

New York's Energy Technology Clusters

Leveraging New York State's
Intellectual Resources for
Producing Clean Energy
Technology



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Introduction

New York has shown a strong commitment to renewable energy in recent years through its investment of Systems Benefit Charge (SBC) funds, the Renewable Portfolio Standard (RPS), the Regional Greenhouse Gas Initiative (RGGI), and the “15 by 15” framework. In addition to environmental benefits, using renewable energy keeps about half of energy expenditures in-state, which is a significant improvement over traditional energy sources. If, however, New York were to use clean energy technology developed and manufactured in-state, then almost all energy expenditures, about \$58 billion per year, would stay in the local economy. As the world converts from traditional energy sources to renewables, much of the money that now flows to oil-rich regions will instead flow to the regions that produce the equipment and infrastructure to capture renewable resources. New York is well positioned to capitalize on renewables because of the various clusters of clean energy technology corporations and research universities that are already established across the state. These clusters can be leveraged to develop and enhance a thriving clean energy industry.

Existing Energy Clusters

New York’s leading technological universities, corporations, and entrepreneurs have taken a collaborative approach to clean technology initiatives, resulting in one of most vibrant networks for clean energy-related research in the United States. This collaborative network has emerged in recent years to become a series of identifiable technology clusters, with each cluster providing leadership in a targeted sector of clean technology manufacturing, commercialization and research; a phenomenon which has been reinforced by the varying assets and competencies of New York’s diverse regions and communities.

The emergence of energy clusters across New York presents an important economic opportunity for the State. By taking greater advantage of the State’s existing energy clusters, New York can emerge as a global center for innovation in clean technology and induce some of the world’s most promising corporations to locate, expand or retain operations in-state. By developing clean technologies in-state, New York can establish itself as a dominant player in the world’s future energy industry and enable more of the state’s energy expenditures to remain within the local economy. It also would result in the creation of new, skilled jobs for New Yorkers, increased tax revenues, a substantial influx of investment capital, and the growth of peripheral businesses that support the clean technology industry.

New York's ENERGY TECHNOLOGY CLUSTERS



Transportation
Alternative fuel: hydrogen



Biomass
Alternate fuel: Biomass
Biomass feedstocks
Biomass combined heat and power
Biogas logistics/economics
Biowaste
Gasification



Renewable Energy Generation and Storage
Solar Photovoltaics
Wind Energy
Fuel Cells, PEM and SOFC.
Hydrogen Generation
Hydrogen Storage



Environmental Systems
Building Envelope
Space heating and cooling
Lighting
Building Codes and Standards
Building Management Systems
Solar Thermal

Policy and Financing
Renewable energy policy
Capitalization and financing



Fundamental Renewable Research
Material Science
Fuel Cells

Implementation of Clean Energy Solutions

A large-scale switch from traditional to renewable energy will require the involvement of the New York State government. New York's existing public policies and incentive programs have been designed primarily to support the growth of a consumer market for renewable energy in New York State, which will provide security, environmental, and health benefits to New Yorkers. The State can gain economic benefits (stronger economy and job growth), by encouraging, coordinating and fostering in-state development and production of renewable technologies and infrastructure by enhancing the energy technology clusters that have emerged across the state.

New York can become a leading technology supplier to the state, country, and world by broadening its public policies and programs to benefit clean technology manufacturers and by supporting its energy clusters in developing new technologies and moving them into the marketplace.

By implementing these measures, New York State can maintain its leadership and contend with other areas such as California, New Jersey, Massachusetts, Japan, and Germany which have aggressive policies and producer-incentive programs already in place, and thus are poised to benefit most from the vast growth of the renewable industry.

Expanding the Energy Clusters

The existing energy clusters can be formalized, coordinated, and strengthened to become a series of energy technology Centers that build on existing strengths and core competencies. The Centers would yield growth through state-of-the-art R&D, manufacturing, and prototyping facilities; human talent development; workforce training; and partnerships between industry, government, and R&D facilities. They will succeed by encouraging activities that add to the State's desired energy technology portfolio, based on an Energy Roadmap and long term plan.

The Energy Centers would:

- coordinate strong partnerships and collaborations between industry, universities and government.
- be led by universities that have strong collaborations with industry in their energy sector.
- be geographically distributed across New York State to take advantage of cur-

“As the world converts from traditional energy sources to renewables, much of the money that now flows to oil-rich regions will instead flow to the regions that produce the equipment and infrastructure to capture renewable resources.”

Six primary energy clusters currently exist in New York

Energy Technology Cluster	Selected Examples of Industry	Universities with Core Competencies: Primary and (Complimentary)
Transportation	General Motors, Delphi, Harris RF Communications, Applied Coatings Inc., EnrG Inc., Senser Inc.	RIT (Alfred, Cornell, CNSE, RPI, Univ. of Rochester)
Biomass	Empire Biofuels, Northeast Biofuels, Western New York Energy, Nextgen Fuel, Northern Biodiesel, United Environment & Energy	SUNY ESF (Cornell, Clarkson)
Environmental Systems	Carrier Corporation, Northeast Natural Homes, NuClimate Air Quality Systems, O'Brien & Gere, OP-TECH Environmental Services Inc., Oneida Air Systems	Syracuse U. (CNSE/ NISE, RPI, Clarkson)
Renewable Energy Generation and Storage	GE Energy, GE Global Research, Plug Power, MTI, Daystar Technologies, SuperPower, Blasch, EYP AE	CNSE/UAlbany (RPI, Union, Cornell, RIT)
Policy and Financing		Pace Law (Columbia, Albany Law)
Fundamental Renewable Research	Brookhaven National Laboratory	Stony Brook (CNSE/ UAlbany, RPI, RIT)

rent technology clusters and their core capabilities.

- serve as major regional resources for energy technology manufacturing, prototyping and development in New York State, and work with industry to set up state of the art manufacturing facilities.
- work closely with company partners, incubate start-up companies, and serve as a place for university-business co-location.
- provide leadership in collaborative research and technology transfer to stimulate regional and state wide economic development.
- raise awareness of united and combined resources related to new energy technology available in New York State.
- increase leverage of state based resources.

Conclusions

While serving an important economic function, the current energy clusters across New York would be able to provide far greater benefits to the state by formalizing, shaping, and expanding their strengths by forming energy Centers. By broadening the capabilities of New York's existing energy clusters, New York can harness the inherent strengths and diverse capabilities of its many communities into an engine for robust economic growth and social gain.

In recent years, New York State has invested hundreds of millions of dollars in public funds¹ to help establish a cleaner and more sustainable energy future. By 2013, after New York reaches the goal of meeting 25% of its electricity needs from renewable energy sources as stated in the Renewable Portfolio Standard (RPS), New Yorkers will boast the most environmentally benign electricity grid in the United States. New York's existing hydroelectric power plants satisfy about 19% of the State's 25% target, and the remaining 6% will be supplied by newly constructed renewable resource generation.

Governor Eliot Spitzer announced New York State's Clean Energy Plan in April 2007. The Plan includes a framework called "15 by 15," which establishes a target to reduce New York's electricity consumption by 15% below the expected forecast level in 2015, which is currently the most aggressive target in the nation.² Since New York's rising energy demand is expected to require an additional 10-15% of power generating capacity over the next ten years, the implementation of the 15 by 15 framework would ultimately keep New York's electricity demand stable, or even below its current level.³

While public policy initiatives like the RPS and 15-by-15 described above have successfully supported the growth of an in-state consumer market for renewable energies, these programs are not designed to attract clean technology businesses into New York State. Since the clean technology industry represents some of the fastest growing companies in the world, New York continues to lose substantial economic development opportunities to states and countries with more competitive public policies and incentive programs such as California, Massachusetts, Japan, and Germany.

1 New York State Public Service Commission, System Benefits Charge, < <http://www.dps.state.ny.us/sbc.htm#Snapshot> > [November 21, 2007]

2 Governor Eliot Spitzer, "15 by 15" A Clean Energy Strategy for New York, Crains Business Breakfast Forum (New York, NY), April 19, 2007 < http://riverkeeper.org/document.php/570/Gov_Spitzers_15.pdf > [November 21, 2007]

3 Governor Eliot Spitzer, "15 by 15" A Clean Energy Strategy for New York, Crains Business Breakfast Forum (New York, NY), April 19, 2007 < http://riverkeeper.org/document.php/570/Gov_Spitzers_15.pdf > [November 21, 2007]

Over 90% of New York's energy use is powered by fossil fuels and nuclear power (with the rest coming from biofuels and hydropower).⁴ This heavy reliance on traditional energy sources creates a number of problems for New Yorkers.

Human Health Effects

Many products of combustion negatively affect the human body, including carbon monoxide, sulfur dioxide, and oxides of nitrogen. These chemicals react in the air to form still more pollutants including particulate matter and ozone (the primary constituent of smog).

Environmental Effects

The same pollutants that can harm humans can cause problems for New York's flora, fauna, and agricultural crops. In addition, acid deposition, caused by products of combustion, has had a well documented affect on New York's natural areas, especially the Adirondacks.

Global climate change is expected to have a profound effect on New York if forceful corrective action is not taken soon.⁵ Global climate change threatens the extinction of many species, the spread of diseases new to New York, an increase in severe weather, and flooding of New York's coastlines. New York residents are responsible for 12.5 tons of CO₂-equivalent greenhouse gas emissions per capita per year. While this is only half⁶ of the national average, much more can still be done to address this serious issue.

Finally, transporting large quantities of petroleum through the Atlantic shipping channels near New York creates the possibility that New York's coast line will be affected by an oil spill in the future.

4 New York State Energy Research and Development Authority, New York State Energy Fast Facts, 2004 < http://www.nyserda.org/Energy_Information/fastfacts.html > [November 21, 2007]

5 Union of Concerned Scientists, Climate Change in the U.S. Northeast: A Report of the Northeast Climate Impacts Assessment, October 2006 < http://www.climatechoices.org/assets/documents/climatechoices/NECIA_climate_report_final.pdf. > [May 2007]

6 Carbon Planet, Greenhouse Gas Emissions By Country, 2007 < http://www.carbonplanet.com/home/country_emissions.php > [November 21, 2007]

Economic Impact

New York's current fuel source portfolio negatively affects the economy in two ways: through "external costs" of energy use and by directing energy expenditures out of the region.

The direct cost of energy to end users does not pay for the full societal costs of that energy use. The external costs include subsidizing the fossil fuel and nuclear industries' operating expenses, storage of nuclear waste, coping with environmental damage, medical treatment of human health effects, and military protection of energy supplies.

Since 58% of the oil consumed in United State's is imported, the payments for the fuel are removed from the nation's economy, resulting in the direct transfer of wealth to politically unstable regions of the world and indirect losses to potential GDP, including the negative externalities of adjusting to volatility in energy prices.⁷ In 2004 alone, about 51% (or \$29.3 billion) in New York State's energy expenditures were directed out-of-state⁸, representing 3.5% of its total GSP (Gross State Product).⁹

A peak (followed by a decline) in global oil production also looms as a constant threat to world economies. The United States, the United Kingdom, and Norway are among the many nations that have already reached a domestic peak in oil production, forcing nations to become increasingly dependent on regions with the highest concentration of petroleum resources, particularly the Middle East. Estimates of the amount of undiscovered oil that can be recovered vary, but there is less ambiguity regarding the geopolitical ramifications and devastating economic consequences that would follow a peak in global oil production if appropriate measures are not taken immediately to begin reducing global dependency on petroleum products.¹⁰



Astronauts of the STS-92 Space Shuttle capture a layer of regional smog extending across Upstate New York in October 2000.

(Source: http://visibleearth.nasa.gov/view_detail.php?id=1519)

7 David L. Greene and Sanjana Ahmad, Costs of U.S. Oil Dependence: 2005 Update, January 2005 < http://cta.ornl.gov/cta/Publications/Reports/ORNLTM2005_45.pdf > [November 21, 2007]

8 New York State Energy Research and Development Authority, New York State Energy Fast Facts, 2004 < http://www.nyserda.org/Energy_Information/fastfacts.html > [November 21, 2007]

9 Ibid

10 Josef Auer, "Energy prospects after the petroleum age" Deutsche Bank Research, December 2, 2004 < http://www.dbresearch.de/PROD/DBR_INTERNET_DE-PROD/PROD0000000000181487.PDF > [November 21, 2007]



New York's energy infrastructure may be leveraged by terrorists.

Security Impact

Our current energy portfolio leaves New York vulnerable in three ways. First, it is possible that our fuel supply line will become interrupted by a variety of events including an embargo by a fossil fuel- rich country, a hostile country blocking a foreign shipping lane or pipeline, a terrorist strike against a fuel-supply pipeline, or the shutdown of an oil refinery due to Gulf Coast hurricanes or a terrorist strike. Because New Yorkers' physical well being is so dependent on energy supplies, the current fuel mix puts the state at risk.

Second, terrorists may attempt to leverage the energy infrastructure as a weapon against New Yorkers. For example, a terrorist strike against localized energy infrastructure could cause great destruction to people and property.

Third, U.S. energy expenditures have been shown to fund terrorist activity.¹¹ As discussed above, much of the money spent on energy flows to foreign countries. Many of these countries, and the people operating the businesses within those countries, are hostile to the U.S.

The Renewable Energy Solution

By switching to renewable energy technologies, New York State can avoid the health, environmental, economic, and security issues with traditional fuel sources described above. Also, switching to renewables would lead to job growth in New York. According to a study conducted at the University of California at Berkeley, renewable technologies create more jobs per MW than coal or natural gas.¹² Clean technologies can help recapture some of the manufacturing jobs that the state has lost to foreign competitors in recent years. Clean technologies also present substantial indirect employment opportunities. According to New York's Department of the State Comptroller, about 63% of the expected job growth from the implementation of New York's RPS program is linked to indirect employment growth to support renewable energy.¹³

11 D. Kaplan, "The Saudi Connection: How billions in oil money spawned a global terror network," U.S. News and World Report. Dec. 7, 2003. Available at < <http://www.usnews.com/usnews/news/articles/031215/15terror.htm> >. Accessed December 2007.

12 Daniel M. Kammen, Kamal Kapadia and Matthias Fripp, Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?, January 13, 2006 < <http://rael.berkeley.edu/files/2004/Kammen-Renewable-Jobs-2004.pdf> > [November 21, 2007]

13 Alan G. Hevesi and Kenneth B. Bleiwas, Energizing the Future: Benefits of Renewable Energy for New York State, March 2005 < <http://www.osc.state.ny.us/osdc/renewableenergy.pdf> > [November 21, 2007] The RPS

New York's most viable renewable resources include biomass (including biofuels), solar energy (electrical and thermal), and wind power (land-based and offshore). New York can also take a leadership role in developing a hydrogen economy for long term sustainability, which will be needed to address the intermittency of renewable energy once it reaches high penetration levels. Energy efficiency technologies will reduce traditional fuels in the short run and decrease the renewable energy infrastructure needed in the future.

Biomass

Biomass, like traditional fossil fuels, is a form of stored solar energy. It is derived from renewable, organic matters including agricultural food crops, grassy and woody plants, aquatic plants, wood wastes and residues, animal waste, and the organic component of municipal and industrial waste. Bioenergy technologies use biomass to produce heat, electricity, plastics and other chemical based materials, and biofuels such as E85 ethanol and renewable biodiesel.

The burning of biomass matter to produce energy is considered environmentally benign, because the carbon dioxide released into the atmosphere is equivalent to the amount of carbon dioxide captured during the growth of the biomass, resulting in no net increase of carbon dioxide in the atmosphere.

As of 2004, biofuels accounted for only 3% of primary energy consumption in New York State.¹⁴ However, if current research and development efforts are successful, then locally produced cellulosic ethanol has the potential to replace the state's oil imports used for transportation fuels,¹⁵ and help national efforts to reduce dependence on foreign oil.

is expected to create 15,880 direct jobs and 43,000 indirect jobs.

14 New York State Energy Research and Development Authority, New York State Energy Fast Facts, 2004 <http://www.nyserda.org/Energy_Information/fastfacts.html> [November 21, 2007]

15 New York State Energy Research and Development Authority, Biofuels Get Boost in Western New York, Region Receives First Shipment of Biodiesel, NYSERDA and NOCO Announce Start of Ethanol Initiative, August 19, 2002 <http://www.nyserda.org/Press_Releases/press_archives/2002/08_19_02.asp> [November 21, 2007]



“Only 0.75% of new York’s area would be needed to produce all the electricity we use.”
 (Photo source: <http://www.nrel.gov/data/pix/jpegs/10280.jpg>)

Wind Development in New York, based on NYISO queue (in addition to existing wind plants).

Wind Farm	Online Date	Capacity (MW)
Noble Chateaugay Windpark	2008	128
Noble Clinton Windpark I	2008	101
Noble Ellenburg Windpark	2008	81
Noble Altona Windpark	2008	102
Maple Ridge	2006	321
Jordanville Wind Farm	2008	136
Noble Bliss Windpark	2008	101
Cohocton Wind Farm	2008	83
Dutch Hill Wind Farm	2008	43
Windfarm Prattsburgh	2008	56
Jersey-Atlantic	2006	8

Solar

Solar technologies such as photovoltaics (PV), solar thermal, and concentrating solar are being used to harness the energy of the sun by converting it into usable forms of power such as hot water and electricity. According to University at Albany Professor Richard Perez, “Only 0.75% of new York’s [land] area would be needed to produce all the electricity we use.”¹⁶ According to *New York’s Solar Roadmap*, deploying 2 GW of solar PV in the state in the next decade is a reasonable goal.¹⁷

Worldwide demand for solar photovoltaics has seen a significant rise in demand, growing at about 25% per annum over the past 15 years.¹⁸ Grid-connected solar PV systems are designed to generate electricity that can be consumed directly on site or fed onto the grid. Because the solar resource is highly correlated with peak-demand periods, PV mitigates the risk of expensive power outages like those experienced in New York in 1977 and 2003 which can result from overloading the grid.¹⁹

Wind

Wind energy is one of the fastest growing energy sources in New York State. About 28,000 MW of land based²⁰ and 5,200 MW of offshore (Long Island)²¹ wind potential exist in the state, enough to meet 65 percent of New York’s electricity demand.²²

New York State has increased its investment in wind generated power capacity in recent years, mostly as a result of the implementation of New York’s Renewable Portfolio Standard (RPS), which mandates that 25% of the state’s electricity needs

16 Richard Perez, Is There Really Enough Sun in the Empire State?, May 14, 2007 < <http://www.asrc.cstm.albany.edu/perez/2007/richard-perez-solar-new-york-2007.pdf> > [October 2007] Assumes 10% conversion efficiency.

17 The Solar Initiative of New York, “New York’s Solar Roadmap, May 2007 < http://www.neny.org/download.cfm/NENY_Membership_Application.pdf?AssetID=225 > [December 2007]

18 Solarbuzz, Fast Solar Energy Facts: Global Performance, 2007 < <http://www.solarbuzz.com/FastFactsIndustry.htm> > [November 21, 2007]

19 U.S. Photovoltaic Industry, Solar-Electric Power: The U.S. Photovoltaic Industry Roadmap, May 2001 < http://photovoltaics.sandia.gov/docs/PDF/PV_Road_Map.pdf > [November 21, 2007]

20 D.L. Elliott, L.L. Wendell, and G.L. Gower, An Assessment of the Available Windy Land Area and Wind Energy Potential in the Contiguous United States, August 1991 < <http://www.osti.gov/energycitations/servlets/purl/5252760-ccuOpk/5252760.PDF> > [November 21, 2007] This analysis factors in environmental and land use exclusions for wind class of 3 and higher.

21 AWS Scientific, Inc., Long Island’s Offshore Wind Energy Development Potential: A Preliminary Assessment, April 2002 < <http://www.lipower.org/pdfs/cei/wind/phase1.pdf> > [November 21, 2007]

22 Assumes 33% capacity factor from wind turbines. Assumes 150,247 GWh/year from Appendix A.

come from renewable sources of energy by 2013.²³ Much of the expected increase in renewable capacity will come from wind power. To begin meeting this target, New York State has established contracts with agreements to purchase about 1,088 MW of wind capacity by the end of 2008, over 95% of which will come from wind power generated within the state.²⁴ This investment will require the private construction of new wind power facilities in New York, as detailed in the table at left.²⁵

Hydrogen

Hydrogen can be extracted from water through electrolysis to serve as a synthetic fuel. It acts as a clean method to store and transport renewable energy when, for example, energy from the wind or sun is used to drive the electrolysis. Hydrogen can be used any way a gaseous fuel such as natural gas is used today: to power vehicles, to heat buildings, to power industrial processes, for cooking, and to generate electricity. Hydrogen can be used to store renewable energy for times when the resource is quiescent and to transport it from regions with strong resources to areas with high population densities. Hydrogen energy will become especially important when the penetration of renewable resources on the electric grid increases above today's levels. The *New York State Hydrogen Energy Roadmap* envisions linked hydrogen energy clusters across the state by 2020.²⁶

Efficiency

Energy-efficient technologies and practices of conservation provide immediate benefits to help combat the negative effects of our current energy use. For example, if every American home replaced just one traditional light bulb with a compact fluorescent bulb, we would save enough energy to light more than 3 million homes for a year, save more than \$600 million in annual energy costs, and prevent green-

23 New York State Energy Research and Development Authority, New York's Continued Commitment to Clean, Renewable Energy Could Foster \$1.4 Billion of Investments in New York: Renewable Portfolio Standard Program Progress, April 19, 2007 < http://www.nyserda.org/Press_Releases/2007/PressRelease20071904.asp > [November 21, 2007]

24 Ibid

25 New York State Energy Research and Development Authority, New York State Invests in Renewables, Spring 2007, p. 3. < <http://www.powernaturally.org/publications/NYSInvest13final.pdf> > [October 2007]

26 Energetics, Albany Nanotech, and the National Hydrogen Association, New York State Hydrogen Energy Roadmap, October 2005. < <http://www.energetics.com/meetings/nyhydrogen/pdfs/roadmap.pdf> > [December 2007]



Advanced lighting technologies such as this LED panel can cut energy use significantly.

(Photo source: <http://www.asvl.com/images/ASV%20Lite%20-%200001-%20Basic.jpg>)

house gases equivalent to the emissions of more than 800,000 cars.²⁷

Fuel efficient and hybrid vehicles provide immediate cost advantages to their owners, and the design of “green buildings” for new residential and commercial construction projects are helping homes and businesses become more energy efficient and reduce utility bills. Since 1999, NYSERDA has committed more than \$92 million in federal and State funds to provide assistance for green building projects affecting more than 137 million square feet of building space in New York State.²⁸

The ENERGY STAR Program, developed by the U.S. Department of Energy and the U.S. Environmental Protection Agency, is also helping many Americans, including New Yorkers, become more energy efficient. In 2006 alone, Americans saved enough energy through the ENERGY STAR Program to avoid greenhouse gas emissions equivalent to those from 25 million cars.²⁹

27 Energy Star, Compact Fluorescent Light Bulbs, 2007 < http://www.energystar.gov/index.cfm?c=cfls.pr_cfls > [November 21, 2007]

28 New York State Energy Research and Development Authority, Green Building Services, 2007 < http://www.nyserdera.org/programs/Green_Buildings/default.asp > [November 21, 2007]

29 Energy Star, Compact Fluorescent Light Bulbs, 2007 < http://www.energystar.gov/index.cfm?c=cfls.pr_cfls > [November 21, 2007]

A large-scale switch from traditional to renewable energy will require the involvement of the New York State government. It is unlikely that New York residents and businesses will make the switch to renewable energy based on free market forces alone. Electricity and fuel are commodities, and whether they come from traditional or renewable sources matters little to most end users. The market's inherent inability to include externalities in pricing structures will make traditional energy sources appear artificially cheaper. A strong governmental program to move New York to renewable energy will provide long-term benefits to the state's security, health, economy, and the environment. It is therefore an appropriate measure to take.

New York has been a national leader in some instances of renewable energy policy. The Regional Greenhouse Gas Initiative (RGGI), the System Benefit Charge (SBC) funds distributed through NYSERDA, and the aggressive Renewable Portfolio Standard have been innovative and relatively effective. To make a large-scale switch to renewable energy, however, two changes are needed in the incentives programs.

First, the amount of financial backing from the state needs to be increased. The experiences of California, New Jersey, Germany, and other regions around the world have shown that when greater financial incentives are provided, renewable energy will be adopted at a meaningful scale.³⁰ An overview of current incentives can be found in the "Technology Pull" section below.

Second, New York's current incentive programs are geared toward the installation and use of renewable energy. This will provide security, environmental, and health benefits to New Yorkers, but in order for the State to gain the full economic benefits of renewable energy, including a stronger economy and job growth, New York needs to encourage in-state development and production of renewable energy equipment. The "Technology Push" section below describes some new incentive programs that encourage the development and production of new energy technologies and how the existing energy clusters across New York can best be utilized to accomplish this.

³⁰ The California Solar Initiative, for example, has committed \$3.4 billion of government funds aimed at creating 3,000 MW of newly installed solar electricity capacity over the next 11 years. NYS, on the other hand, has committed \$50 million since the inception of its PV Incentive Program in 1998, resulting in about 5,300 kW of installed capacity. Solar Energy Industries Association, US Solar Industry Year in Review: US Solar Energy Industry Charging Ahead, 2006 < http://www.seia.org/Year_in_Solar_2006.pdf > [November 21, 2007] and Clean Power Research, NYSERDA PV Incentive Program Status, October 26, 2007 < <http://www.clean-power.com/PowerNaturally/> > [November 21, 2007]

“In order for the State to gain the full economic benefits of renewable energy, New York needs to encourage the in-state development and production of renewable energy equipment.”

Technology Pull: Deployment Incentives

As mentioned above, New York currently has several incentive programs in place, such as RGGI, RPS, and SBC-funded subsidies. To effect a large scale switch to renewable energy, new, targeted incentive programs should be added and all of the incentive programs should receive greater funding.

SBC-Funded Subsidies

In 1998, the New York State public benefits charge was established by the order of the New York State Public Service Commission (PSC). Under this program, the New York State Energy Research and Development Authority (NYSERDA) received funding from the PSC to administer the New York Energy SmartSM Public Benefits Program, which had initial funding of \$234.3 million for the years 1998-2001. This funding was extended in 2001 through the year 2006, with an annual budget of \$150 million.³¹

The New York Energy Smart Program is organized into a portfolio of four major initiatives, including (1) promoting energy efficiency and demand management (2) facilitating renewable energy development, (3) providing energy services to low income New Yorkers, and (4) conducting research and development on renewable technologies. Activities pursued within these initiatives include marketing, providing financial incentives, developing and testing new products, commercializing new technologies, gathering renewable energy related data and information, and disseminating information to increase consumer energy awareness.³² While the SBC program does include some technology development efforts, it has largely been focused on encouraging the use of existing technology in the marketplace.

Through the SBC funded New York Energy Smart program, approximately 106 GWh of renewable energy has been generated. As of March 2007, the program has been responsible for the creation or retention of about 3,700 jobs, has saved New Yorkers an estimated \$438 million on their annual utility bills, and has reduced greenhouse gas emissions equivalent to removing 380,000 cars from New York State highways.³³

31 New York State Energy Research and Development Authority, New York Energy SmartSM Program: Quarterly Evaluation and Status Report, March 31, 2007 < http://www.nyserdera.org/Energy_Information/SBC/sbcmar2007.pdf > [November 21, 2007]

32 Ibid.

33 Ibid.

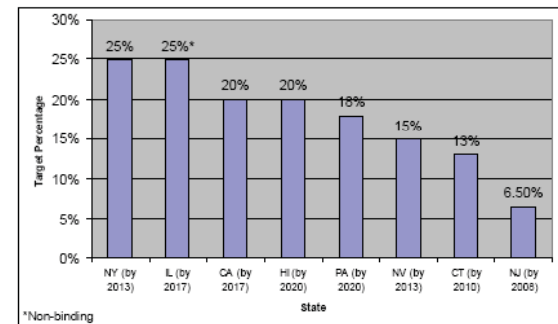
Renewable Portfolio Standard (RPS)

In September 2004, the New York State Public Service Commission (PSC) adopted a renewable energy portfolio standard that requires 25% of the state's electricity to be supplied from renewable energy sources by 2013. While the graph below shows that New York's 25% target is the most aggressive in the United States, about 19% of New York's electricity needs are currently being satisfied by large hydroelectric power.³⁴ This means that 6% of the 25% RPS target will be met by newly installed renewable capacity between 2006 and 2013. The accompanying bar chart shows the leading RPS programs in the US.

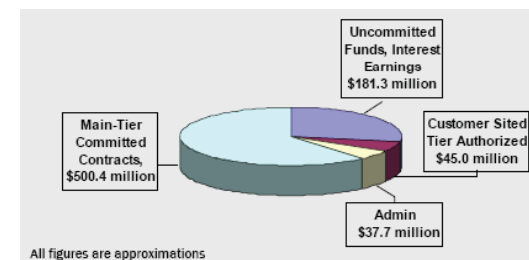
NYSERDA is in charge of implementing New York's RPS program through two Tiers:

- 1. Customer- Sited Tier Program** is modeled after the New York Energy Smart Program currently administered by NYSERDA. It provides incentives for the installation of solar PV systems and small wind projects, as well as funding for installation training, education, and outreach programs throughout the state.
- 2. Main- Tier Program** will be responsible for meeting most of the renewable requirements established by the RPS. The Main – Tier is designed to develop large scale renewable energy projects in New York State, including wind farms, biomass systems, and new hydroelectric power generating facilities.

The total renewable capacity supported by the RPS program since its inception could approach 1,162 MW by the fall of 2008. This includes 1,088 MW of wind power from twelve sites, 65 MW of biomass power from three sites, and 9 MW of small hydro power from eleven sites, in addition to the 4.6 MW of installed solar and small wind capacity from Tier 1 funding. This total renewable capacity is expected to provide enough clean energy to supply 600,000 average size homes per year. NYSERDA estimates that the 1,162 MW of renewable capacity could generate more than \$720 million of in-state economic benefits over a 20-year period, excluding the impact of any economic roll-over multipliers or energy price suppression effects. In addition to these significant economic benefits, the expected accomplishments of the RPS program through 2008 will also provide substantial environmental benefits, with potential reductions of 2,000 tons of nitrogen oxides, 4,400 tons of sulfur oxides, and 1.3 million tons of carbon dioxide per year.³⁵



States with the most aggressive renewable portfolio standards.
(Source: http://www.eere.energy.gov/states/maps/renewable_portfolio_states.cfm#chart)



New York's RPS Funding.
(Source: <http://www.tughillcouncil.com/JoeVisalli-AOTConPPP.pdf>)

³⁴ Database of State Incentives for Renewables & Efficiency, New York Incentives for Renewables and Efficiency: Renewable Portfolio Standard, July 17, 2007 < http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=NY03R&state=NY&CurrentPageID=1&RE=EE=1 > [November 21, 2007]

³⁵ State of New York Public Service Commission, Commission Updated on Renewable

According to New York's Renewable Energy Policy Project (REPP) the implementation of New York's RPS program will result in the direct creation of 15,880 jobs, while the New York State Office of the State Comptroller estimates that indirect employment opportunities related to the RPS program could approach 43,000 jobs by 2013.³⁶

RGGI

In 2005, Governor George E. Pataki of New York initiated discussions with eleven other regional governors to explore the possibility of designing a program that would help the states meet their various goals for reducing greenhouse gas emissions. These discussions resulted in the implementation of the Regional Greenhouse Gas Initiative (RGGI or "ReGGie"), "a cooperative effort by 9 Northeast and Mid-Atlantic states to... design... a regional cap-and-trade program initially covering carbon dioxide emissions from power plants within the region. In the future, RGGI may be extended to include other sources of greenhouse gas emissions, and greenhouse gasses other than CO₂."³⁷ The creation of RGGI will play a key role in developing a market for trading carbon credits in the U.S.

RGGI offers both up-state and down-state New York some unique economic development opportunities. An interesting spin-off of RGGI has been the incorporation of renewable energy "offset projects," such as landfill capture and combustion or methane capture from animal operations.³⁸ These offset projects can lead to job creation for New York's up-state rural communities, and can help spur the development of the clean technology industry in New York State. As for downstate, New York City's position as the financial capital of the world makes it "the logical location for trading and trading support jobs in the U.S."³⁹



States involved with RGGI
(Source: NYSERDA)

Energy Program, August 22, 2007 < [http://www3.dps.state.ny.us/pscweb/webfileroom.nsf/0/FE634CB91814E4738525733F006B4060/\\$File/pr07077.pdf?OpenElement](http://www3.dps.state.ny.us/pscweb/webfileroom.nsf/0/FE634CB91814E4738525733F006B4060/$File/pr07077.pdf?OpenElement) > [November 21, 2007]

³⁶ Alan G. Hevesi and Kenneth B. Bleiwas, *Energizing the Future: Benefits of Renewable Energy for New York State*, March 2005 < <http://www.osc.state.ny.us/osdc/renewableenergy.pdf> > [November 21, 2007]

³⁷ Regional Greenhouse Gas Initiative, *About RGGI*, 2007 < <http://www.rggi.org/about.htm> > [November 21, 2007]

³⁸ New York City Investment Fund, *Cleantech: A New Engine of Economic Growth for New York State*, January 16, 2007 < http://www.nycif.org/pdfs/cleantech_4pg.pdf > [November 21, 2007]

³⁹ *Ibid.*

Executive Order 111

On June 10, 2001, Governor Pataki directed state agencies, state authorities and other affected entities to be more energy efficient and environmentally aware when he announced Executive Order no. 111. The Executive Order has helped establish an ongoing commitment by New York to be a leader in addressing issues such as energy efficiency, renewable energy, green building practices and alternate fuel vehicles.⁴⁰

Technology Push: R&D Incentives and Energy Technology Centers

As the world converts to renewable energy, necessitated by looming environmental consequences and the anticipated reduction in fossil fuel supplies (peak oil), New York would reap immense economic benefits by becoming a key supplier of renewable energy technology to the state, country, and world.

In order to become a technology supplier to the country and world, New York must support the infrastructure to develop new technology and move it into the marketplace, with the goal of manufacturing products in New York when economically feasible.

R&D Incentive Programs

New York's existing public policies and incentive programs have been designed primarily to support the growth of a consumer market for renewable energy in New York State. However, these programs have lacked the incentives necessary to induce the development of a clean technology industry in the state. In order for New York to establish a strong in-state clean technology industry, its existing policies and programs must be expanded and refocused to include new production-related incentives for clean technology companies. If New York broadened its public programs to include incentives that benefit clean technology producers, New York could compete with other leaders such as California, New Jersey, Massachusetts, Japan, and Germany which have aggressive incentive programs already in place, and thus are poised to benefit most from the growth of the renewable energy industry.

“The existing energy clusters can be formalized to become a series of Energy Technology Centers that build on existing strengths and core competencies, with a greater degree of coordination between them.”

⁴⁰ New York State Energy Research and Development Authority, Executive Order No. 111, January 2007 < <http://www.nyserda.org/Programs/exorder111.asp> > [November 21, 2007]

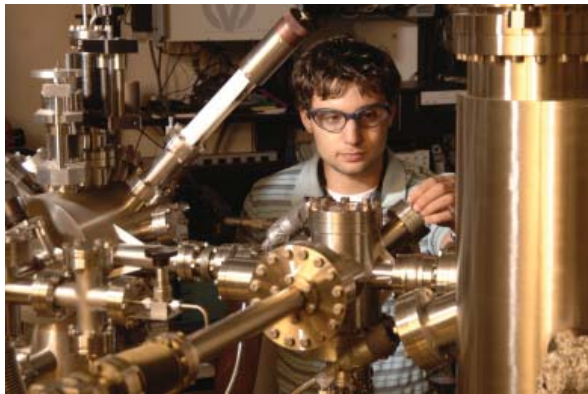
Once New York creates a competitive producer-based incentive program, it will be better positioned to leverage its many other assets. Upstate New York is home to many high tech corporations, leading universities, research facilities, and scientists, and can draw on its manufacturing tradition. New York City's experienced financial institutions, available investment capital, and sheer energy demand are among the State's inherent assets that appeal to clean technology businesses and entrepreneurs.

In addition to providing production incentives, there are many other ways in which New York State can promote the development of a clean technology industry. In a report titled, "Cleantech: A New Engine of Economic Growth in New York State," the New York City Investment Fund offered many recommendations that should be considered by the state. Some of these recommendations include: (1) the creation of a targeted marketing effort, which should be directed towards the clean technology industry to help build awareness of New York State's existing assets; (2) a commitment by the New York State public pension funds to allocate at least \$150 million to fund managers that in turn commit to invest those monies in cleantech companies and projects located in New York State; (3) improve the linkages between New York's technology and investment capital; and (4) increase the State's focus on producers versus consumers with respect to city/state investment.⁴¹

By broadening the State's existing policies and programs to include clean technology producers, New York State can harness its inherent strengths and diverse capabilities into an engine for robust economic growth and social gain. New York State has the potential of becoming the global center of the clean technology industry. The next section purposes a way this could be accomplished.

Expanding the Energy Clusters

The existing energy clusters can be formalized to become a series of Energy Technology Centers that build on existing strengths and core competencies, with a greater degree of coordination between them. The Centers would yield growth through state-of-the-art manufacturing, prototyping and R&D facilities; increasing human talent and developing a trained workforce; and solidifying partnerships between industry, government, and R&D facilities. These clusters can be successful by encouraging activities that add to the State's desired energy technology portfolio, based on an Energy Roadmap and long term plan.



The Energy Centers would be led by universities that have strong collaborations with industry in their energy sector.

⁴¹ New York City Investment Fund, Cleantech: A New Engine of Economic Growth for New York State, January 16, 2007 < http://www.nycif.org/pdfs/cleantech_4pg.pdf > [November 21, 2007]

The Energy Centers would:

- coordinate strong partnerships and collaborations between industry, universities and government.
- be led by universities that have strong collaborations with industry in their energy sector.
- be geographically distributed across New York State to take advantage of current technology clusters and their core capabilities.
- serve as major regional resources for energy technology manufacturing, prototyping and development in New York State, and work with industry to set up state of the art manufacturing facilities.
- work closely with company partners, incubate start-up companies, and serve as a place for university-business co-location.
- provide leadership in collaborative research and technology transfer to stimulate regional and state wide economic development.
- raise awareness of united and combined resources related to new energy technology available in New York State.
- increase leverage of state based resources.

Geographic Distribution of Energy Technology Centers

Industries choose to locate their businesses in communities that offer distinct advantages for their operations and strategic goals, and the clean technology industry in New York State has evolved into identifiable technological clusters that reflect the inherent resources and competencies of New York's various regions. This phenomenon has been reinforced by a number of factors, including strong historical ties to large corporations such as General Electric in New York's Capital Region and General Motors in Rochester, as well as geographical predispositions such as the concentration of biofuels and biomass development in New York's more rural Central Region. The table below provides details on the suggested Energy Centers, based on the clusters that have already formed around the state, the technologies they specialize in, and the major businesses and universities that contribute to the Centers.



The Energy Centers will replicate CNSE's successful operations model

New York State Regional Competencies in Clean Technologies

Energy Technology Cluster	Location in New York	Technologies	Selected Examples of Industry	Universities with Core Competencies: Primary and (Complimentary)
Transportation	Western	Alternative fuel: Hydrogen	General Motors, Delphi, Harris RF Communications, Applied Coatings Inc., EnrG Inc., Senser Inc.	RIT (Alfred, Cornell, CNSE, RPI, Univ. of Rochester)
Biomass	Central	Alternate fuel: Biomass Biomass feedstocks ,Biomass combined heat and power, Biogas logistics/economics, Biowaste, Gasification	Empire Biofuels, Northeast Biofuels, Western New York Energy, Nextgen Fuel, Northern Biodiesel, United Environment & Energy	SUNY ESF (Cornell, Clarkson)
Environmental Systems	Central	Building EnvelopeSpace heating and cooling, Lighting, Building Codes and Standards, Building Management Systems, Solar Thermal	Carrier Corporation, Northeast Natural Homes, NuClimate Air Quality Systems, O'Brien & Gere, OP-TECH Environmental Services Inc., Oneida Air Systems	Syracuse U. (CNSE/ NISE, RPI, Clarkson)
Renewable Energy Generation and Storage	Capital Region	Solar Photovoltaics, Wind Energy, Fuel Cells, PEM and SOFC, Hydrogen Generation, Hydrogen Storage	GE Energy, GE Global Research, Plug Power, MTI, Daystar Technologies, SuperPower, Blasch, EYP AE	CNSE/UAlbany (RPI, Union, Cornell, RIT)
Policy and Financing	New York Metro	Renewable energy policy, Capitalization and financing		Pace Law (Columbia, Albany Law)
Fundamental Renewable Research	Long Island	Material Science, Fuel Cells	Brookhaven National Laboratory	Stony Brook (CNSE/ UAlbany, RPI, RIT)

University Resources

The proposed Energy Technology Centers would be based at universities to leverage their R&D capabilities. As shown in Appendix B, New York's universities are engaged in a wide range of cutting edge renewable energy research and development. While universities typically conduct research in several – if not all – areas of clean technology, there is one university within each existing Cluster that has a core competency in that cluster's focus, as shown in the table to the left. Shared research projects and research facilities are common among New York State universities, resulting in a vast network of technology-centric initiatives across the state, which would be carried over to the Centers.

The Energy Centers will replicate the operations model of the College of Nanoscale Science and Engineering (CNSE) at the University at Albany, which successfully established a nanoelectronics cluster. The following three concepts were used by CNSE to form the existing cluster and will be used to create technology clusters at each energy center:

1. **Anchor tenant:** CNSE hosts the anchor tenant IBM, which attracted numerous other business tenants such as ASML, TEL, Infineon, etc. This creates a self-sustaining ecosystem of businesses.
2. **Technology Transfer:** Targeted academic and industrial research is licensed and incorporated into processes and products.
3. **Industry- University- Government Partnership:** The co-location of academic researchers and facilities leverages New York State research funding.

At the heart of the Centers will be state-of-the-art research facilities that will attract world-leading clean technology businesses to locate their operations on-site and spur economic development throughout each region. Each facility will be designed to serve the needs of the businesses and types of research it will support, and planning for each site should accommodate expected growth and spill out into supporting industries.

Technology Transfer

The core mission of each Energy Center will be to work with company partners to jointly develop progressive renewable technology that can be effectively used in the marketplace. By conducting research in partnership with the companies, the



The Energy Centers will allow New York's clean technology businesses to better leverage its university resources.

“The current energy clusters across New York would be able to provide far greater benefits to the state by shaping them into formal Energy Centers.”

university-based research effort will be focused on the most promising and useful technology.

The Energy Centers will hold a series of technology-specific forums and conferences aimed at linking these high-technology businesses with vendors and regional academic institutions. The purpose of these meetings is to help businesses overcome impediments to their growth, create increased sales for the vendors, and leverage the academic resources of the region. These events will be modeled after the successful New York Fuel Cell Network. At NYFCN forums, the four New York fuel cell OEMs give presentations on the technical issues that their companies are trying to overcome to an audience of vendors/ suppliers and academic institutions. The vendors and academic institutions are invited to submit white papers proposing solutions to the problems that they heard about. The OEMs then select the most appropriate concepts and form partnerships with those proposers to secure funding and carry out the research. This model will be used at the Energy Centers to help high technology companies not only overcome technology hurdles, but address other business-related issues as well.

Business Acceleration

The Energy Centers will provide business acceleration services to startup and growing companies to encourage job and growth via the introduction of new technology to the marketplace. The Energy Centers help companies meet six key business challenges, described below:

Product Development. Businesses need to offer its customers products that are more highly valued than those of competitors or competing processes, but in high-tech industries extensive resources are often needed simply in order to develop the product. The Energy Centers would assist firms through technology transfer, advice from the leading researchers in their fields, and access to cutting edge equipment needed for product development and prototyping.

It is vital that a business' core technologies are protected by the patent system. The Energy Centers would advise high-technology businesses in protecting their IP and would refer clients to regional law firms specializing in IP when appropriate.

Business Development. The Energy Centers would create a vertically integrated supply chain among renewable energy companies by bringing together materials suppliers, equipment manufacturers, process developers, and manufacturers. The problem-solving forums mentioned above would also serve to bring companies in contact with potential customers.

Business Strategy. Many high-tech businesses are founded by scientists with more technical than business experience. The Energy Centers will offer incubation services such as assistance with creating business strategies and plans needed for successful fundraising and business execution. Staff at the Centers will have experience assisting high-technology businesses formulate successful plans and strategies. Staff will meet with entrepreneurs and businesses to analyze all aspects of a business, make strategy recommendations, and assist with the creation of a business plan, as appropriate.

The Centers will assist clients by creating technology roadmaps specific to the product(s) being developed by each company, modeled on the International Technology Roadmap for Semiconductors. The Centers will use their technical expertise to assist companies in positioning both their current products and their development strategies for future opportunities.

Human Resources. Finding qualified staff and management with relevant training and experience is even more important for high-technology businesses than those in other industries. The Centers will assist businesses gain staff through workforce training, graduate degree education, job fairs, and other activities.

The Centers will host industry-specific job fairs to assist regional businesses find the workforce they need. The Centers would also assist with executive recruiting and HR software management.

Capital. The Energy Centers will connect clients with appropriate investors such as angels, venture capitalists, institutional investors, pension funds, and government sources. The Centers will also assist with identifying grant opportunities and the preparation of grant applications.

Manufacturing and Business Execution. The Energy Centers will assist businesses by streamlining their management practices and making their manufacturing processes more efficient. It is a truism that products can be manufactured more cheaply outside of New York. The Centers will help identify the products that will benefit the most from New York's native high technology skill sets and advanced manufacturing techniques.

While serving an important economic function, the current energy clusters across New York would be able to provide far greater benefits to the state by shaping them into formal Energy Centers. The Centers will have greater visibility, include a more businesses and entrepreneurs in their activities, and have greater coordination to provide services efficiently.



The Energy Centers will assist New York's clean technology companies with efficient manufacturing practices.

Conclusions

New York State is poised to become the global leader of the quickly growing clean technology industry. The expansion of a clean technology industry in New York would benefit the State's economy, and would send a clear message to the world that New York is committed to a sustainable and independent energy future. Therefore, a coordinated effort to strengthen current policies and funding to support the State's emerging network of clean technology research is a very appropriate action for State officials to take.

Through the creation of Energy Centers throughout the State based on the currently existing energy clusters, and by broadening the State's existing policies and incentive programs to producers-related incentives, New York can harness the inherent strengths and diverse capabilities of its many communities into an engine for robust economic growth and social gain.

**2005
NEW YORK STATE
ENERGY FAST FACTS**

PRIMARY ENERGY CONSUMPTION	
<i>Virtually unchanged from 2004</i>	
Primary consumption (4.8% of U.S. total) (trillion Btu)	4,346.9
By sector:	
Residential (16%)	687.1
Commercial (13%)	557.6
Industrial (5%)	198.0
Transportation (27%)	1,179.4
Electric Generation (39%)	1,724.8
By fuel type:	
Petroleum (41%)	1,777.1
Natural gas (29%)	1,237.7
Nuclear (10%)	438.0
Coal (7%)	316.1
Hydro (5%)	238.2
Biofuels (3%)	120.0
Net imported electricity (5%)	219.7
Primary consumption per capita (million Btu)	226.0

NET ENERGY CONSUMPTION AND EXPENDITURES	
Net Energy Consumption (trillion Btu)	Estimated Expenditures (billion dollars)
Total	3,134.7 \$57.6
By sector:	
Residential (27%)	859.5 (31%) \$17.7
Commercial (26%)	818.3 (29%) \$16.9
Industrial (9%)	265.8 (5%) \$3.1
Transportation (38%)	1,191.2 (35%) \$20.0
By fuel type:	
Petroleum (49%)	1,536.4 (45%) \$26.0
Natural gas (30%)	928.3 (20%) \$11.7
Electricity (16%)	512.6 (34%) \$19.8
Biofuels (3%)	89.8
Coal (2%)	67.6 (1%) \$0.1
Estimated out-of-state energy expenditures	\$29.3

AVERAGE ENERGY PRICES		
	2005	2004
Gasoline - all grades (gallon)	\$2.39	\$1.88
Heating oil (gallon)	\$2.40	\$1.70
Natural gas (thousand cubic feet)		
Residential	\$14.79	\$12.50
Commercial	\$13.11	\$10.11
Industrial	\$11.19	\$8.05
Electricity (kilowatthour)		
Residential	15.7¢	14.5¢
Commercial	13.2¢	13.0¢
Industrial	7.6¢	7.0¢

GREENHOUSE GAS EMISSIONS FROM FUEL COMBUSTION	
Total (million tons of CO ₂ equivalent)	240.8
By sector:	
Residential (17%)	41.3
Commercial (15%)	35.6
Industrial (5%)	13.3
Transportation (36%)	86.2
Electric Generation (27%)	64.3
By fuel type:	
Petroleum (57%)	138.0
Natural gas (30%)	72.0
Coal (13%)	30.2
Greenhouse gas emissions per capita (tons of CO ₂ equivalent)	12.5

ELECTRICITY	
<i>Sales increased 4% from 2004</i>	
Sales to ultimate consumers (gigawatthours)	150,247
By sector:	
Residential (34%)	50,533
Commercial (51%)	76,396
Industrial (13%)	19,848
Transportation (2%)	3,470
Annual average electricity use per household (Kwh)	5,974
Generation (gigawatthours)	167,208
By fuel type:	
Nuclear (25%)	42,443
Natural Gas (20%)	33,117
Hydro (14%)	23,076
Coal (12%)	21,256
Net Imported Electricity (13%)	21,291
Petroleum (14%)	23,008
Biofuels (2%)	2,916
Wind (-)	101

PETROLEUM	
<i>Consumption decreased 4% from 2004</i>	
Consumption (4% of U.S. total) (million barrels)	319.7
By sector:	
Residential (12%)	38.7
Commercial (9%)	27.5
Industrial (2%)	6.5
Transportation (65%)	208.6
Electric generation (12%)	38.4
Dependence on foreign oil	90%
In-State production (thousand barrels)	211.0
Annual average fuel oil use per household (gallons)	511.0

NATURAL GAS	
<i>Consumption increased 6% from 2004</i>	
Consumption (4% of U.S. total) (billion cubic feet)	1,204
By sector:	
Residential (33%)	401
Commercial (31%)	367
Industrial (7%)	83
Transportation (4%)	49
Electric generation (25%)	304
In-State production (billion cubic feet)	55
Annual average natural gas use per household (Mcf)	69

ADDITIONAL STATISTICS	
Population (6.5% of U.S. total) (million)	19.3
Number of housing units (million)(2004)	7.8
Gross State Product (billion 2000 dollars)	\$867.1
Motor vehicle registrations (million) (2004)	11.1
Vehicle miles of travel (billion miles) (2004)	137.9
Heating degree days (unchanged from 2004)	5,984
Cooling degree days (increased 59% from 2004)	944

DATA SOURCE

**NEW YORK STATE
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DEVELOPMENT AUTHORITY**

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Appendix A: New York Energy Statistics

Appendix B: R&D Assets

Organization	Location	URL	Areas of Interest
Alfred University	Alfred, NY	www.alfred.edu	Ceramics, photocatalysts, fuel cells, photovoltaics, wind energy, pollution.
Binghamton University	Binghamton, NY	www.binghamton.edu	Sensors, batteries, fuel cells, superconductors, catalysts, pollution abatement, materials.
Brookhaven National Laboratory	Upton, NY	www.bnl.gov	Biodiesel, geothermal, corrosion, wind turbines, nondestructive testing, computational mechanics, hydrogen storage, petroleum geochemistry, catalysis, methane hydrates, energy efficiency, combustion, residential heating.
Clarkson University	Potsdam, NY	www.clarkson.edu	Biofuels, fuel cells, wind energy, environmental manufacturing management, air pollution.
College of Environmental Science and Forestry	Syracuse, NY	www.esf.edu	Molten carbonate fuel cells, biomass feedstocks, biofuels, lignocellulosics, biohydrogen production, CHP, gasification, photovoltaics, membrane gas separation, renewable energy policy, carbon sequestration, biomass economics.
College of Nanoscale Science and Engineering	Albany, NY	www.cnse.edu	Photovoltaics, power electronics, hydrogen energy, fuel cells, superconductors, sensors, ultracapacitors, energy efficiency, renewable energy policy, nanotechnology, MEMS.
Columbia University	New York, NY	www.columbia.com	Carbon sequestration, photovoltaics, smart electric grids, wind energy systems, biomass, nuclear power.
Cornell University	Ithaca, NY	www.cornell.edu	Biofuels, combustion, brownfield remediation, pollution mitigation, fuel cells, material science, nanotechnology.
Farmingdale State College	Farmingdale, NY	www.farmingdale.edu	Photovoltaics.
Morrisville State College	Morrisville, NY	www.morrisville.edu	Biogas, biowaste, bioenergy, wind energy.
Pace University	New York, NY	www.pace.edu	Energy policy, green market development, utility regulation, public energy investment decisions.
Rensselaer Polytechnic Institute	Troy, NY	www.rpi.edu	Lighting, fuel cells, photovoltaics, biomass, hydrogen energy, wind energy, nanotechnology.
Rochester Institute of Technology	Rochester, NY	www.rit.edu	Fuel cells, MEMS, polymers.
Stony Brook University	Stony Brook, NY	www.sunysb.edu	Hydrogen energy, photovoltaics, polymers, energy efficiency, pollution monitoring, combustion.
SUNY Cobleskill	Cobleskill, NY	www.cobleskill.edu	Biowaste, gasification.
Syracuse University	Syracuse, NY	www.syracuse.edu	Air and water quality, green buildings, biofuels.
University at Buffalo	Buffalo, NY	www.buffalo.edu	Green buildings, power conversion, pollution.

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