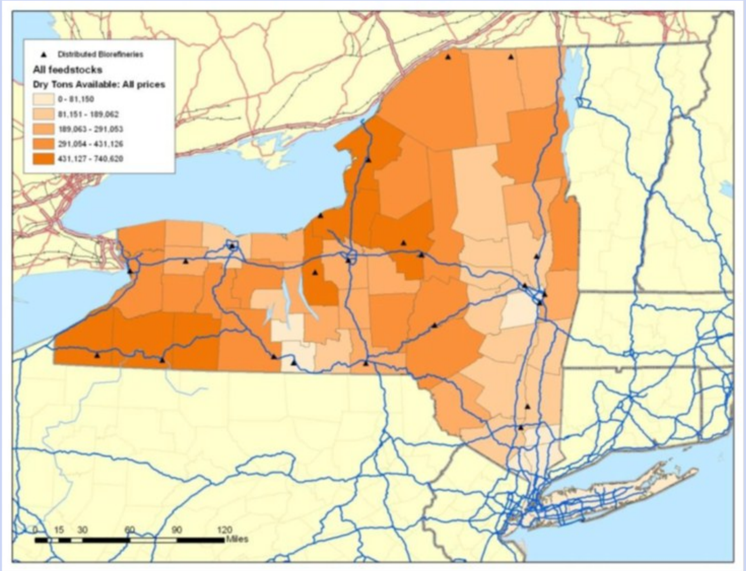
Scenario Analysis

	Scenario 1 Big Step	Scenario 2 Giant Leap	Scenario 3 Distributed Production
Conversion Technology	Near-term	Advanced	Advanced
Energy Crop Area (million acres)	0.98	1.68	1.68
Perennial Grasses & Short-rotation Woody Crop Biomass (million dry tons – Mdt)	4.6	8.2	8.2
Forest biomass (Mdt)	4.8	6.4	6.4
Number/Sites of Biorefineries	4/4	12/4	24/22
Biorefinery production capacity (million gallons per year - MGY)	~90	~354	~60
Total State Production Capacity Ethanol (MGY)	508	1,449	1,449
Percentage of State Gasoline Consumption in 2020	5.6%	16%	16%
Number of Jobs	3,800 - 7,800	14,000	14,000
GHG Emission Reductions (million tonnes/yr)	1.8 – 3.7	7.8	9.7
NO_x Emissions (tonnes/yr)	2,000 – 5,000	9,700	8,800

Biorefinery Siting Maps



Biomass supply sheds with representative biorefinery sites shown for scenarios 1 and 2.



Biomass supply sheds with representative biorefinery sites shown for scenario 3.

Economic Impact Analysis

	Number of Jobs Created	Estimate of Labor Income (Wage & Salary payments) in millions	Value-added projection (GDP) in billions
Scenario 1a	3,891	$172.6	$0.46
Scenario 1a	7,780	$350.4	$0.93
Scenario 1a	14,604	$640.6	$1.73
Scenario 1a	14,019	$614.7	$1.66
Scenario 1a	14,189	$608.3	$1.78
Scenario 1a	14,236	$616.9	$1.79

The economic analysis estimates

- 80% of associated jobs would be in the feedstock industry (forestry and agriculture) and feedstock transportation
- 6-12% of associated jobs would be in the biofuel refineries
- average income of $44,361 per job (Scenario 1)

Jobs are not expressed in terms of whether or not they are full-time or non-seasonal jobs. In this analysis, a seasonal farm job and a full-time factory job producing ethanol are each considered one job.

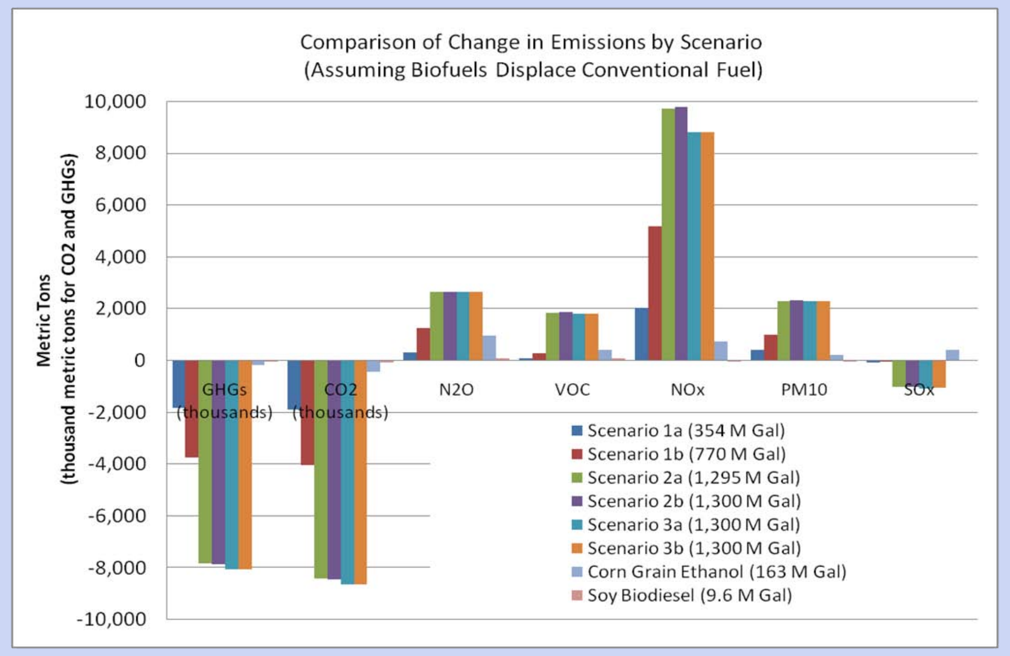
Lifecycle Analysis

The Roadmap conducted a greenhouse gas (GHG) lifecycle analysis using the New York Greenhouse Gas, Regulated Emissions, and Energy Use in Transportation (NY-GREET) model. NY-GREET allows users to evaluate the total fuel-cycle (i.e., "well-to-wheels") emissions and energy use characteristics of different conventional and alternative fuel vehicles operating in New York State. NY-GREET was used to calculate "well-to-pump", per mile, and aggregate life cycle emissions for each Roadmap scenario.

Based on this analysis, lignocellulosic ethanol (LCE) pathways in New York show potential to decrease greenhouse gas (GHG) emissions by millions of tons annually compared to gasoline. Moreover, these benefits are even greater under a distributed, localized biofuels industry (Scenario 3). Corn ethanol and soy biodiesel production also reduce GHGs and petroleum consumption, though to a lesser degree than LCE. The tradeoffs associated with biofuels production include increased emissions of some air pollutants that may lead to increased public health concerns in locations where feedstock expansion and fuel production occur.

Overall lifecycle analysis results suggest that

- displacing gasoline with LCE produced in New York State will reduce GHG emissions between 1.8 million (Scenario 1) and 8 million (Scenario 3) tonnes per year.
- displacing petroleum fuels with LCE will reduce life cycle consumption of fossil fuels between 20 million MMBtu (Scenario 1) and more than 100 million MMBtu (Scenario 3).



Conversion Technologies

Fifteen current technologies were evaluated for converting solid biomass to liquid fuels. The Roadmap summarized process descriptions, current development status, and estimated economic and performance attributes for the year 2020. Lignocellulosic material (such as wood or perennial grasses) generally requires a greater degree of pretreatment in preparation for the conversion process. Lignocellulosic technologies may be moving beyond the pilot phase into the demonstration stage, or may be expected to move into the demonstration phase around the 2015 to 2025 period. Only three of the technologies described are currently in commercial use, all based on grain-to-ethanol processes (for example, corn and sugar cane).

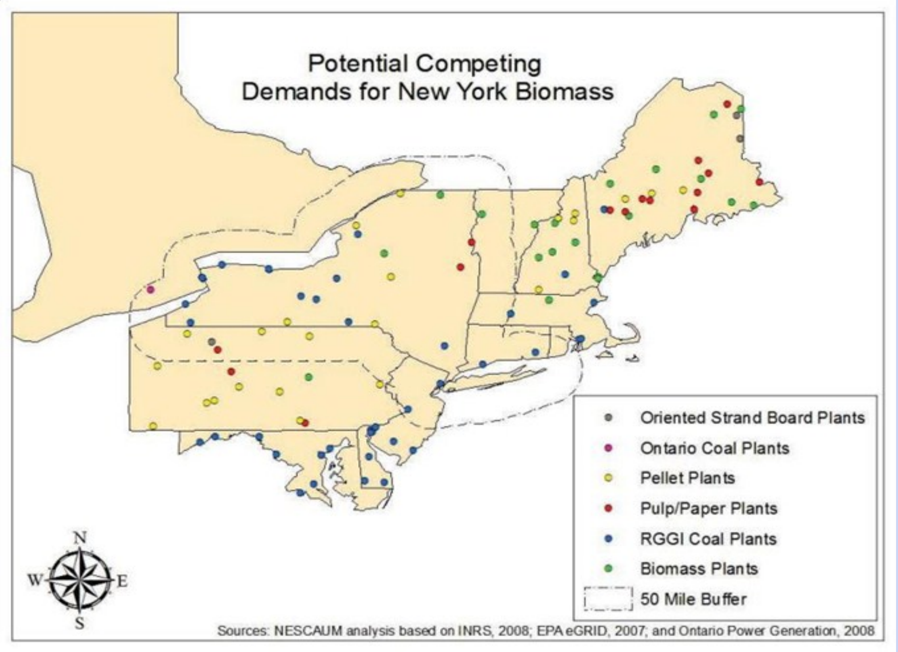
	Scenario 1 Big Step	Scenario 2 Giant Leap	Scenario 3 Distributed Production
Ethanol Technology	Gasification	Hydrolysis/Fermentation	Hydrolysis/Fermentation
Biodiesel Technology	Esterification	Esterification	Esterification

Competing Uses

Analysis in the Roadmap assumes that all of the sustainably available biomass in New York is sold for lignocellulosic ethanol production.

In reality, there are competing uses and competing markets for woody biomass. Competing demand for biomass feedstocks will reduce availability for biofuel production.

This figure illustrates competing demand for woody biomass in and around New York State.



The Roadmap may be accessed at: http://www.nyserda.org/publications/renewablefuelsroadmap/default.asp