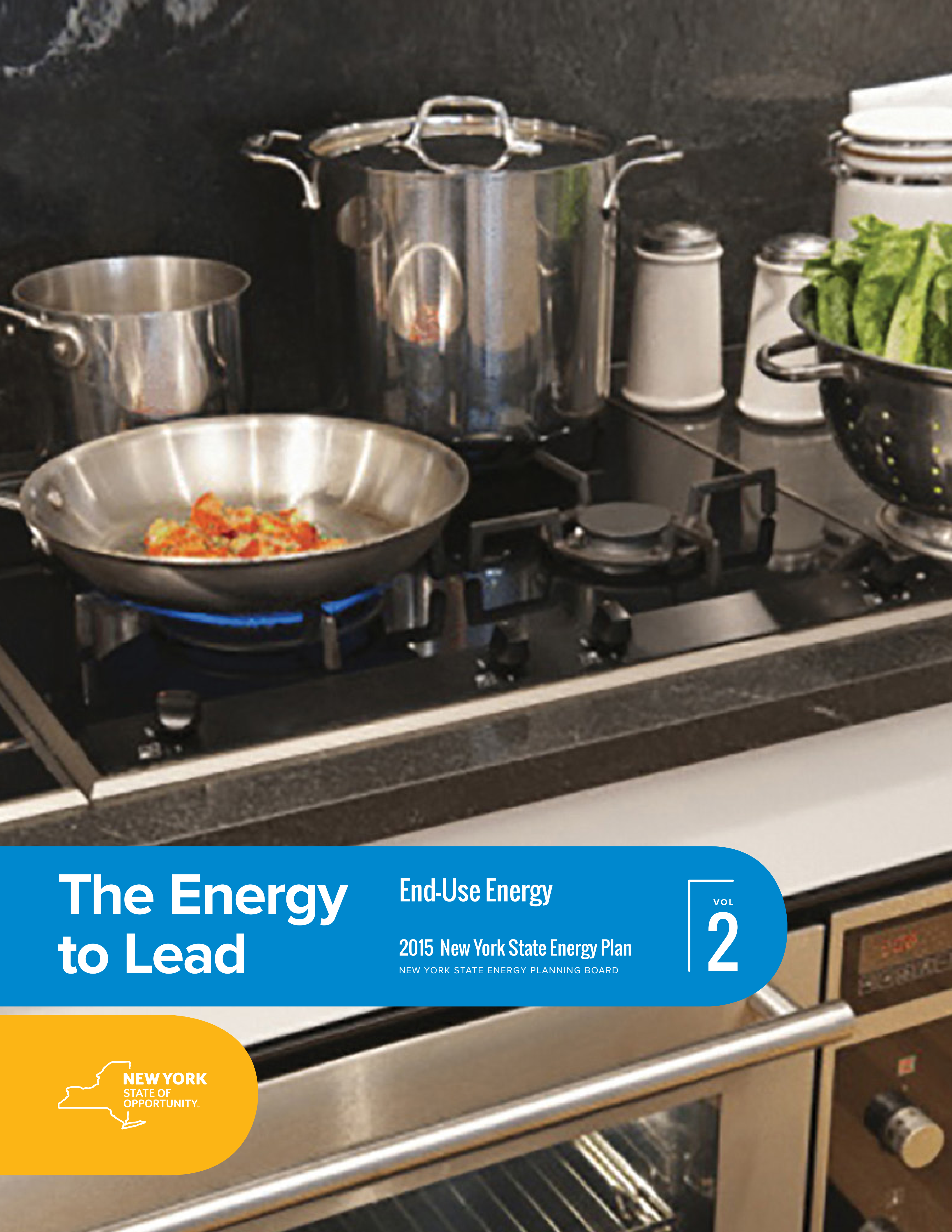

# The Energy to Lead

## End-Use Energy

VOL 2

2015 New York State Energy Plan

NEW YORK STATE ENERGY PLANNING BOARD

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# Introduction

This chapter discusses the use and cost of the energy that is used by buildings, industry, and transportation; highlights the initiatives that increase the efficiency of energy use; and explores the pathways by which energy use and development of clean-energy technologies contribute to New York's economic growth.

Energy is used on-site in buildings to provide a multitude of services related to business and human needs including heating and cooling, lighting, refrigeration, information and communication, health care, education, and entertainment. Energy is used in manufacturing and industrial processes to produce a wide range of products. The transportation sector uses energy to move both people and goods. The benefits of improvements in the end-use efficiency of buildings and industry extend beyond the customers' on-site location to include energy "system benefits," such as lower energy costs for all consumers and avoided infrastructure costs.

The term "end-use energy" includes energy used on-site by residential, commercial, and industrial customers as well as energy used by vehicles. End-use energy includes natural gas used on-site that is transported to customers by pipeline; liquid fuels used on-site, such as heating oil that are transported to customers by a combination of pipeline, tanker, barge, rail car, and truck; liquid fuels, such as gasoline and diesel that are transported to fueling sites where they are distributed to individual cars and trucks; and electricity used on-site that is transmitted by wire to the end-use customers from a network of generators located throughout the region that are powered by a wide range of primary fuels, e.g. natural gas, coal, nuclear, and renewable resources, such as wind.

Using energy more efficiently in buildings, industry, and transportation reduces the overall costs of meeting energy needs, while increasing economic activity and reducing emissions of greenhouse gases and other pollutants. At the same time, businesses become more competitive, families save money, and the quality of life is enhanced by increasing comfort, safety and productivity.


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# 1 Energy Use and Cost

This section provides a summary of the energy use and expenditure history and reference forecasts that support the New York energy planning process. Statewide energy use and expenditure data are disaggregated by sector and fuel type. Forecasts are shown for oil and natural gas commodity prices, based on world and national markets, as well as forecasts for prices of selected retail fuel products. The reference forecasts of energy use and end-use energy prices are developed to provide analytical underpinnings for New York's energy planning and policy development process. Objective analysis of the potential impacts of any policies or actions must begin with projections of what is expected in the absence of those policies or actions. The critical metric in analysis of any policy or action being considered is the expected incremental change, relative to a reference forecast, that is estimated to occur as a result of the policy or action.

The concept of a reference forecast is to project what is reasonably and plausibly likely to occur given recent history, current trends, and policies and regulations that are known with some level of certainty. The reference forecasts are intended to project long-term trends that represent general direction and order of magnitude; they are not intended to provide detailed information about short-term (monthly or seasonal) market dynamics or predictions of what may occur over the next one to three years.

## New York's Total Energy Expenditures

New York's total expenditures for energy across all customer sectors in 2012 was approximately $61 billion, as shown in Table 1A. Total expenditures for energy is the product of both the quantity used and the price per unit of energy. Transportation comprised the largest amount at $25 billion, while the residential, commercial, and industrial sectors comprised $17 billion, $16 billion, and approximately $2 billion respectively.

New York's total expenditures for energy has increased by an average of 1.7 percent per year from 2000 to 2012, as shown in Table 1B. Total fuel expenditures for the transportation sector have increased by an average of 5 percent per year over this period. Total fuel expenditures for the residential sector have increased by an average of 0.4 percent, while the commercial sector has seen an average decline in expenditures of 0.1 percent per year.

**Table 1A | Energy Expenditures by Sector (Millions 2011$)**

| SECTOR | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| Residential | 15,032 | 14,981 | 16,544 | 20,514 | 18,914 | 18,308 | 17,344 |
| Commercial | 13,396 | 13,885 | 16,288 | 18,826 | 18,173 | 17,250 | 16,100 |
| industrial | 4,799 | 4,070 | 3,117 | 3,602 | 2,432 | 2,389 | 2,101 |
| Transportation | 13,798 | 12,093 | 14,158 | 20,644 | 22,954 | 26,693 | 25,486 |
| **TOTAL** | **47,025** | **45,029** | **50,106** | **63,586** | **62,474** | **64,640** | **61,031** |

**Table 1B | Energy Expenditures by Sector — Average Annual Growth Rate**

| SECTOR | 1990–2000 | 2000–2012 |
|---|---|---|
| Residential | 1.0% | 0.4% |
| Commercial | 2.0% | -0.1% |
| Industrial | -4.2% | -3.2% |
| Transportation | 0.3% | 5.0% |
| **TOTAL** | **0.6%** | **1.7%** |

Source: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. 2012 values based on EIA preliminary estimates.

A significant proportion of New York's energy expenditures flow outside the State's economy to other states and countries. For 2012, estimated energy expenditures totaled approximately $61 billion. Of this amount, approximately 60 percent or $36 billion was estimated to leave New York in the form of the commodity, processing, and transportation costs of fuel used directly by end-use customers (e.g. gasoline, heating oil, and natural gas); the cost of fuel used to generate electricity (e.g. natural gas and coal); the net cost of imported electricity; and federal taxes. Table 2 provides a breakout of estimated 2012 energy expenditures by fuel type with the estimated percentage that leaves New York's economy.

**Table 2 | Energy Expenditures that Leave New York's Economy in 2012**

| FUEL TYPE | TOTAL ENERGY EXPENDITURES | PERCENTAGE OF ENERGY EXPENDITURES THAT LEAVE NY | AMOUNT OF ENERGY EXPENDITURES THAT LEAVE NY |
|---|---|---|---|
| **Electricity** | 21,825 | 31% | 6,766 |
| **Natural Gas** | 8,084 | 50% | 4,042 |
| **Coal** | 127 | 85% | 108 |
| **Gasoline** | 18,691 | 80% | 14,952 |
| **Other Petroleum** | 12,305 | 85% | 10,459 |
| **TOTAL** | **61,031** | **60%** | **36,327** |

Source: NYSERDA. *Patterns and Trends: New York State Energy Profiles* (1997–2011). June 2013. 2012 values based on EIA preliminary estimates.

Note: Energy expenditures that leave New York's economy include the commodity, processing, and transportation costs of fuel used directly by end-use customers, the cost of fuel used to generated electricity, and the net cost of imported electricity and federal taxes.

## New York's Energy Expenditures by Sector

Expenditures by fuel type within each customer sector are shown in Tables 3 through 6. In the residential sector, electricity represents about 52 percent of the total energy expenditure in 2012, while natural gas and petroleum represent about 29 percent and 19 percent, respectively. In the commercial sector, electricity represents about 71 percent of the total energy expenditure in 2012, while natural gas and petroleum represent about 16 percent and 12 percent, respectively. In the industrial sector, electricity represents about 42 percent of the total energy expenditure in 2012, while natural gas and petroleum represent about 23 percent and 29 percent, respectively.

In the transportation sector, petroleum products represent about 98 percent of the total energy expenditures. With respect to individual petroleum products, gasoline represents about 73 percent of the total energy expenditure and distillate, i.e. diesel fuel, represents about 17 percent.

**Table 3A | Residential Sector Fuel and Electricity Expenditures (Millions 2011$)**

| SECTOR | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| **Coal** | 8 | 3 | 1 | 2 | 0 | 0 | 0 |
| **Petroleum** | 3,121 | 2,134 | 3,537 | 4,394 | 3,410 | 3,554 | 3,320 |
| Distillate | 2,667 | 1,762 | 2,898 | 3,716 | 2,580 | 2,743 | 2,597 |
| Kerosene | 118 | 56 | 164 | 229 | 139 | 116 | 110 |
| LPG | 337 | 316 | 476 | 449 | 690 | 695 | 613 |
| **Natural Gas** | 4,305 | 4,663 | 5,154 | 6,967 | 5,656 | 5,398 | 4,987 |
| **Electricity** | 7,597 | 8,182 | 7,851 | 9,151 | 9,848 | 9,356 | 9,037 |
| **TOTAL** | **15,032** | **14,981** | **16,544** | **20,514** | **18,914** | **18,308** | **17,344** |

**Table 3B | Residential Sector Fuel and Electricity Expenditures — Average Annual Growth Rate**

| SECTOR | 1990–2000 | 2000–2012 |
|---|---|---|
| **Coal** | -18.3% | -- |
| **Petroleum** | 1.3% | -0.5% |
| Distillate | 0.8% | -0.9% |
| Kerosene | 3.4% | -3.3% |
| LPG | 3.5% | 2.1% |
| **Natural Gas** | 1.8% | -0.3% |
| **Electricity** | 0.3% | 1.2% |
| **TOTAL** | **1.0%** | **0.4%** |

Source: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. 2012 values based on EIA preliminary estimates.

**Table 4A | Commercial Sector Fuel and Electricity Expenditures (Millions 2011$)**

| SECTOR | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| **Coal** | 16 | 12 | 5 | 9 | 0 | 1 | 1 |
| **Petroleum** | 1,806 | 1,202 | 1,439 | 2,366 | 1,946 | 2,455 | 1,993 |
| Distillate | 1,011 | 683 | 916 | 1,649 | 1,109 | 1,468 | 1,180 |
| Kerosene | 18 | 32 | 66 | 79 | 21 | 27 | 25 |
| LPG | 71 | 67 | 101 | 86 | 161 | 185 | 163 |
| **Residual** | 706 | 420 | 356 | 552 | 656 | 776 | 625 |
| **Natural Gas** | 1,876 | 2,081 | 3,715 | 3,748 | 3,225 | 2,714 | 2,619 |
| **Electricity** | 9,699 | 10,590 | 11,129 | 12,704 | 13,001 | 12,080 | 11,488 |
| **TOTAL** | **13,396** | **13,885** | **16,288** | **18,826** | **18,173** | **17,250** | **16,100** |

**Table 4B | Commercial Sector Fuel and Electricity Expenditures — Average Annual Growth Rate**

| SECTOR | 1990–2000 | 2000–2012 |
|---|---|---|
| **Coal** | -11.6% | -15.3% |
| **Petroleum** | -2.2% | 2.7% |
| Distillate | -1.0% | 2.1% |
| Kerosene | 14.0% | -7.8% |
| LPG | 3.5% | 4.1% |
| **Residual** | -6.6% | 4.8% |
| **Natural Gas** | 7.1% | -2.9% |
| **Electricity** | 1.4% | 0.3% |
| **TOTAL** | **2.0%** | **-0.1%** |

Source: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. 2012 values based on EIA preliminary estimates.

**Table 5A | Industrial Sector Fuel and Electricity Expenditures (Millions 2011$)**

| SECTOR | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| **Coal** | 247 | 181 | 156 | 104 | 117 | 123 | 127 |
| **Petroleum** | 519 | 240 | 368 | 598 | 424 | 596 | 604 |
| Distillate | 277 | 128 | 190 | 310 | 260 | 382 | 413 |
| Kerosene | 26 | 21 | 88 | 133 | 33 | 50 | 104 |
| LPG | 27 | 30 | 14 | 82 | 87 | 28 | 19 |
| **Residual** | 190 | 62 | 76 | 73 | 43 | 136 | 68 |
| **Natural Gas** | 854 | 1,486 | 779 | 1,010 | 670 | 620 | 478 |
| **Electricity** | 3,178 | 2,164 | 1,814 | 1,890 | 1,221 | 1,051 | 892 |
| **TOTAL** | **4,799** | **4,070** | **3,117** | **3,602** | **2,432** | **2,389** | **2,101** |

**Table 5B | Industrial Sector Fuel and Electricity Expenditures — Average Annual Growth Rate**

| SECTOR | 1990–2000 | 2000–2012 |
|---|---|---|
| **Coal** | -4.5% | -1.7% |
| **Petroleum** | -3.4% | 4.2% |
| Distillate | -3.7% | 6.7% |
| Kerosene | 13.0% | 1.4% |
| LPG | -6.1% | 2.7% |
| **Residual** | -8.8% | -0.9% |
| **Natural Gas** | -0.9% | -4.0% |
| **Electricity** | -5.5% | -5.7% |
| **TOTAL** | **-4.2%** | **-3.2%** |

Source: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. 2012 values based on EIA preliminary estimates.

**Table 6A | Transportation Sector Fuel and Electricity Expenditures (Millions 2011$)**

| SECTOR | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| **Petroleum** | 13,443 | 11,749 | 13,864 | 20,271 | 22,540 | 26,292 | 25,078 |
| **Distillate** | 1,956 | 1,653 | 1,985 | 3,344 | 3,661 | 4,571 | 4,212 |
| Gasoline | 11,111 | 9,770 | 11,101 | 14,908 | 16,590 | 19,220 | 18,691 |
| Jet Fuel | 320 | 262 | 490 | 1,733 | 1,423 | 2,000 | 1,876 |
| LPG | 11 | 7 | 15 | 6 | 15 | 21 | 24 |
| **Residual** | 46 | 57 | 274 | 279 | 852 | 480 | 276 |
| **Electricity** | 356 | 344 | 293 | 374 | 414 | 401 | 408 |
| **TOTAL** | **13,798** | **12,093** | **14,158** | **20,644** | **22,954** | **26,693** | **25,486** |

**Table 6B | Transportation Sector Fuel and Electricity Expenditures — Average Annual Growth Rate**

| SECTOR | 1990–2000 | 2000–2012 |
|---|---|---|
| **Petroleum** | 0.3% | 5.1% |
| **Distillate** | 0.1% | 6.5% |
| Gasoline | 0.0% | 4.4% |
| Jet Fuel | 4.4% | 11.8% |
| LPG | 3.2% | 4.0% |
| **Residual** | 19.5% | 0.1% |
| **Electricity** | -1.9% | 2.8% |
| **TOTAL** | **0.3%** | **5.0%** |

Source: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. 2012 values based on EIA preliminary estimates.

## Energy Use for Space Heating in New York

Energy use for space heating in New York is shown in Table 7, disaggregated by the number of occupied housing units that use each fuel and energy type as the primary source of space heat. Natural gas provides space heating for the largest proportion of housing units in New York at about 54 percent of total units, followed by fuel oil, including kerosene, at about 30 percent and electricity at about 9 percent. Liquid petroleum gas, i.e. propane, provides about 3 percent, while wood provides about 2 percent.

**Table 7 | New York State Space Heating by Fuel**

| FUEL | OCCUPIED HOUSING UNITS | PERCENT OF TOTAL |
|---|---|---|
| **Utility Gas** | 3,908,626 | 54.2% |
| **Fuel Oil or Kerosene** | 2,173,724 | 30.1% |
| **Electricity** | 653,872 | 9.1% |
| **LPG** | 224,689 | 3.1% |
| **Wood** | 134,125 | 1.9% |
| **Other** | 61,827 | 0.9% |
| **No Fuel Reported** | 38,928 | 0.5% |
| **Coal** | 18,216 | 0.3% |
| **Solar Energy** | 1,680 | 0.0% |
| **TOTAL** | **7,215,687** | **100.0%** |

Source: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. Originally from the American Community Survey. 1-Year estimates. 2011.

## New York's Energy Flow from Primary to End-Use

Figure 1 provides a comprehensive illustration of how New York's primary sources of energy flow to each end-use sector to meet customers' needs, i.e. net use of energy in buildings, industries, and vehicles. Primary energy includes the energy used to generate and deliver electricity to all types of customers, as well as the energy used directly by customers at dispersed locations to provide transportation, space heat, water heat, cooking, process heat, and other uses. The end-use sectors are residential, commercial, industrial, and transportation.

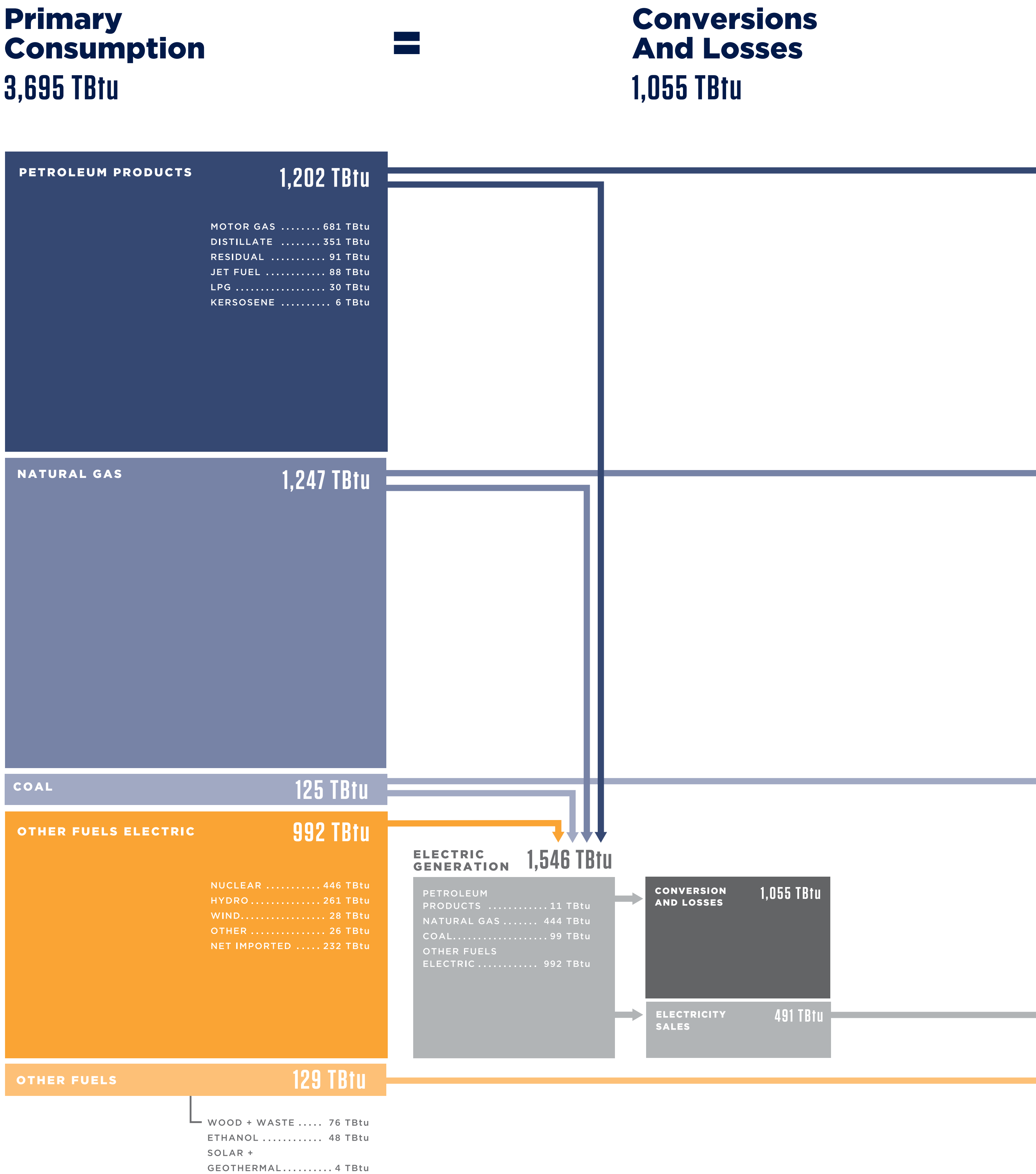
Energy use at both primary and net levels, i.e. end-use sectors, is estimated in British Thermal Units (Btu) to provide equivalent comparisons across different fuel and energy types. In 2011, New York's total or primary use of energy totaled 3,695 trillion Btu (TBtu), while net use of energy at the end-use level was 2,640 TBtu, or 71 percent of total primary energy. The difference between total primary energy (for all fuels and all sectors) and net energy is the amount of energy that is "lost" (in various forms of heat) in the process of generating and delivering electricity to the end-use customers (1,055 TBtu, or 29 percent of New York's total primary energy).

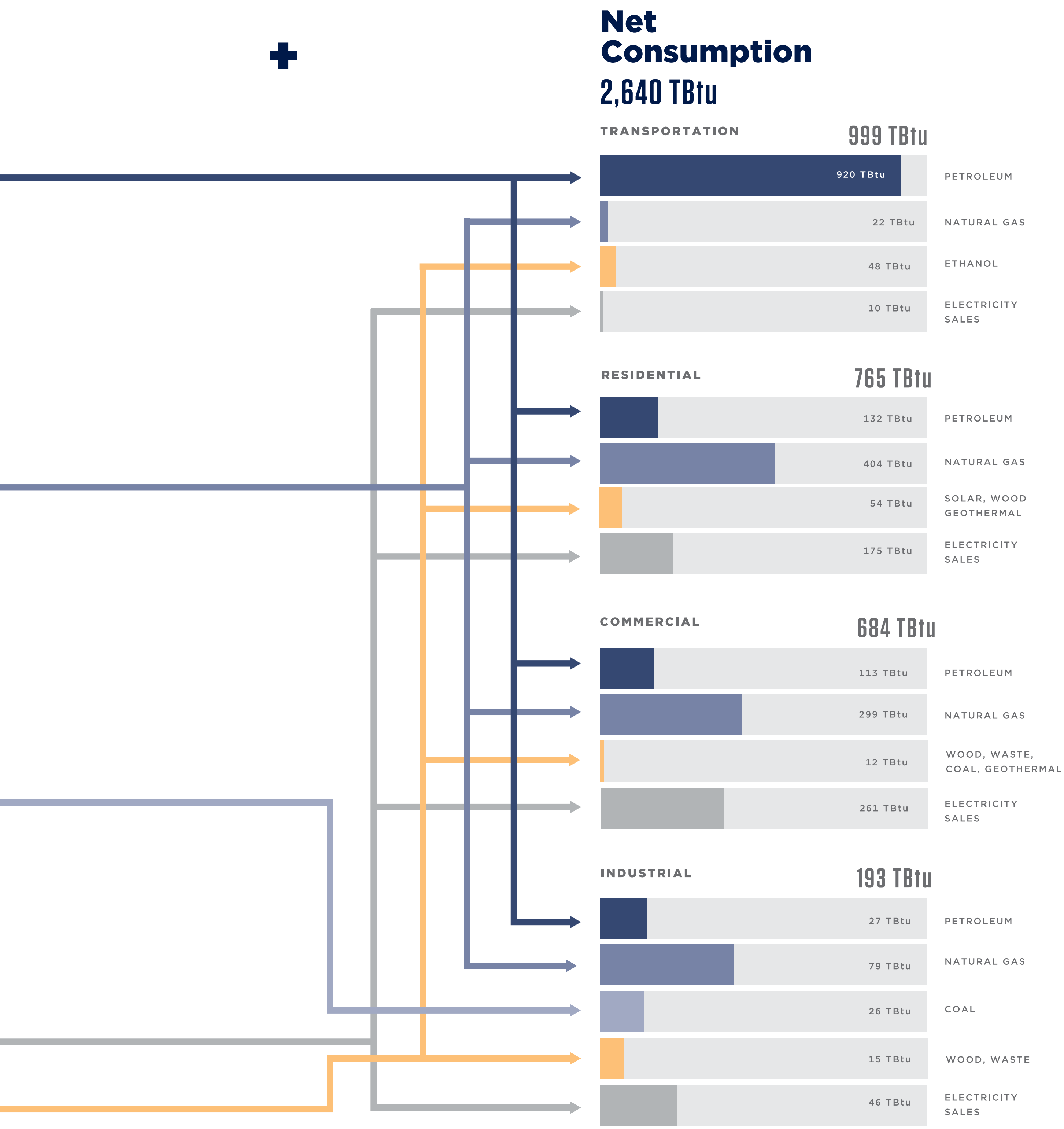
Petroleum products represent 1,202 TBtu, or about 33 percent of New York's total primary energy use. About 77 percent of the petroleum products used in New York is used by the transportation sector to move people and goods. Most of the remainder is used directly by the residential and commercial sectors to provide space heat (11 percent and 9 percent, respectively). Only about one percent of petroleum products used in New York is used to generate electricity.

Natural gas represents 1,247 TBtu, or about 34 percent of New York's total primary energy use. About 36 percent of the natural gas used in New York is used to generate electricity, which is distributed across all the customer sectors. About 32 percent of the natural gas used in New York is used on-site by residential customers (primarily for space heat), while about 24 percent is used on-site by commercial customers. About six percent is used by industrial customers.

Nuclear energy used to generate electricity represents 446 trillion Btu, or about 12 percent of New York's primary energy use. Hydropower used to generate electricity represents 261 TBtu, or about seven percent of primary energy use. Electricity imported from outside New York represents 232 TBtu, or about 6 percent of primary energy use. Coal represents only 125 TBtu, or about 3 percent of total primary energy use. Nearly 80 percent of the coal used in New York is used to generate electricity, with the remainder used primarily by industrial customers.

**Figure 1 | 2011 New York State Energy Flow Diagram**






Notes: Data are from 2011. Ethanol values are embedded in motor gasoline, but are excluded from petroleum products total.

Source: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013.

The total amount of primary energy used to create electricity used in New York is estimated to be 1,546 TBtu, or about 42 percent of all primary energy used. Figure 1 indicates that 491 TBtu, or about 32 percent of the primary energy used to create electricity is actually delivered to the end-use sectors in the form of electricity at the plug; the remaining 68 percent is used in converting fuel to electricity and in delivering the electricity through the transmission and distribution system. This means that for every kilowatt-hour saved by the end-use customer (3,412 Btu per kWh at the plug), more than three times that much energy (10,750 Btu per kWh) is saved at the primary level, taking into account the total energy needed to generate and deliver that electricity.

## New York's Total Primary Energy Use by Fuel

Table 8 (A-D) shows New York's total primary energy use (across all sectors, including electricity generation) by fuel for both selected historical years and forecast years through 2030. From 2000 to 2012, New York's total primary energy use has decreased from 4,054 TBtu to 3,672 TBtu, or an average annual rate of minus 0.8 percent, largely due to reduced use of petroleum. From 2012 through 2030, total primary energy use is projected to increase by 198 TBtu, or an average annual rate of 0.3 percent. Over this period, natural gas use is projected to increase by 257 TBtu, or an average annual rate of 1.1 percent.

**Table 8A | New York State Primary Energy Use by Fuel in TBtu – Historical**

| FUEL | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| Petroleum | 1,712 | 1,369 | 1,530 | 1,721 | 1,270 | 1,202 | 1,202 |
| Coal | 350 | 305 | 331 | 257 | 167 | 125 | 84 |
| Natural Gas | 895 | 1,295 | 1,280 | 1,107 | 1,224 | 1,247 | 1,224 |
| Nuclear | 250 | 277 | 329 | 443 | 438 | 446 | 432 |
| Renewables | 68 | 82 | 130 | 91 | 157 | 161 | 161 |
| Hydro | 279 | 270 | 264 | 277 | 236 | 261 | 243 |
| Imported Electricity | 45 | 113 | 155 | 182 | 249 | 232 | 305 |
| Other | 22 | 31 | 35 | 22 | 22 | 21 | 21 |
| TOTAL | 3,621 | 3,742 | 4,054 | 4,100 | 3,763 | 3,695 | 3,672 |

**Table 8B | New York State Primary Energy Use by Fuel in TBtu – Forecast**

| FUEL | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| Petroleum | 1,204 | 1,193 | 1,184 | 1,175 |
| Coal | 74 | 102 | 112 | 113 |
| Natural Gas | 1,342 | 1,330 | 1,407 | 1,481 |
| Nuclear | 446 | 446 | 446 | 446 |
| Renewables | 161 | 169 | 169 | 170 |
| Hydro | 252 | 253 | 253 | 252 |
| Imported Electricity | 215 | 246 | 216 | 211 |
| Other | 21 | 22 | 22 | 22 |
| **TOTAL** | **3,715** | **3,761** | **3,809** | **3,870** |

**Table 8C | New York State Primary Energy Use by Fuel – Average Annual Growth Rate - Historical**

| FUEL | 1990–2000 | 2000–2012 |
|---|---|---|
| Petroleum | -1.0% | -2.0% |
| Coal | -0.6% | -10.8% |
| Natural Gas | 3.6% | -0.4% |
| Nuclear | 2.8% | 2.3% |
| Renewables | 6.7% | 1.8% |
| Hydro | -0.6% | -0.7% |
| Imported Electricity | 13.2% | 5.8% |
| Other | 4.8% | -4.2% |
| **TOTAL** | **1.1%** | **-0.8%** |

**Table 8D | New York State Primary Energy Use by Fuel – Average Annual Growth Rate - Forecast**

| FUEL | 2012-2020 | 2020-2030 | 2012-2030 |
|---|---|---|---|
| Petroleum | -0.1% | -0.2% | -0.1% |
| Coal | 2.5% | 1.0% | 1.7% |
| Natural Gas | 1.0% | 1.1% | 1.1% |
| Nuclear | 0.4% | 0.0% | 0.2% |
| Renewables | 0.6% | 0.1% | 0.3% |
| Hydro | 0.5% | 0.0% | 0.2% |
| Imported Electricity | -2.7% | -1.5% | -2.0% |
| Other | 0.6% | 0.0% | 0.3% |
| **TOTAL** | **0.3%** | **0.3%** | **0.3%** |

Sources: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. 2012 values based on EIA preliminary estimates. Electricity Sector forecast based on 2013 New York State Energy Plan IPM modeling. Other sectors based on forecasts from EIA's *Annual Energy Outlook*, 2012. Gasoline is included in Petroleum total, however Ethanol, which is implicit in gasoline's total has been excluded from Petroleum and incorporated in the Renewable total.

## New York's Total Primary Energy Use by Sector

Table 9 (A-D) shows New York's total primary energy use by sector (across all fuels, including the fuel used to generate electricity used by each sector) for both selected historical years and forecast years through 2030. In 2012, the commercial sector uses about 35 percent of primary energy, the residential sector uses 29 percent, the transportation sector uses 28 percent, and the industrial sector uses the remaining 8 percent.

**Table 9A | New York State Primary Energy Use by Sector in TBtu – Historical**

| SECTOR | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| Residential | 1,024 | 1,069 | 1,215 | 1,273 | 1,136 | 1,106 | 1,093 |
| Commercial | 1,038 | 1,129 | 1,337 | 1,342 | 1,251 | 1,276 | 1,270 |
| Industrial | 626 | 630 | 533 | 406 | 280 | 294 | 280 |
| Transportation | 933 | 914 | 972 | 1,079 | 1,096 | 1,021 | 1,029 |
| **TOTAL** | **3,621** | **3,742** | **4,054** | **4,100** | **3,763** | **3,695** | **3,672** |

**Table 9B | New York State Primary Energy Use by Sector in TBtu – Forecast**

| SECTOR | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| Residential | 1,074 | 1,079 | 1,089 | 1,104 |
| Commercial | 1,315 | 1,355 | 1,409 | 1,475 |
| Industrial | 287 | 297 | 301 | 301 |
| Transportation | 1,039 | 1,030 | 1,010 | 990 |
| **TOTAL** | **3,715** | **3,761** | **3,809** | **3,870** |

**Table 9C | New York State Primary Energy Use by Sector - Average Annual Growth Rate - Historical**

| SECTOR | 1990–2000 | 2000–2012 |
|---|---|---|
| Residential | 1.7% | -0.9% |
| Commercial | 2.6% | -0.4% |
| Industrial | -1.6% | -5.2% |
| Transportation | 0.4% | 0.5% |
| **TOTAL** | **1.1%** | **-0.8%** |

**Table 9D | New York State Primary Energy Use by Sector - Average Annual Growth Rate – Forecast**

| SECTOR | 2012-2020 | 2020-2030 | 2012-2030 |
|---|---|---|---|
| Residential | -0.2% | 0.2% | 0.1% |
| Commercial | 0.8% | 0.9% | 0.8% |
| Industrial | 0.7% | 0.1% | 0.4% |
| Transportation | 0.0% | -0.4% | -0.2% |
| **TOTAL** | **0.3%** | **0.3%** | **0.3%** |

Sources: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. 2012 values based on EIA preliminary estimates. Electricity Sector forecast based on 2013 New York State Energy Plan IPM modeling. Other sectors based on forecasts from EIA's *Annual Energy Outlook*, 2012.

## New York's Electricity Requirement

New York's total electricity requirement to meet the needs of all sectors combined is expected to grow at an average annual rate of 0.7 percent per year from 2012 through 2030, as shown in Table 10 (A-D).

Electricity use by customer sector is shown in Figure 2. The largest proportion of the total is used by commercial customers at about 55 percent. Residential customers use 34 percent; industrial customers use 9 percent and the transportation sector uses about 2 percent. From 2012 to 2030, commercial customer electricity use is projected to increase at an average annual rate of 0.8 percent; residential electricity use is projected to increase at an average annual rate of 0.6 percent; industrial electricity use is expected to decline at an average annual rate of 0.9 percent and transportation sector use is projected to remain relatively unchanged.

**Table 10A | New York State System Level Electricity Requirement in GWh - Historical**

| | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| **Requirement** | 140,919 | 146,352 | 154,793 | 167,208 | 163,505 | 163,330 | 163,659 |

**Table 10B | New York State System Level Electricity Requirement in GWh - Forecast**

| | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| **Requirement** | 166,030 | 171,176 | 177,884 | 185,384 |

**Table 10C | New York State System Level Electricity Requirement - Average Annual Growth Rate - Historical**

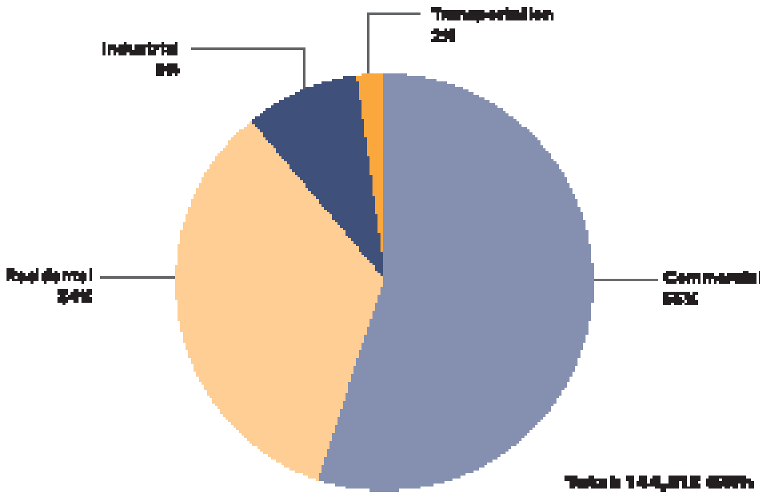
| | 1990-2000 | 2000-2012 |
|---|---|---|
| **Requirement** | 0.9% | 0.5% |

**Table 10D | New York State System Level Electricity Requirement - Average Annual Growth Rate - Forecast**

| | 2012-2020 | 2020-2030 | 2012-2030 |
|---|---|---|---|
| **Requirement** | 0.6% | 0.8% | 0.7% |

Sources: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. Total electricity requirement for New York for year 2011 and forecast through 2022 is from NYISO. *Gold Book*. 2012. Forecast years 2022-2030 are based on 2013 New York State Energy Plan IPM modeling.

**Figure 2 | Electricity End-Use by Sector (2012)**




Source: EIA. *Preliminary Data*. 2012

**Table 11A | Electricity End-Use Average Annual Growth Rate by Sector – Historical**

| SECTOR | 1990-2000 | 2000-2012 |
|---|---|---|
| **Residential** | 1.1% | 1.4% |
| **Commercial** | 2.3% | 1.4% |
| **Industrial** | -2.0% | -3.8% |
| **Transportation** | -0.1% | 1.0% |

**Table 11B | Electricity End-Use Average Annual Growth Rate by Sector – Forecast**

| SECTOR | 2012-2020 | 2020-2030 | 2012-2030 |
|---|---|---|---|
| **Residential** | 0.6% | 0.6% | 0.6% |
| **Commercial** | 0.8% | 0.9% | 0.8% |
| **Industrial** | -0.9% | -1.0% | -0.9% |
| **Transportation** | 0.0% | 0.0% | 0.0% |

Sources: NYSERDA. P*atterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. Forecast years based on NYISO. *Gold Book*. 2013 and projections from EIA's *Annual Energy Outlook*, 2012.

## Residential Energy Use by Fuel Type

New York's residential energy use by fuel type is shown in Table 12 (A-D). Electricity comprises the largest proportion of residential energy use at 47 percent in 2012, followed by natural gas use at 36 percent and distillate heating oil at 10 percent. From 2012 to 2030, electricity use in the residential sector is projected to increase at an average annual rate of 0.5 percent. Natural gas use in the residential sector is projected to stabilize at approximately 2012 levels, while use of petroleum is projected to decrease at an average annual rate of about 2.3 percent.

**Table 12A | Residential Sector On-Site Fuel and Electricity Use in TBtu – Historical**

| FUEL | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| Distillate | 184 | 167 | 205 | 204 | 119 | 107 | 116 |
| Kerosene | 10 | 7 | 13 | 12 | 6 | 4 | 5 |
| LPG | 14 | 16 | 22 | 18 | 22 | 20 | 20 |
| Coal | 1 | 0.7 | 0.3 | 0.3 | 0 | 0 | 0 |
| Wood | 38 | 52 | 83 | 50 | 49 | 51 | 50 |
| Natural Gas | 348 | 387 | 413 | 417 | 400 | 404 | 400 |
| Electricity Generated for On-Site Use (Primary) | 429 | 440 | 479 | 571 | 540 | 519 | 502 |
| TOTAL | 1,024 | 1,069 | 1,215 | 1,273 | 1,136 | 1,106 | 1,093 |

**Table 12B | Residential Sector On-Site Fuel and Electricity Use in TBtu – Forcast**

| FUEL | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| Distillate | 108 | 97 | 86 | 77 |
| Kerosene | 5 | 5 | 5 | 5 |
| LPG | 19 | 18 | 18 | 18 |
| Coal | 0 | 0 | 0 | 0 |
| Wood | 50 | 50 | 50 | 50 |
| Natural Gas | 400 | 400 | 400 | 400 |
| Electricity Generated for On-Site Use (Primary) | 493 | 510 | 530 | 554 |
| TOTAL | 1,074 | 1,079 | 1,089 | 1,104 |

**Table 12C | Residential Sector On-Site Fuel and Electricity Use – Average Annual Growth Rate - Historical**

| FUEL | 1990–2000 | 2000–2012 |
|---|---|---|
| Distillate | 1.1% | -4.6% |
| Kerosene | 2.9% | -7.3% |
| LPG | 4.3% | -0.7% |
| Coal | -14.5% | -- |
| Wood | 8.1% | -4.1% |
| Natural Gas | 1.7% | -0.3% |
| Electricity Generated for On-Site Use (Primary) | 1.1% | 0.4% |
| **TOTAL** | **1.7%** | **-0.9%** |

**Table 12D | Residential Sector On-Site Fuel and Electricity Use – Average Annual Growth Rate - Forecast**

| FUEL | 2012-2020 | 2020-2030 | 2012-2030 |
|---|---|---|---|
| Distillate | -2.3 | -2.3% | -2.3% |
| Kerosene | -0.6% | 0.2% | -0.1% |
| LPG | -1.2% | 0.0% | -0.5% |
| Coal | 0.0% | 0.0% | 0.0% |
| Wood | 0.0% | 0.0% | 0.0% |
| Natural Gas | 0.0% | 0.0% | 0.0 |
| Electricity Generated for On-Site Use (Primary) | 0.2% | 0.8% | 0.5% |
| **TOTAL** | **-0.2%** | **0.2%** | **0.1%** |

Sources: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. 2012 values based on EIA preliminary estimates. Electricity forecast based on 2013 New York State Energy Plan IPM modeling. Fuels forecast based on EIA's *Annual Energy Outlook*, 2012.

## Commercial Energy Use by Fuel Type

New York's commercial energy use by fuel type is shown in Table 13 (A-D). Electricity comprises the largest proportion of commercial energy use at 66 percent (2012), followed by natural gas use at 24 percent and distillate heating oil at 5 percent. From 2012 to 2030, electricity use in the commercial sector is projected to increase at an average annual rate of 0.8 percent. Natural gas use in the commercial sector is projected to increase at an average annual rate of 1.1 percent, while use of petroleum is projected to decrease at an average annual rate of about 0.1 percent.

**Table 13A | Commercial Sector On-Site Fuel and Electricity Use in TBtu – Historical**

| FUEL | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| Distillate | 90 | 92 | 88 | 105 | 60 | 60 | 60 |
| Kerosene | 2 | 4 | 5 | 4 | 1 | 1 | 1 |
| LPG | 4 | 5 | 6 | 4 | 7 | 7 | 7 |
| Residual | 109 | 85 | 59 | 63 | 59 | 45 | 56 |
| Coal | 5 | 5 | 2 | 4 | 0.1 | 0.1 | 0.1 |
| Wood | 4 | 7 | 14 | 8 | 8 | 8 | 8 |
| Waste | 0.2 | 3 | 4 | 3 | 2 | 2 | 2 |
| Natural Gas | 201 | 239 | 378 | 283 | 294 | 299 | 308 |
| Electricity Generated for On-Site Use (Primary) | 623 | 689 | 780 | 868 | 819 | 854 | 828 |
| **TOTAL** | **1,038** | **1,129** | **1,337** | **1,342** | **1,251** | **1,276** | **1,270** |

**Table 13B | Commercial Sector On-Site Fuel and Electricity Use in TBtu – Forecast**

| FUEL | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| Distillate | 60 | 60 | 59 | 59 |
| Kerosene | 1 | 1 | 1 | 1 |
| LPG | 7 | 7 | 7 | 7 |
| Residual | 55 | 54 | 55 | 55 |
| Coal | 0.1 | 0.1 | 0.1 | 0.1 |
| Wood | 8 | 8 | 8 | 8 |
| Waste | 2 | 2 | 2 | 2 |
| Natural Gas | 363 | 366 | 374 | 385 |
| Electricity Generated for On-Site Use (Primary) | 819 | 857 | 902 | 957 |
| **TOTAL** | **1,315** | **1,355** | **1,409** | **1,475** |

**Table 13C | Commercial Sector On-Site Fuel and Electricity Use – Average Annual Growth Rate - Historical**

| FUEL | 1990–2000 | 2000–2012 |
|---|---|---|
| Distillate | -0.2% | -3.1% |
| Kerosene | 13.4% | -12.7% |
| LPG | 4.3% | 0.4% |
| Residual | -5.9% | -0.5% |
| Coal | -8.3% | -22.4% |
| Wood | 12.7% | -4.3% |
| Waste | 35.3% | -5.4% |
| Natural Gas | 6.5% | -1.7% |
| Electricity Generated for On-Site Use (Primary) | 2.3% | 0.5% |
| **TOTAL** | **2.6%** | **-0.4%** |

**Table 13D | Commercial Sector On-Site Fuel and Electricity Use – Average Annual Growth Rate - Forecast**

| FUEL | 2012–2020 | 2020–2030 | 2012–2030 |
|---|---|---|---|
| Distillate | -0.1% | -0.1% | -0.1% |
| Kerosene | 0.6% | 0.5% | 0.5% |
| LPG | 0.2% | 0.3% | 0.3% |
| Residual | -0.4% | 0.1% | -0.1% |
| Coal | -0.3% | -0.1% | -0.2% |
| Wood | 0.0% | 0.0% | 0.0% |
| Waste | 0.0% | 0.0% | 0.0% |
| Natural Gas | 2.2% | 0.5% | 1.2% |
| Electricity Generated for On-Site Use (Primary) | 0.4% | 1.1% | 0.8% |
| **TOTAL** | **0.8%** | **0.9%** | **0.8%** |

Sources: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. 2012 values based on EIA preliminary estimates. Electricity forecast based on 2013 New York State Energy Plan IPM modeling. Fuelsforecast based on EIA's *Annual Energy Outlook*, 2012.

## Industrial Energy Use by Fuel Type

New York's industrial energy use by fuel type is shown in Table 14 (A-D). Electricity comprises the largest proportion of industrial energy use at 50 percent (2012), followed by natural gas use at 26 percent and distillate heating oil at 6 percent. From 2012 to 2030, electricity use in the industrial sector is projected to decrease at an average annual rate of 0.9 percent. Natural gas use in the industrial sector is projected to increase at an average annual rate of 2.7 percent, while use of petroleum is projected to increase at an average annual rate of about 0.3 percent.

**Table 14A | Industrial Sector On-Site Fuel and Electricity Use in TBtu – Historical**

| FUEL | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| Distillate | 24 | 18 | 19 | 20 | 13 | 16 | 18 |
| LPG | 2 | 3 | 8 | 9 | 2 | 2 | 5 |
| Residual Oil | 29 | 13 | 13 | 8 | 3 | 8 | 5 |
| Kerosene | 1 | 2 | 1 | 4 | 3 | 1 | 1 |
| Wood | 26 | 20 | 31 | 16 | 13 | 14 | 13 |
| Waste | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| Coal | 83 | 72 | 73 | 40 | 25 | 26 | 26 |
| Natural Gas | 105 | 221 | 100 | 84 | 78 | 79 | 75 |
| Electricity Generated for On-Site Use (Primary) | 355 | 279 | 286 | 225 | 140 | 147 | 137 |
| **TOTAL** | **626** | **630** | **533** | **406** | **280** | **294** | **280** |

**Table 14B | Industrial Sector On-Site Fuel and Electricity Use in TBtu – Forecast**

| FUEL | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| Distillate | 20 | 20 | 20 | 20 |
| LPG | 5 | 5 | 5 | 5 |
| Residual Oil | 5 | 5 | 5 | 5 |
| Kerosene | 1 | 1 | 1 | 1 |
| Wood | 13 | 13 | 13 | 13 |
| Waste | 2 | 2 | 2 | 2 |
| Coal | 25 | 25 | 22 | 19 |
| Natural Gas | 91 | 105 | 115 | 120 |
| Electricity Generated for On-Site Use (Primary) | 126 | 122 | 119 | 117 |
| **TOTAL** | **287** | **297** | **301** | **301** |

**Table 14C | Industrial Sector On-Site Fuel and Electricity Use – Average Annual Growth Rate - Historical**

| FUEL | 1990–2000 | 2000–2012 |
|---|---|---|
| Distillate | -2.1% | -0.3% |
| LPG | 13.3% | -4.7% |
| Residual Oil | -8.1% | -7.7% |
| Kerosene | -4.9% | -2.2% |
| Wood | 1.9% | -6.8% |
| Waste | 1.8% | 1.8% |
| Coal | -1.2% | -8.3% |
| Natural Gas | -0.5% | -2.4% |
| Electricity Generated for On-Site Use (Primary) | -2.1% | -6.0% |
| **TOTAL** | **-1.6%** | **-5.2%** |

**Table 14D | Industrial Sector On-Site Fuel and Electricity Use – Average Annual Growth Rate - Forecast**

| FUEL | 2012–2020 | 2020–2030 | 2012–2030 |
|---|---|---|---|
| Distillate | 0.8% | -0.1% | 0.3% |
| LPG | 0.3% | 0.0% | 0.1% |
| Residual Oil | 1.0% | -0.2% | 0.4% |
| Kerosene | 0.0% | 0.0% | 0.0% |
| Wood | 0.0% | 0.0% | 0.0% |
| Waste | 0.0% | 0.0% | 0.0% |
| Coal | -0.4% | -2.6% | -1.6% |
| Natural Gas | 4.3% | 1.4% | 2.7% |
| Electricity Generated for On-Site Use (Primary) | -1.4% | -0.4% | -0.9% |
| **TOTAL** | **0.7%** | **0.1%** | **0.4%** |

Sources: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. 2012 values based on EIA preliminary estimates. Electricity forecast based on 2013 New York State Energy Plan IPM modeling. Fuels forecast based on EIA's *Annual Energy Outlook*, 2012."

## Transportation Energy Use by Fuel Type

New York's transportation energy use by fuel type is shown in Table 15 (A-D). Gasoline comprises the largest proportion of transportation energy use at 69 percent in 2012, followed by distillate use at 16 percent and jet fuel at 9 percent. From 2012 to 2030, gasoline use in the transportation sector is projected to decrease at an average annual rate of 0.6 percent. Distillate use in the transportation sector is projected to increase at an average annual rate of 0.9 percent, while use of jet fuel is projected to continue at current levels.

**Table 15A | Transportation Sector On-Site Fuel and Electricity Use in TBtu – Historical**

| FUEL | 1990 | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|
| Distillate | 126 | 124 | 134 | 166 | 165 | 166 | 161 |
| Gasoline | 731 | 692 | 692 | 717 | 721 | 681 | 706 |
| Jet Fuel | 31 | 44 | 54 | 115 | 84 | 88 | 88 |
| LPG | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| Natural Gas | 5 | 9 | 9 | 13 | 19 | 22 | 21 |
| Residual | 9 | 15 | 51 | 36 | 76 | 32 | 23 |
| Electricity | 31 | 30 | 30 | 32 | 31 | 31 | 30 |
| **TOTAL** | **933** | **914** | **972** | **1,079** | **1,096** | **1,021** | **1,029** |

**Table 15B | Transportation Sector On-Site Fuel and Electricity Use in TBtu – Forecast**

| FUEL | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| Distillate | 185 | 191 | 192 | 189 |
| Gasoline | 689 | 675 | 655 | 638 |
| Jet Fuel | 88 | 88 | 88 | 88 |
| LPG | 1 | 1 | 1 | 1 |
| Natural Gas | 21 | 21 | 21 | 21 |
| Residual | 26 | 25 | 24 | 24 |
| Electricity | 29 | 29 | 29 | 30 |
| **TOTAL** | **1,039** | **1,030** | **1,010** | **990** |

**Table 15C | Transportation Sector On-Site Fuel and Electricity Use – Average Annual Growth Rates - Historical**

| FUEL | 1990–2000 | 2000–2012 |
|---|---|---|
| Distillate | 0.6% | 1.5% |
| Gasoline | -0.5% | 0.2% |
| Jet Fuel | 5.8% | 4.1% |
| LPG | 4.6% | -0.9% |
| Natural Gas | 5.7% | 8.0% |
| Residual | 19.6% | -6.6% |
| Electricity | -0.2% | -0.1% |
| **TOTAL** | **0.4%** | **0.5%** |

**Table 15D | Transportation Sector On-Site Fuel and Electricity Use – Average Annual Growth Rates - Forecast**

| FUEL | 2012-2020 | 2020-2030 | 2012-2030 |
|---|---|---|---|
| Distillate | 2.1% | -0.1% | 0.9% |
| Gasoline | -0.6% | -0.6% | -0.6% |
| Jet Fuel | 0.1% | 0.0% | 0.0% |
| LPG | 0.0% | 0.0% | 0.0% |
| Natural Gas | 0.0% | 0.0% | 0.0% |
| Residual | 1.3% | -0.5% | 0.3% |
| Electricity | -0.4% | 0.3% | 0.0% |
| **TOTAL** | **0.0%** | **-0.4%** | **-0.2%** |

Sources: NYSERDA. P*atterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. 2012 values based on EIA preliminary estimates. Electricity forecast based on 2013 New York State Energy Plan IPM modeling. Fuels forecast based on EIA's *Annual Energy Outlook*, 2012." TBtu value for gasoline includes ethanol.

## New York's Fuel Prices

Commodity prices on which New York's retail fuel prices are based are shown in Table 16 (A-D). In 2012, on an equivalent million British thermal unit (MMBtu) basis, the commodity price of crude oil (West Texas Intermediate) is more than four times the price of natural gas (Henry Hub). Table 17 (A-D) shows historical and projected retail prices for selected petroleum products, while Table 18 (A-D) shows retail prices for natural gas for various customer types.

**Table 16A | Crude Oil and Natural Gas Spot Prices in 2011$/MMBtu – Historical**

| FUEL | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| West Texas Intermediate Crude Oil | $4.69 | $6.84 | $11.25 | $14.13 | $16.36 | $16.89 |
| Henry Hub | $2.49 | $5.63 | $10.00 | $4.51 | $4.00 | $3.69 |

**Table 16B | Crude Oil and Natural Gas Spot Prices in 2011$/MMBtu – Forecast**

| FUEL | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| West Texas Intermediate Crude Oil | $20.38 | $21.68 | $22.74 | $23.66 |
| Henry Hub | $4.42 | $4.72 | $5.81 | $6.49 |

**Table 16C | Crude Oil and Natural Gas Spot Prices – Average Annual Growth Rates - Historical**

| FUEL | 1995-2000 | 2000-2012 |
|---|---|---|
| West Texas Intermediate Crude Oil | 7.8% | 7.8% |
| Henry Hub | 17.7% | -3.5% |

**Table 16D | Crude Oil and Natural Gas Spot Prices – Average Annual Growth Rates - Forecast**

| FUEL | 2012-2020 | 2020-2030 | 2012-2030 |
|---|---|---|---|
| West Texas Intermediate Crude Oil | 3.2% | 0.9% | 1.9% |
| Henry Hub | 3.1% | 3.2% | 3.2% |

Sources: EIA. *Annual Energy Outlook, 2012 Reference Case.*

**Table 17A | New York Retail Petroleum Product Prices in 2011$/MMBtu – Historical**

| FUEL | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| **Residential Distillate** | $10.57 | $14.12 | $18.20 | $23.00 | $24.81 | $25.44 |
| **Transportation Gasoline** | $14.13 | $16.04 | $20.80 | $23.02 | $26.09 | $26.66 |

**Table 17B | New York Retail Petroleum Product Prices in 2011$/MMBtu – Forecast**

| FUEL | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| **Residential Distillate** | $29.56 | $31.10 | $32.34 | $33.43 |
| **Transportation Gasoline** | $30.41 | $31.81 | $32.95 | $33.93 |

**Table 17C | New York Retail Petroleum Product Prices – Average Annual Growth Rates - Historical**

| FUEL | 1995–2000 | 2000–2012 |
|---|---|---|
| **Residential Distillate** | 6.0% | 5.0% |
| **Transportation Gasoline** | 2.6% | 4.3% |

**Table 17D | New York Retail Petroleum Product Prices – Average Annual Growth Rates - Forecast**

| FUEL | 2012-2020 | 2020-2030 | 2012-2030 |
|---|---|---|---|
| **Residential Distillate** | 2.5% | 0.7% | 1.5% |
| **Transportation Gasoline** | 2.2% | 0.6% | 1.3% |

Sources: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. Forecast based on EIA's *Annual Energy Outlook*, 2012.

**Table 18A | New York Retail Natural Gas Prices in 2011$/MMBtu – Historical**

| SECTOR | 1995 | 2000 | 2005 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| Industrial | $6.71 | $7.77 | $12.07 | $8.62 | $7.53 | $7.26 |
| Commercial | $8.72 | $9.83 | $13.24 | $10.96 | $9.48 | $9.26 |
| Residential | $12.05 | $12.48 | $16.71 | $14.15 | $13.24 | $13.04 |

**Table 18B | New York Retail Natural Gas Prices in 2011$/MMBtu – Forecast**

| SECTOR | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| Industrial | $7.91 | $8.18 | $9.14 | $9.74 |
| Commercial | $9.79 | $10.00 | $10.78 | $11.27 |
| Residential | $13.52 | $13.72 | $14.43 | $14.88 |

**Table 18C | New York Retail Natural Gas Prices – Average Annual Growth Rates - Historical**

| SECTOR | 1995–2000 | 2000–2012 |
|---|---|---|
| Industrial | 3.0% | -0.6% |
| Commercial | 2.4% | -0.5% |
| Residential | 0.7% | 0.4% |

**Table 18D | New York Retail Natural Gas Prices – Average Annual Growth Rates - Forecast**

| FUEL | 2012-2020 | 2020-2030 | 2012-2030 |
|---|---|---|---|
| Industrial | 1.5% | 1.8% | 1.6% |
| Commercial | 1.0% | 1.2% | 1.1% |
| Residential | 0.6% | 0.8% | 0.7% |

Sources: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013. Forecast based on EIA's *Annual Energy Outlook*, 2012.


H.T.S

# 2 Efficiency for Buildings and Industry

## Reducing Energy Use in Buildings and Industry

New York has a decades-long history in supporting energy efficiency policies and programs, and has been a pioneer in the country in revealing the value of energy efficiency as a priority energy resource. Such value can be noted in the value of efficiency as a low-cost energy resource, as well as assessing both the environmental and economic benefits of energy efficiency strategies. Further, New York leadership in energy efficiency can be noted in the State's ability to identify emerging challenges in energy efficiency policy and to pursue strategies that most effectively address those challenges. New York has built a robust suite of initiatives to help consumers realize the benefits of efficiency for their individual energy needs, as well as pursue initiatives that build support among the entire energy efficiency industry "supply chain" so that energy-efficient choices become an easy choice for consumers when facing energy-related purchases. New York's forward-thinking, multi-sector, comprehensive approach to efficiency programs has been recognized by the American Council for an Energy-Efficient Economy (ACEEE) in rating New York State third in the nation for energy efficiency.[1]

New York is the second most energy-efficient state in the nation on a per capita basis.[2] While the past three decades have seen growing populations in some parts of the State, and greater demands for energy-consuming technologies throughout the State, energy use per capita in New York has remained relatively flat – 39 percent lower than the national average.[3] Several infrastructure and demographic factors help achieve this, including the State's highly energy-efficient urban transportation system and high concentration of multi-family housing. However, the State's aggressive approach to public investments in energy efficiency policy has also contributed to this energy-efficient prominence. Further, as the vast majority of the primary fuel inputs into our energy systems are imported from out-of-state, energy efficiency becomes a critical means to help stem the flow of New York dollars to these out-of-state sources, can help to reduce energy costs for New York homeowners and businesses, and thus provide resources for a more economically competitive State and contribute to a higher quality of life.

New York's buildings and industry account for about 72 percent of the total primary energy used in New York in 2012; the remaining 28 percent of primary energy is used by the transportation sector. The total primary energy used by buildings and industry includes the fuels used on-site at the customers' location, such as natural gas and heating oil, as well as fossil fuel and other forms of energy used to generate the electricity that is ultimately used at the customers' location, as discussed in the Energy End-Use and Cost Section. This section focuses on "buildings and

**1.** ACEEE. *2011 State Energy Efficiency Scorecard*. October 2011. http://aceee.org/research-report/e115

**2.** NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013.

**3.** NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013.

industry" end-use efficiency activities; transportation efficiency programs are discussed in the Transportation Section and electric system efficiency activities, e.g. improving generation and delivery of electricity, are addressed in the Sources Chapter. However, the benefits of improvements in the end-use efficiency of buildings and industry extend beyond the customers' on-site location to include energy "system benefits," such as lower energy costs for all consumers and avoided infrastructure costs.

Energy efficiency improvements result in economic benefits to both the participating customers and to the State's economy as a whole. Energy costs have been identified as among the top three costs for New York businesses; therefore, businesses become more competitive by reducing their energy costs. For example, well-designed energy projects for commercial buildings can result in Returns on Investment (ROI) to the participating customers of between 15 and 30 percent per year. Further, investments in and annual savings from energy efficiency projects create measurable net macroeconomic benefits to New York in the form of increased employment, increased labor income, and increased Gross State Product. For instance, the New York Energy $mart$^{SM}$ Program has created approximately 4,200 jobs through 2012 compared to the number of jobs that would have existed in the absence of the program.[4]

Beyond benefits that can be directly measured in dollars, the consumers and businesses that invest in energy efficiency projects realize additional co-benefits, such as increased comfort. Further, all New Yorkers realize the environmental benefits of energy efficiency due to reduced on-site fuel use, reduced emissions from power plants or reduced water waste through improved processes.

New York's current activities and opportunities in energy efficiency are discussed below. Despite these achievements, New York is already identifying the next opportunity for energy efficiency programs. Key policy considerations for future energy efficiency activities are to build from the markets that have been established by previous program activities, look to new opportunities and strategies that can achieve higher levels of penetration of efficiency programs, and increase the scale of energy efficiency in the State's energy economy. Among other activities, this will require the use of new strategies that do not depend

**4.** NYSERDA. 2012 *New York Energy $mart$^{SM}$ Evaluation Contractor Reports*. June 2013. http://www.nyserda.ny.gov/BusinessAreas/Energy-Data-and-Prices-Planning-and-Policy/Program-Evaluation/NYE$-Evaluation-Contractor-Reports/2012-Reports/Cadmus.aspx only on public investment interventions to achieve energy savings, and rather seek to create opportunity for private capital to reveal new value of efficiency investments or employ social science theories that seek to change the energy behaviors of New Yorkers to improve overall energy efficiency and reduce energy waste in the economy.

## New York's Approach to Energy Efficiency

New York has long been one of the nation's leaders in implementing energy efficiency programs and strategies to address barriers to the natural or economic adoption of energy-efficient decisions by consumers. This approach has called on the resources of New York's energy agencies and utilities to deliver a broad spectrum of programs to advance the State's energy policy objectives. In addition, New York has also embraced a variety of strategies to help overcome known barriers to the natural adoption of energy efficiency by the economy generally. These strategies include "resource acquisition" approaches that are designed to induce customer interest in purchases with higher efficiency and overcome the initial higher cost of more efficient purchases. "Market transformation" activities are geared at working with all market actors, including product manufacturers, wholesalers and retailers, and energy services companies and building contractors who deliver products and services to consumers. These market transformation efforts are also closely associated with consumer education programs in an effort to create a better-educated consumer who is more aware of the products and services that are offered by the "upstream" market players. Of particular value to the government sector have been performance contracting activities that provide attractive financing options for efficiency interments, and which can help to improve the operating budgets of State agencies. Further, New York has been active in seeking improved building codes and appliance standards as a means of ensuring a strong baseline of efficiency as new products and improved building practices emerge in the economy.

Energy efficiency resources help the State to cost-effectively meet its energy needs, while increasing economic activity and reducing emissions of greenhouse gases and other pollutants. Using energy more efficiently in buildings and industry reduces energy bills, makes businesses and industry more competitive, helps New Yorkers save money, and enhances quality of life by increasing comfort, safety, and productivity. In addition to directly creating clean energy jobs, end-use energy efficiency creates jobs across all sectors by stimulating New York's economy with dollars that would otherwise have been spent on wasted energy. Further, energy efficiency resources enhance the reliability of energy systems and reduce exposure to price volatility associated with dependence on fossil fuels.

Beyond reducing the amount of energy used by residential, commercial, and industrial customers who install energy efficiency measures, many of New York's energy efficiency programs are designed to transform markets by permanently changing the products, services, and delivery mechanisms available for improved efficiency; increasing consumer demand for such products and services; and changing consumer behavior with respect to energy use. Market transformation programs take advantage of many different strategies that can influence all factors in the market – from product manufacturers to wholesalers and distributors to retailers and customers. These strategies are ultimately designed to foster systemic change in the impact of energy efficiency in the economy as well as increase the adoption of innovative energy efficiency products and services. Resource acquisition programs are designed to acquire near-term cost-effective energy savings and foster participation at a minimized cost to ratepayers through various types of incentives.[5] Financing mechanisms can address the lack of access to capital to fund energy efficiency investments, one of the barriers to adoption of cost-effective energy efficiency measures. When coupled with advances in building codes and appliance standards – which set a floor or baseline efficiency and performance level – and strong code enforcement efforts, these efforts can propel the market toward greater efficiency with impacts lasting well into the future.

## New York's Programs and Achievements

New York has a decades-long history supporting energy efficiency across all sectors. Annual funding committed to efficiency programs by New York's utilities and energy authorities began with a modest $25 million in 1984 and has risen to more than over $1 billion for 2012. Through the Public Service Commission (PSC), New York State Energy Research and Development Authority (NYSERDA), New York Power Authority (NYPA), Long Island Power Authority (LIPA), Homes and Community Renewal (HCR), and the electric and gas utilities within the State, New York has a robust network of providers that deliver efficiency programs

**5.** The existing EEPS programs use resource acquisition strategies, while the SBC programs use market transformation strategies.

which provide valuable efficiency opportunities to all sectors in the economy, and all customers seeking services.

The Energy Efficiency Portfolio Standard (EEPS) is advancing the State's '15 by 15' goal to reduce electricity end-use 15 percent below 2015 forecasted levels by 2015.[6] EEPS was initiated with the objective to achieve cumulative annual electric and gas energy efficiency savings of 7,700 GWh and 26 million dekatherms (Dt) by 2015, respectively.[7] Statewide programs are administered by NYSERDA, while more localized programs are administered by electric and gas utilities and LIPA. The aggregate cumulative annual savings targets of currently approved electric and gas EEPS programs through 2015 are 10,273 GWh and 21.5 million Dt, respectively.[8] As of May 2013, the total electric savings achieved and committed across the EEPS electric programs were 4,821 GWh, while gas savings achieved and committed across the EEPS gas programs totaled 9.5 million Dt.[9]

The PSC also approved $523 million System Benefits Charge (SBC)-funded Technology and Market Development (T&MD) programs from 2012 to 2016.[10] Administered by NYSERDA, the T&MD portfolio encompasses programs designed to accelerate energy innovation through support for scientific research and market analysis, investment in technology development and demonstration, promotion of a clean energy economy through business and market development, acceleration of adoption of clean energy technologies and practices, and the incorporation of more rigorous energy use standards in codes and industry best practices.

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**6.** EEPS electricity programs established in June 2008; natural gas programs established in May 2009. The electricity goal is 1,900 GWh per year (2011 through 2015), and the natural gas goal is 3.8 million Dt per year (2011 through 2015).

**7.** In 2011, the electric energy efficiency savings objective was increased to 11,200 GWh as resource acquisition programs initiated prior to the establishment of EEPS were rolled into the EEPS portfolio of programs.

**8.** When targets tied to 2008 through 2011 funding that were unspent as of December 31, 2011 and subsequently repurposed are reflected, the targets here will decrease by an as yet undetermined amount.

**9.** Achieved electric savings of 3,309 GWh and committed savings of 1,512 GWh. Achieved gas savings of 5.8 million Dt and committed savings of 3.7 million dekatherms.

**10.** PSC. *Case 10-M-0457: In the Matter of the System Benefits Charge IV: Order Continuing System Benefits Charge Funded Programs.* 2011. PSC. Case 05-M-0090: System Benefits Charge. July 2011. SBC was established in 1996 to fund public policy initiatives not expected to be adequately addressed by New York's competitive electricity markets. SBC-funded programs are designed to serve the diverse needs of New York energy consumers from residential homeowners and tenants, to manufacturing facilities and commercial office buildings.

Through the Regional Greenhouse Gas Initiative (RGGI), New York and its partner states pioneered the nation's first market-based, mandatory cap-and-trade program.[11] RGGI-funded programs are designed to encourage a more comprehensive climate change strategy by filling critical gaps and targeting fuels not adequately addressed through SBC, EEPS, Renewable Portfolio Standard (RPS), and federally-funded efficiency activities. The investments seek to advance the State's broad energy goal of moving toward a clean energy economy through reductions in greenhouse gases (GHGs).[12] New York offers residential, commercial, industrial (RCI) and municipal; transportation; power supply and delivery; and multi-sector RGGI-funded programs that reduce energy consumed by end users through energy efficiency improvements and enhanced operating practices, reducing on-site emissions. A major component of the RGGI-funded program offerings is Green Jobs–Green New York (GJGNY), which is a statewide program to promote energy efficiency and the installation of clean technologies to reduce energy costs and greenhouse gas emissions.[13] GJGNY provides subsidized energy audits to single family, multi-family, small business, and not-for-profit building owners; offers financing options for the completion of energy efficiency services; supports sustainable community development; and creates opportunities for green jobs. Through December 31, 2012, approximately $16 million has been spent on RGGI RCI and municipal programs and $43.7 million on GJGNY, respectively resulting in 4,574 MWh and 12,321 MWh of cumulative annual electricity reductions and 249,652 MMBtu and 327,372 MMBtu of cumulative annual energy reductions.

In 2009, NYSERDA received $153 million from the federal American Recovery and Reinvestment Act (ARRA): $123 million from the State Energy Program and $30 million from the Energy Efficiency and Conservation Block Grant (EECBG).[14] ARRA-funded energy efficiency

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**11.** RGGI is a cooperative effort by several Northeastern and Mid-Atlantic States (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. (New Jersey also participated in RGGI through 2011.) *Regional Greenhouse Gas Initiative*. August 2012. http://www.rggi.org.

**12.** NYSERDA. *Operating Plan for Investments in New York Under the $CO_2$ Budget Trading Program and the $CO_2$ Allowance Auction Program*. 2012.

**13.** The Green Jobs-Green New York Act of 2009 ("the Act," A.8901/S.5888 and chapter amendment A.9031/S.6032) was signed into law on October 9, 2009.

**14.** NYSERDA. *American Recovery and Reinvestment Act 2012 Impact Evaluation Report: Energy Efficiency and Conservation Block Grant*. September 2012. *NYSERDA. American Recovery and Reinvestment Act 2012 Impact Evaluation Report: State Energy Programs.* April 2012.

programs provided funding to small municipalities, schools, hospitals, public colleges and universities, and non-profits for installation of cost-effective energy technologies, such as general retrofits, lighting, cooling, heating, motors, building envelope, facility optimization, combined heat and power systems, and geothermal systems.[15] ARRA funding also supported building code compliance support, assessment, and training programs; renewable energy programs; and transportation projects.

The NYSERDA System-Wide Program (SWP) was an electricity demand reduction program operated in the Consolidated Edison Company of New York (Con Edison) service territory from March 2005 to March 2009. The overall SWP goal was to achieve 150,000 kW of demand reduction, and the original SWP total budget was set at $112 million. While the SWP is currently completed, NYSERDA reports on the annual savings being achieved from encumbered projects.

Administered by HCR, the Weatherization Assistance Program (WAP) is a national energy conservation program designed to reduce energy consumption and the impact of high energy costs on low-income families.[16] The program targets the most cost-effective measures, as determined from an on-site energy audit of the building. WAP serves homeowners and renters in all types of housing units, including single and multi-family housing, manufactured housing, and group homes. WAP receives federal funding through the Low Income Home Energy Assistance Program (LIHEAP), and coordinates with other local, State, and federal programs, such as the NYSERDA EmPower New York and Multifamily Performance programs. WAP also received approximately $394 million in ARRA funds, which HCR used to weatherize more than 72,000 homes.

NYPA offers energy-related projects, programs and services and financing for the audit, design, and installation of energy efficiency upgrades for its customers; statewide public entities including public schools, local governments, Office of General Service (OGS) facilities, State University of New York (SUNY) campuses; as well as independent not-for-profit colleges and universities. NYPA recovers costs through customer and program participant bill surcharges; participating facilities retain all the energy bill savings once the NYPA loan is repaid, usually within 10

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**15.** In addition, 60 Native American communities, municipalities, and counties received $175.6 million in direct EECBG funding. DOE. *EECBG State and Local Grant Allocations.* 2010.

**16.** Energy efficiency measures include: air sealing, i.e., weather stripping and caulking; wall and ceiling insulation; heating system improvements or replacements; providing efficiency improvements in lighting; hot water tank and pipe insulation; and replacing refrigerators with ENERGY STAR qualified units.

years or less. NYPA's planned investment in energy efficiency measures for program participants is $1.4 billion from 2008 to 2015, including annual investments of more than $200 million between 2012 and 2015, and projected energy reductions for 2008 to 2015 are estimated to be 1,411 GWh and 248 MW.

In January 2009, a 10-year, $924 million Efficiency Long Island program was initiated by LIPA to reduce Long Island peak electric demand by 520 MW by 2018, resulting in the deferral or elimination of one large power plant and avoiding high-cost peak power production, equivalent to saving 2.2 million barrels of oil annually. Efficiency Long Island offers residential and business customers programs that support increased levels of energy efficiency in new and retrofit construction, as well as supporting sales of energy-efficient products.

**Table 19 | State Energy Efficiency Achievements**

| FUNDING SOURCE | YEAR RANGE | CUMULATIVE ANNUAL GWh REDUCTION | CUMULATIVE ANNUAL FUEL REDUCTION (TBtu) | CUMULATIVE PROGRAM DOLLARS SPENT (MILLIONS) |
|---|---|---|---|---|
| **EEPS I-II** | 2009 to 2012 | 3,131 | 6 | $771 |
| **SBC I-IV** | 1998 to 2012 | 4,376 | 5 | $1,482 |
| **RGGI** | 2010 to 2012 | 17 | 0.6 | $60 |
| **ARRA** | 2009 to 2012 | 154 | 0.8 | $136 |
| **SWP** | 2005 to 2012 | 271 | 0 | $50 |
| **Weatherization** | 1998 to 2012 | 909 | 49 | $1,085 |
| **NYPA** | 1990 to 2012 | 1,158 | 3.1 | $1,382 |
| **LIPA** | 1999 to 2012 | 1,323 | N/A | $472 |

Note: Cumulative annual reductions are savings realized in a single calendar year from all installed measures.

Cumulative Program Dollars spent reflects expenditures as accounted for by each individual reporting entity.

EEPS I&II include programs administered by both NYSERDA and Utilities. Administrative and evaluation costs are included in utility programs and are excluded in NYSERDA programs.

SBC I-IV, RGGI, ARRA, and SWP do not include administrative and evaluation costs. EEPS I, SBC III, ARRA, and SWP are completed programs that continue to accrue annual savings. SBC I-II are also completed programs for which annual savings are no longer included in cumulative reductions.

Weatherization includes production expenses, but does not include administrative costs or training and technical assistance.

NYPA includes full project costs, i.e. design and construction.

LIPA includes allocated administrative costs.

Sources: NYSERDA, DPS, NYPA, LIPA, HCR.

New York is also leading by example and improving the efficiency of more than 16,000 State government buildings, for which it spends approximately $500 million annually on energy.[17] BuildSmart NY is Governor Cuomo's aggressive initiative for accelerating cost-effective clean energy and energy efficiency projects in approximately 212 million square feet of space. Executive Order (EO) 88, issued in December 2012, mandates a 20 percent improvement in the energy performance of State government buildings by April 2020, resulting in $100 million in annual taxpayer savings and reducing 8 million metric tons of greenhouse gas emissions – the equivalent of removing 1.6 million cars from the road.[18] BuildSmart NY will prioritize projects at the largest and most inefficient buildings, saving taxpayer money on energy costs, reducing the dependence on fossil fuels, catalyzing the marketplace, creating clean energy jobs, and increasing investment opportunities for private building owners and the clean energy technology industry.

More than 90 percent of the State's square footage and energy consumption is associated with six State government entities: SUNY; Department of Corrections and Community Supervision (DCOS); City University of New York (CUNY); OGS; Office of Mental Health (OMH); and the Metropolitan Transportation Authority (MTA). One of the key findings about the buildings operated by those six entities is that individually-metered buildings are more efficient than master-metered building complexes where one meter records all energy use. BuildSmart NY calls for energy master plans and energy audits to help find and prioritize energy efficiency opportunities at master-metered facilities. Several large SUNY campuses are currently undergoing energy master plans through BuildSmart NY.

The State's efficiency programs build upon the success of regional and local energy efficiency and sustainability initiatives. The Cleaner, Greener Communities Program was announced by Governor Cuomo in his 2011 State of the State Address as a $96 million dollar competitive grant program to assist Regional Economic Development Council (REDC) regions in developing and implementing regional

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**17.** NYPA. *BuildSmart NY Baseline Energy Performance of New York State Government Buildings.* 2013.
**18.** EO 88 requirements include annual reporting of energy use on all buildings larger than 20,000 gross square feet and submetering master-metered campuses, such as universities, hospitals, and correctional facilities, to enable statewide benchmarking of energy performance; as well as performing energy audits of buildings with the lowest energy performance and addressing identified cost-effective energy efficiency measures within two years.

comprehensive sustainable growth and carbon reduction strategies.[19] Expected to be published in Fall 2013, the Climate Smart Communities Program will publish an interactive online database of leading practices for municipalities to reduce GHG emissions from the land-use, transportation, green building, housing, infrastructure, and green infrastructure sectors, and incorporate practices relating to climate change resilience and adaptation.

Further, in April 2007, New York City Mayor Michael Bloomberg issued PlaNYC, which included a target of reducing the City government's GHG emissions and associated energy consumption by 30 percent by 2017. Forty five percent of PlaNYC's goal is from benchmarking and retrofitting existing buildings and replacing equipment with more efficient models.[20] Part of the City's long-term plan to achieve the 2017 target includes the "Greening the Codes" process, led by the U.S. Green Building Council, which brings together technical experts to identify barriers and suggest additions to building, construction, and fire codes to increase building efficiency and encourage the use of distributed generation.

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**19.** NYSERDA. *RFP 2391: Cleaner, Greener Communities Regional Sustainability Planning Program*. 2012. http://www.nyserda.ny.gov/Funding-Opportunities/Closed-Funding-Opportunities/RFP-2391-Cleaner-Greener-Communities-Regional-Sustainability-Planning-Program.aspx

**20.** The City of New York. *About PlaNYC*. 2011. http://www.nyc.gov/html/planyc2030/html/about/about.shtml. The "Greener, Greater Buildings Plan" requires annual benchmarking of energy use in buildings 50,000 square feet and larger—the most aggressive green retrofit initiative adopted in the United States. City Executive Order 109 further committed the City to spend 10 percent of its annual energy budget on energy efficiency programs.

# Energy Efficiency in Building Construction and Renovation

Among the most significant steps New York can take to realize additional energy efficiency savings for all fuels is to continue to update and enforce the Energy Conservation Construction Code ("Energy Code") and appliance and equipment standards to move building construction and renovations toward "net-zero energy buildings."[21] Enhanced codes and appliance and equipment standards improve building stock and equipment efficiency, lower demands on New York's electricity and gas delivery infrastructures, and lower GHG and other harmful emissions.

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**21.** A "net-zero energy building" is a building with greatly reduced energy needs through efficiency gains such that the balance of the energy needs can be supplied by renewable technologies. NREL. *Zero Energy Buildings: A Critical Look at the Definition*. 2006.

## Building Energy Codes

The Energy Code establishes energy efficiency standards for all new buildings and those undergoing additions or alterations. The most recent Energy Code was adopted in December 2010.[22] Updates for the commercial and residential provisions of the Energy Code, scheduled for release in 2014, will increase the efficiency of the commercial and residential Energy Code by approximately 18 percent and 24 percent, respectively.[23] Supporting a long-term State goal of net-zero energy buildings and resilient building performance, these updates incorporate higher equipment efficiency and building envelope requirements, and testing requirements for some building systems, and encourage the use of performance-based compliance paths to provide architects and engineers with greater design flexibility.[24]

Some municipalities have adopted local energy codes requiring building performance above the current Energy Code to advance high-performance building design and construction practices.[25] New York is exploring an "above-minimum code" mechanism, such as a stretch code or green construction code, for use by municipalities to standardize such actions.

The American Recovery and Reinvestment Act of 2009 (ARRA) requires that New York establish a plan for achieving 90 percent Energy Code compliance in new construction and renovations by 2017.[26] The Energy Code is adopted at the State level and enforced locally, although

**22.** In effect since 1979, the Energy Code is a statewide regulation adopted by the State Fire Prevention and Building Code Council (Code Council).

**23.** The current Energy Code applicable to residential and commercial buildings is based on the 2009 International Energy Conservation Code (IECC) and ASHRAE 90.1-2007. Updates to the Energy Code will be based on the 2012 IECC and ASHRAE 90.1-2010. Any amendment of the Energy Code is subject to the statutory mandate that the Energy Code remain "cost effective with respect to building construction in the State" (Energy Law § 11-103(2)). The State will provide training to address these updates.

**24.** Historically, Energy Codes approach buildings compliance through a prescriptive list of building requirements that must be met for all building components. In contrast, a performance-based compliance path considers the integrative aspects of each of the building's components and measures whole building energy performance.

**25.** Article 11 of the State Energy Law allows municipalities to adopt and enforce a local energy code, provided that such local codes are more stringent than the State's Energy Code. Communities that have adopted such local energy codes include, but are not limited to, the Towns of Greenburgh, Hempstead, Babylon, Yorktown, Southampton, Brookhaven, Riverhead, Smithtown, Clarkstown, and the Villages of Bedford, Tarrytown, and Hastings on Hudson.

**26.** New York's first baseline compliance assessment was conducted by Vermont Energy Investment Corporation (VEIC). *New York Energy Code Compliance Study.* January 2012. http://www.nyserda.ny.gov/-/media/Files/Publications/Research/Energy-Efficiency-Services/VEIC-Statewide-Compliance-Study-Report.pdf code enforcement resources vary by locality. To realize the full potential of efficiency benefits of the Energy Code, enhanced State partnership with local government is essential. Comprehensive training and direct support for code enforcement personnel, design professionals, builders and others, targeting all stages of construction projects,[27] as well as the use of "third party" energy specialists in the design, testing, and inspection stages will be instrumental in achieving the ARRA compliance goal. [28]

Increasing the energy performance of buildings in New York includes the adoption and enforcement of advancing Energy Codes as well as promotion of above-minimum codes and guidelines applicable to buildings, sites, and neighborhoods.

## Appliance and Equipment Standards

New York has an important role in shaping federal appliance and equipment efficiency standards, primarily through participating in the federal rule-making process and through market transformation programs that raise the market penetration for higher efficiency products, paving the way for future standards. States are critical stakeholders in ensuring that federal standards reflect regional and state needs, and key participants in helping prepare the market for future changes. With the breadth of appliances and equipment covered by federal energy efficiency standards, the potential to shape them provides more significant energy savings opportunity when compared to establishing state standards.

Under State Energy Law, New York has the authority to develop efficiency standards for 19 product categories. Since thirteen products are pre-empted by federal standards, the State can realize additional energy savings by pursuing energy efficiency standards for the remaining

**27.** NYSERDA trained an estimated 17,000 code enforcement officials, architects, engineers, and builders.
**28.** The specialists will be involved with implementation of some of the most significant 2014 Energy Code updates, including mandatory blower door testing used to confirm the air tightness of new residential construction.

six products.[29] These activities often spur the development of federal standards efforts as manufacturers become concerned about the impact of overlaying the various State standards with the national or international markets for their products. However, given rapid technological innovation and market advancements for certain products like consumer electronics, it can be a challenge to establish meaningful energy efficiency standards and adopt regulations before product innovation occurs.[30]

With continued education, timely adoption of code updates, and robust enforcement, the State's Energy Code and equipment and appliance standards can increasingly contribute to the State's energy efficiency portfolio and net-zero energy building goals.

**29.** The federal standards are captured in 42 U.S.C. 6291-6317 and in 10 C.F.R. 430-431. Per Article 16 of the State Energy Law, the six remaining products not pre-empted for New York are: consumer audio and video products (defined as televisions, VCRs, digital TV adapters, DVD players, and portable rack systems); portable light fixtures; bottle-type water dispensers; commercial hot food holding cabinets; portable electric spas; and residential pool pumps. NYSERDA and DOS are working to adopt regulations for these products, but the State has focused on harvesting the greater savings opportunities available through improving Energy Code compliance, given ARRA code compliance requirements, and the acceleration of Energy Code updates. In addition, industry compliance with California's higher stringency consumer audio and video product standards has offset the need for New York to adopt standards for these products.

**30.** The specificity of the Energy Law precludes DOS from promulgating standards, with NYSERDA's assistance, for recent consumer electronic product innovations, such as digital video recorders (DVRs), Blu-ray players, video gaming consoles, and tablets, which are responsible for an increasing amount of end-use energy demand. In comparison, California Public Resources Code provides agencies the authority to identify and promulgate new appliance and equipment standards as technological innovation and market advancements occur. *California Public Resources Code, Section 25402*. http://law.onecle.com/california/public-resources/25402.html

# Potential for Additional Energy Savings

## Draft Energy Efficiency and Renewable Resources Potential Study

A study assessing the economic and achievable potential of energy efficiency over the next 10 and 20 years has been initiated as part of the 2013 State Energy Plan process. The Draft Energy Efficiency and Renewable Resource Potential in New York (Potential Study) quantitatively estimates the magnitude of cost-effective energy efficiency opportunities for electricity, natural gas and petroleum products, including distillate and residual fuel oil, propane, and kerosene, for New York's residential, commercial and industrial customers.[31] The Potential Study evaluates the opportunities for end-use energy efficiency technologies in the context of natural gas commodity prices that are projected to remain relatively low for the foreseeable future due to expanded supplies and improved recovery technologies. Natural gas commodity prices have a significant impact on both the price of natural gas used on-site by customers for such uses as space heating, and the price of electricity that is centrally generated but delivered by wires for use by individual customers.

Economic efficiency potential includes all cost-effective efficiency potential, based on a simple comparison of the present value of costs and benefits over the expected lifetime of the equipment. Economic efficiency potential provides a theoretical outer boundary for the amount of energy efficiency that is possible, given that it does not take into account the availability of capital; willingness of customers to spend, borrow, or take on risk; nor does it consider market barriers related to technical knowledge, awareness, or capabilities at any level of the supply chain. Economic efficiency does, however, recognize constraints due to availability of resources such as implementation contractors and

**31.** Optimal Energy, Inc. *Draft Energy Efficiency and Renewable Resource Potential in New York State.* 2013.

efficiency equipment. In general, the resource constraints result in a ramping up of the installation rate of efficiency measures over the first 10 to 15 years of the study.

Achievable efficiency potential is the subset of economic efficiency potential (based on a total resource cost perspective) that is estimated to be realistically achievable through a well-designed portfolio of effectively administered efficiency programs that encourage participation by a combination of innovative financing, incentives, information, and technical assistance. Further, achievable potential takes into account various market and social barriers to efficiency adoption, reasonable penetration rates of adoption, and the costs associated with program administration, including monitoring and evaluation of programs to measure and validate the savings.

As summarized in Table 20 (A-C), results of the Potential Study indicate that, even with the impacts of relatively low natural gas commodity prices, there are extensive opportunities for increased energy efficiency in New York that are both cost-effective and achievable, encompassing all customer sectors and energy types.[32] The Potential Study estimates that by 2030, based on achievable potential, electricity use could be reduced by 40,500 GWh, or 20 percent below the forecast.[33] The Potential Study also estimates that, by 2030, based on achievable potential, natural gas use and petroleum use could be reduced by 12 percent and 20 percent, respectively, from forecasted levels of use.

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**32.** Relatively low natural gas commodity prices reduce the price to consumers for both on-site natural gas use and electricity, thereby providing substantial energy bill benefits across all customer sectors. However, lower natural gas commodity prices also have the effect of extending the payback period of energy efficiency investments due to the lower level of potential dollar savings from these improvements.

**33.** The electricity forecast used as the starting point for the Potential Study includes the GWh that are expected to be reduced by the existing EEPS programs. This means that of the 40,500 GWh energy efficiency potential estimated for 2030, it is expected that 17,013 GWh would be achieved by EEPS programs that have already been initiated.

**Table 20A | Summary of Potential Electric Savings Relative to Forecast**

| ELECTRICITY | 2020 | 2030 |
|---|---|---|
| **Forecast (GWh)** | 182,406 | 202,397 |
| **Economic Energy Efficiency Potential (GWh)** | 64,125 | 86,604 |
| Percent of Forecast | 35% | 43% |
| **Savings Expected from EEPS (GWh)** | 11,230 | 17,013 |
| Percent of Forecast | 6% | 8% |
| **Achievable Potential (GWh)** | 22,960 | 40,500 |
| Percent of Forecast | 13% | 20% |

**Table 20B | Summary of Potential Natural Gas Savings Relative to Forecast**

| NATURAL GAS | 2020 | 2030 |
|---|---|---|
| **Forecast (TBtu)** | 896 | 960 |
| **Economic Energy Efficiency Potential (TBtu)** | 171 | 297 |
| Percent of Forecast | 19% | 31% |
| **Achievable Potential (TBtu)** | 50 | 112 |
| Percent of Forecast | 6% | 12% |

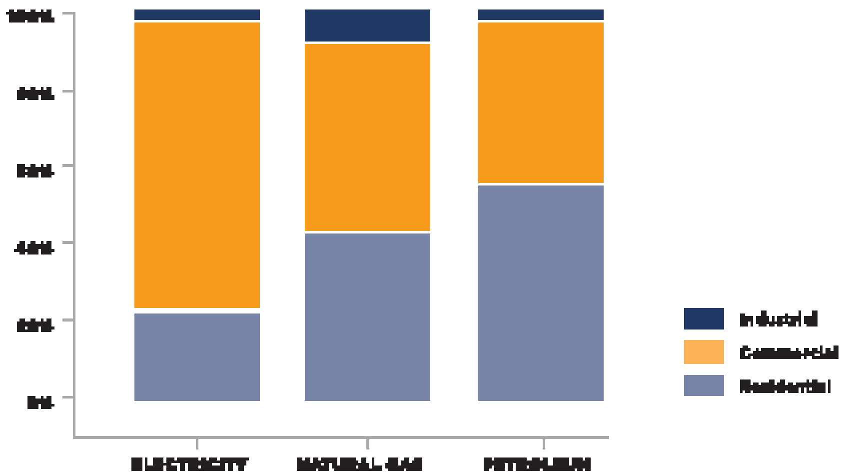
**Table 20C | Summary of Potential Petroleum Savings Relative to Forecast**

| PETROLEUM | 2020 | 2030 |
|---|---|---|
| **Forecast (TBtu)** | 257 | 218 |
| **Economic Energy Efficiency Potential (TBtu)** | 65 | 123 |
| Percent of Forecast | 25% | 57% |
| **Achievable Potential (TBtu)** | 19 | 43 |
| Percent of Forecast | 7% | 20% |

Note: The electricity forecast used as the starting point for the Potential Study includes the GWh that are expected to be reduced by the existing EEPS program.

Source: Optimal Energy, Inc. *Draft Energy Efficiency and Renewable Resource Potential in New York State*. 2013.

**Figure 3 | Proportion of Achievable Energy Efficiency Potential for Each Fuel Type Disaggregated by Customer Sector**



Source: Optimal Energy, Inc. *Draft Energy Efficiency and Renewable Resource Potential in New York State*. 2013.

Figure 3 shows the proportion of achievable energy efficiency potential for each fuel type disaggregated by customer sector. For electricity, the largest proportion of the achievable potential is inthe commercial sector (75 percent). The achievable potential for the residential and industrial sectors is 23 percent and two percent, respectively.

For natural gas, the largest proportion of the achievable potential is also in the commercial sector (49 percent). The achievable potential for the residential and industrial sectors is 44 percent and seven percent, respectively.

For petroleum, the largest proportion of the achievable potential is in the residential sector (57 percent). The achievable potential for the commercial and industrial sectors is 41 percent and two percent, respectively.

## Realizing Potential Energy Savings

Achieving a substantial proportion of the economic energy efficiency potential that the Potential Study has identified will necessitate approaching program planning with a broad perspective on the potential energy savings for customers for their entire building, facility, or home across all energy and fuel types. Further, program approaches are needed that evaluate benefits and costs of potential actions in terms of impacts on customers' total energy bills and New York's energy system as an integrated and aggregated whole.

New York is committed to achieving high levels of energy efficiency with its '15 by 15' clean energy goal, which will require the cooperative efforts of many entities, including State agencies and authorities, energy utilities, and municipalities, through ratepayer and statutory programs and policies. Developing a whole building focus will further move the market towards net-zero energy buildings, which are increasingly critical to advance the State's long-term energy and climate policy goals. A whole building focus considers the interactive effects of building components, such as lighting, appliances, and heating and cooling systems, and reviews the building as one integrated whole system, which can enhance the efficiency and comfort of the entire building.[34] Whole building approach programs can be evaluated based on their ability to provide energy and bill savings to customers' total energy use, including electricity, natural gas, and petroleum products. For example, adding insulation to a building along with proper air sealing could not only reduce a building's consumption of natural gas or petroleum products for heating and electricity for cooling, it could provide additional savings to a customer by enabling a smaller sized efficient heating or cooling unit to be installed.

The key to continued effectiveness of the State's clean energy policies is a comprehensive portfolio of energy efficiency programs that encompasses residential, commercial, and industrial customers; supports near term and long term investments; and facilitates improvement at all levels of market participation from end users and retailers to manufacturers, designers, and the building trades. A portfolio that incorporates resource acquisition, market transformation, and enhanced Energy Code approaches, coupled with innovative financing programs,

**34.** This is in contrast with a one-for-one replacement of an old technology with a new technology.

behavioral economic strategies, and community outreach and education programs, will help to propel New York into an expanded leadership role in national energy efficiency policy and strategy. Codes set the base for energy performance levels, market transformation and resource acquisition programs, coupled with financing mechanisms, encourage investments in efficiency significantly above codes, and as technologies advance and the market develops, codes and standards can then be enhanced. For example, the State can implement whole building approaches to efficiency that enhance and continually strengthen the Energy Code along with market transformation and resource acquisition strategies and financing mechanisms to catalyze sustained marketplace adoption.

The State can continue to develop a unified approach to measurement and verification of energy savings, facilitating increased implementation of energy efficiency projects. This builds upon the work of the Evaluation Advisory Group (EAG) and Implementation Advisory Group (IAG), established respectively by the PSC in 2008 and 2010, to develop comprehensive, consistent, and reliable evaluation and reporting standards and protocols as well as coordinated and collaborative implementation strategies for EEPS.[35]

## Customer Accessibility to Information

The ability to deploy the State's current energy efficiency resources is highly dependent on customers' access to energy-related information. Energy customers, including building owners, tenants, and managers, need information about current technologies and energy they use, as well as knowledge about improved systems, products, and practices to help them finance these technologies. Energy information enables informed decisions that provide powerful incentives for designers, installers, manufacturers and sellers to supply products and services that meet consumers' expectations for performance and efficiency. Opportunities to improve the design and delivery of information include optimizing use

**35.** The EAG develops "transparent and technically sound methods for measurement and verification of net energy savings, benefits, and costs, as well as assessment of customer satisfaction and program efficacy" for EEPS. PSC. EEPS Evaluation. February 28, 2012. http://www.dps.ny.gov/EEPS_Evaluation.html. PSC. *Order Combining Incentive Targets, Clarifying Incentive Mechanism Details And Establishing Implementation Advisory Group*. December 2010.

of mass media, the Internet, social media, and community-based organizations.

Consumers can benefit from independent, objective information about their current consumption patterns and information about their options for reducing their energy costs. Energy information enables informed decisions that also provide powerful incentives for designers, installers, manufacturers, and sellers to supply products and services that meet consumers' expectations for performance and efficiency. Opportunities to improve the design and delivery of information include optimizing use of mass media, the Internet, social media, and community-based organizations. Energy benchmarking compares a building's consumption to buildings of similar size and creates a baseline of energy use against which future efficiency investments can be measured, increasing the ability of building owners, operators, managers, tenants, and prospective purchasers to implement energy efficiency upgrades.[36] Advanced metering capable of two-way communication can also provide residential and commercial customers with information on their current energy consumption. Real-time electricity prices, consumption, and tariff information could be made available to ratepayers from load-serving entities. Energy cost information provided in a machine-readable format can aid in the automated control of building loads as customers seek to minimize their costs.

Access to energy information is a core component in marketing and outreach behavioral economic strategies, which can stimulate lasting consumer demand for energy efficiency. For instance, market transformation approaches can involve retailers who sell products that consume energy; if the retailer can realize the advantage of stocking and selling the more energy-efficient option to its customers through informative product displays, that retailer will be more inclined to stock and sell more of that product, as well as adopt the same approach for other energy-efficient products. Embedding behavioral science and economics in energy program design can attract wider adoption of clean energy policies and social benefits.

**36.** An example of a leading energy benchmarking practice is New York City's Local Law 84, which requires annual benchmarking of energy use in buildings more than 50,000 square feet.

## Investing in Energy Efficiency

While investments in energy efficiency have been proven to reduce energy consumption and associated bills for owners of New York's various building stock, the upfront cost of energy efficiency improvements can often prevent or delay investment by consumers and building owners. The State is using multiple approaches to help address the lack of access to capital to fund energy efficiency investments, one of the barriers to adoption of cost-effective energy efficiency measures.

As a part of the Governor Cuomo's effort to improve energy efficiency in the State, the $1 billion New York Green Bank was introduced as the financial engine that will mobilize private investment to build a more cost-effective, resilient and clean energy system in New York. The Green Bank will partner with private sector lenders to accelerate the deployment of clean energy by providing financial products, such as credit enhancement, loan loss reserves and loan bundling, to support securitization and build secondary markets. These products will support economically viable clean energy projects that cannot currently access financing due to market barriers, such as federal policy uncertainty, insufficient performance data, and the lack of publicly traded capital markets for clean energy. Preliminary models suggest that over a five-year period, the Green Bank can at least double the amount of private capital available to grow clean energy markets; and over a 20-year period, it has the potential to deliver nearly ten times more private capital into the current system.[37] In September 2013, NYSERDA filed a petition to use approximately $165 million in uncommitted funds for the Green Bank's initial capitalization. Once approved by the PSC, this funding will permit the Green Bank to leverage private sector financing for clean energy projects that create jobs and help make New York's communities more sustainable.[38]

In 2012, New York was one of the first states in the nation to offer on-bill recovery financing that allows homeowners, small businesses, not-for-profits, and multi-family building owners to pay for efficiency upgrades for their homes and buildings through the savings in their

**37.** *Governor Cuomo Launches New York Green Bank Initiative to Transform the State's Clean Energy Economy*. September 2013. http://www.governor.ny.gov/press/09102013-green-bank-initiative
**38.** NYSERDA. *Petition to Provide Initial Capitalization for the New York Green Bank*. September 2013. http://www.governor.ny.gov/NYGreenBank

monthly utility bill.[39] The GJGNY program can also help address the upfront costs of energy efficiency by providing free or reduced cost audits and low-interest financing for qualified energy efficiency upgrades to New York's residents, not-for-profit, small business, and multi-family building owners.

Municipalities have also been provided authority to offer Property Assessed Clean Energy (PACE) loan programs backed by federal funds, allowing municipalities to provide loans to businesses and residents to make energy efficiency improvements and pay the loans back through assessments on the property where the loan was applied.[40] PACE programs would eliminate the upfront costs of energy improvements by allowing property owners to pay for improvements over 15 to 20 years through an increase in their annual property taxes. However, in July 2010, the Federal Housing Financing Agency (FHFA) issued a statement and directive to Fannie Mae, Freddie Mac and the Federal Home Loan Banks with provisions restricting the funding of mortgages associated with PACE financing for 1-to-4 family buildings due to their lien priority. In June 2012, FHFA issued a notice of proposed rule for residential PACE programs, and plans to issue its final rule in September 2013.[41] While this rule making occurs, many New York PACE programs are on hold; the Town of Babylon continues to operate a residential PACE financing program.

Energize NY Financing is a program of the Energy Improvement Corporation (EIC), a New York not-for-profit local development corporation (LDC) formed to scale the demand for energy efficiency and renewable energy upgrades in residential and commercial properties on behalf of member municipalities.[42] Member municipalities currently eligible to offer Energize NY Financing include the Town of Bedford, Town of Ossining, Village of Croton, City of Peekskill, Town of North Salem, Town of Lewisboro, and the City of White Plains. Orange County, Pound Ridge, Town of Somers, Town of Greenburgh, and the City of New Rochelle will soon be eligible members as they are currently in the process of passing local laws necessary to become municipal members.

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**39.** NYSERDA. *On-Bill Recovery Financing Program*. July 2013. http://www.nyserda.ny.gov/Statewide-Initiatives/On-Bill-Recovery-Financing-Program.aspx

**40.** Chapter 497 of the Laws of 2009.

**41.** FHFA. *FHFA Proposes Rule for PACE Programs*. June 2012. http://www.fhfa.gov/webfiles/24017/PACE61512.pdf

**42.** Energize NY. http://energizeny.org/eic

# 3 Transportation

Transportation is vital to the economic well-being of New York. It provides for the movement of people, goods and services, and is critical to the quality of life for New Yorkers. Although the transportation sector remains heavily dependent on petroleum as a source of energy, New York's uniquely diverse and extensive transportation network and variety of clean fuel options positions the State as a leader in energy-efficient transportation. New York's extensive public transportation network, particularly in the New York metropolitan region, helps establish

New York as the state with the lowest consumption of motor fuel per capita in the Nation.

New York has taken actions in the transportation sector to enhance energy efficiency. For example, New York State has improved the effectiveness and consumer value of more efficient modes of travel (both personal travel and movement of goods); supported more efficient operation of the system through improved system connectivity; and increased capacity utilization through strategies including the use of technologies to provide information on real-time conditions and travel options. This is accomplished while protecting the foundation of the system through infrastructure preservation.

The State is currently engaged in initiatives to support the use of alternative fuel and more efficient vehicles to induce a transition away from petroleum fuels and achieve motor fuel savings. A comprehensive approach to improving the energy efficiency of transportation in New York includes both availability of vehicles, travel options, and education and outreach to inform consumers of fuel efficient and alternative fueled vehicle options, car share programs, and the many behavior related decisions that play an essential role on how much and what kind of energy is being expended for transportation purposes. Partnerships at all levels of government, with industry and not-for-profits are critical to achieve more energy efficient transportation choices. The State plays an important role in supporting the infrastructure needed for a diverse mix of transportation fuels, for example, by encouraging a charging network to power electric vehicles.

This Section will describe the key energy aspects of the transportation system including local, regional and long-distance travel, freight and goods movement, as well as vehicle technology and alternative fuels, and identify where transportation investments and actions contribute to the objectives of the State Energy Plan.

## Overview of Transportation Systems and Energy Use

New York is fortunate to have one of the largest and most diversified multi-modal transportation systems in the nation. The New York State Department of Transportation (DOT) has overall responsibility for transportation policy and planning, but the State's transportation network is owned and operated by many entities including cities, towns, villages, public authorities, and private owners. In addition, planning occurs at all levels involving various entities, such as the Metropolitan Planning Organizations (MPOs). Thus achieving transportation goals and policies is a partnership effort.

New York's transportation system provides essential mobility to people and goods. Annually, the system moves:

- More than 130 billion vehicle miles of travel (resident and non-resident including commercial) on more than 114,000 centerline miles of highways and 17,400 bridges statewide owned and operated by the DOT, public authorities, cities, towns, and villages
- Approximately 2.75 billion passenger trips provided by more than 130 public transportation operators throughout the State, including the Metropolitan Transportation Authority (MTA), accounting for one out of every three public transportation riders in the nation
- More than 80 million airline passengers who travel through 460 public and private aviation facilities within the State
- Approximately 1.5 million riders each year who use Amtrak's Empire and Adirondack services, and more than 8 million rail passengers who pass through Penn Station using Amtrak's Northeast Corridor
- 68 million tons of freight that move across 4,100 largely privately operated miles of rail[1]
- More than 150 million tons of freight that pass through four port authorities (the Port Authority of New York and New Jersey, Albany Port District Commission, Port of Oswego Authority, and Ogdensburg Bridge & Port Authority), the Port of Buffalo and numerous private ports

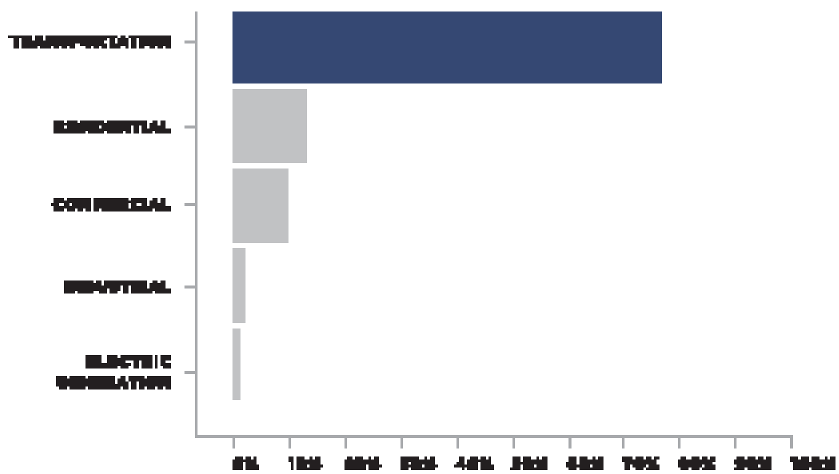
An examination of transportation energy usage, trends and associated costs illustrates that transportation is a significant consumer of energy and is heavily reliant on petroleum. However, the State continues to develop meaningful strategies to reduce the sector's reliance on petroleum use while still providing for the mobility and growth needs of the State's citizens and economy.

**1.** The State has 3,528 miles of actual track, but trackage rights, which allow shippers from one company to operate over the track of another railroad, and provide additional freight carrying capacity results in the higher figure.

## Transportation Energy Use and Costs

Data on New York's major energy consuming sectors, i.e. residential, commercial, industrial, and transportation, shows that the greatest net energy usage occurs within the transportation sector, 37.8 percent of the total energy consumed in the State in 2011.[2] Further, 94 percent of the energy used by the transportation sector is derived from petroleum fuels, and as shown in Figure 4, transportation accounted for 77 percent of all petroleum consumed in New York.

**Figure 4 | New York State Petroleum Use by Sector (2011) [216.4 Million Barrels]**



Source: NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013.

### A Comprehensive and Energy-Efficient System

Transportation is vital to New York's way of life and to its economy as evidenced by the tremendous usage of a multi-faceted transportation system. New York is the third most populated state in the nation and although significant total amounts of energy (one Trillion BTu) are needed to keep its people and economy moving, New York's transportation system, based on motor fuel consumed per capita is more energy efficient than that of any other state in the nation. This can be attributed in large part to the extensive availability and usage of public transportation in New York, particularly in the downstate area.[3]

**2.** NYSERDA. *Patterns and Trends: New York State Energy Profiles (1997–2011)*. June 2013.

**3.** U.S. DOT. *Federal Highway Administration Highway Statistics. 2010.* http://www.fhwa.dot.gov/policyinformation/statistics.cfm

The forms of travel people generally choose in New York, by order of frequency, are automobiles, walking, and transit such as buses, subways, trains, and ferries. Although the same order is reflected with travelers' choices made elsewhere in the country, in New York, walking and transit make up a much greater proportion of trips. According to the 2009 National Household Highway Travel Survey, traveling by car was chosen almost 23 percent less in New York, while the choice to walk was reported to be 12 percent more than the national average, and transit was chosen 10 percent more often. These data underpin that in New York, transit, walking, and biking play critical roles in personal mobility. Approximately two-thirds of New York residents live in and around the New York City Metropolitan area, where the non-motorized modes and transit represent a large proportion of the travel, and many households do not own cars.

For the energy efficiency of New York's transportation sector to be improved, the energy intensity of the different forms of travel (modes) should be considered. Latest available national statistics show that the car consumes the most energy per passenger mile (3,447 Btu). This is more than 50 percent higher than that of intercity rail on a per passenger mile basis (2,271 Btu). Domestic airlines on average consumed nearly 20 percent more energy per passenger mile (2,735 Btu) than the country's intercity rail.[4] While comparable national data for transit buses was not available, the energy intensity for transit buses within New York is 3,121 Btu per passenger mile.[5] If bus ridership levels were to increase, this form of transportation would become more efficient.

## Highway Travel

Highway usage and highway travel activity is typically expressed in Vehicle Miles Traveled (VMT). VMT includes all highway traffic, regardless of purpose or type. VMT can be indicative of social and economic trends.

New York's highway system is used extensively on a daily basis. In 2012, approximately 350 million vehicle miles were driven on New York roads every day, the fourth highest daily VMT (DVMT) in the nation. As illustrated in Figure 5, between 2007 and 2012, DVMT declined steadily.

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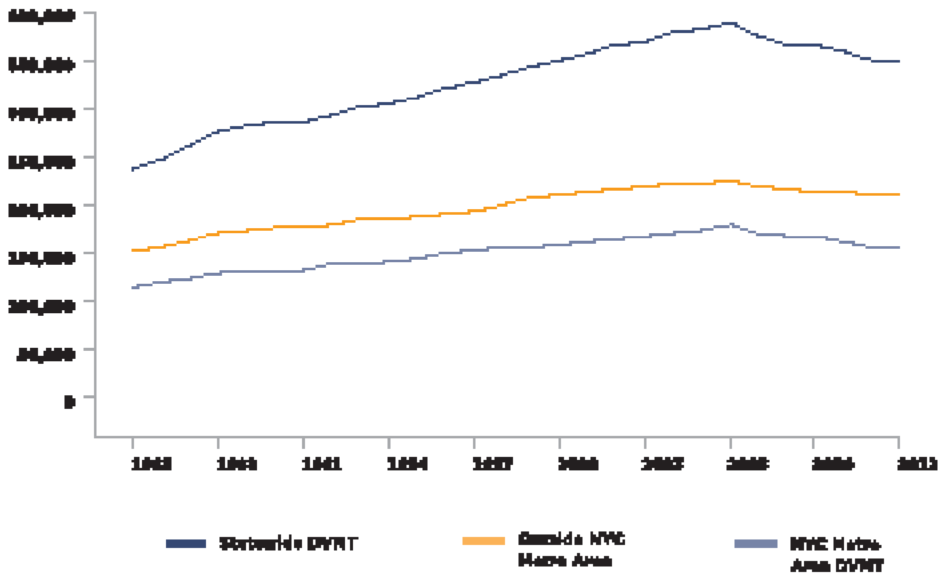
**4.** U.S. DOE. *Transportation Energy Data Book: Edition 31*. July 2012.

**5.** U.S. DOT. *Federal Transit Administration National Transit Database*. 2009. http://www.ntdprogram.gov/ntdprogram/data.htm

This was likely due, at least in part, to economic events including the recession (2007 to 2009), a higher unemployment rate, and volatile gas pricing with spikes occurring in July 2008 and May 2011.

**Figure 5 | Daily Vehicle Miles Traveled (DVMT) in New York (1985-2012)**



Source: DOT. *Highway Data Services Bureau*. 2013.

Historically, there has been a strong correlation between Gross Domestic Product (GDP) and VMT. Essentially, the production of goods and services has an associated impact on travel. It is important to recognize that VMT is not just a measure of how far and how often people and goods move, it is also a measure of the general health of the economy. The key is to make movement as energy-efficient as possible through the availability of effective energy efficient modes of travel and through the use of cleaner vehicles. Notably, over the long term, land use decisions have an impact on the availability of energy efficient travel options.

VMT data can be coupled with data such as household survey data to reveal highway travel patterns. One such categorization involves residential and non-residential travel. Residential travel includes car trips made by in-state residents for the purposes of commuting to work, shopping and other personal and work related trips. Residential VMT constitutes 70 percent of all highway travel in New York. Any strategies targeting this VMT would therefore affect the greater segment of highway travel and potentially result in greater energy efficiencies. Non-residential VMT, which includes commercial and interstate travel, such as freight and bus tourism, is more directly tied to economic activity.

According to the 2009 National Household Travel Survey, while work-related commutes make up a significant percentage of residential vehicle travel (approximately 20 percent), the largest segment of trips (just over a third) are attributable to "return home" travel, which includes a trip back to the residence from any trip purpose (thus it is not directly tied to work commutes). Considerable trips (approximately 34 percent) also are conducted for reasons such as social/recreational and personal business, and may be more discretionary and thus may present opportunities to encourage more efficient travel options and patterns. While there may be opportunities to encourage and enable more energy-efficient commercial travel, strategies should consider the importance of the highway system for commercial transport as well as the role of freight rail and other modes.

## Demographic Trends

Transportation is vital to New York's economy, connecting a workforce to jobs and goods to people. It is an essential component of all aspects of our citizens' lives allowing people and goods to get from where they are to where they want and need to be. Ensuring social equity in access and mobility is an integral element in transportation decision-making.

New York's population of 19.4 million has 11.2 million drivers. A large segment of the State's population, approximately 42 percent, does not drive, either due to age, disability, costs of driving, by choice or other reasons. For this segment of the population, transit, other services or non-motorized transportation provide needed mobility.

By age, the largest population group in New York is between 25 and 54 years old while persons between the ages of 20 and 64 make up most of the drivers. Persons 65 or older constitute 13 percent of the driving population, a significant segment. In the coming years, seniors are expected to account for a greater percentage of drivers. This trend requires consideration of the needs of seniors, in transportation planning and design, e.g. the legibility of road signs. Further, there is expected to be a greater need for transit services. The Millennials, the generation born between 1979 and 1996, and aging Baby Boomers, born between 1945 and

1964, are showing a preference to living in mixed–use, walkable cities and suburbs that are served by transit.

## Cost of Transportation to Consumers

In 2011, transportation expenses accounted for 17 percent of the average household income at the national level, exceeded only by housing (34 percent). Transportation expenses are actually larger than what is spent on food (13 percent) and education (2 percent) combined.[6] Personal transportation-related costs are made up of motor vehicles and parts, motor fuel, and transportation services, such as transit or taxis. Low-income households spend a much greater percentage of their income on transportation. According to national statistics, households in the lowest 20 percent income bracket, meaning those with an average before tax income of around $10,000 per year, spend close to 30 percent on transportation while the highest 20 percent income bracket with an average pay before taxes of more than $157,000, pay less than 10 percent.

Driving a car or having transit service provides accessibility to jobs. Approximately 70 percent of manufacturing and trade jobs – sectors employing large numbers of entry-level workers – are located in the suburbs.[7] Especially low-income inner city dwellers with entry-level job skills or entry-level workers from rural areas need transportation for access to these jobs. Although transit services in New York are available in most metropolitan areas, connections, timeliness, and availability of transit service in suburbs can make transit travel challenging for job access. New York's rural population that does not drive a car is dependent on transportation by others. Many rural areas do not have transit services that provide sufficient access to job locations. This condition is reinforced by low-density residential housing, which makes rural transit service costly to provide. Low-income households in rural areas therefore find themselves at a greater economic disadvantage, as household income is spent on supporting a car or paying for other transportation services. New York's transportation energy policy acknowledges this challenge, but recognizes that it is not feasible to provide transit services in all locations.

**6.** U.S. Bureau of Labor Statistics. *Report 1042, Consumer Expenditures in 2011*. April 2013.

**7.** U.S. DOT, Bureau of Transportation Statistics. *Welfare Reform and Access to Jobs in Boston. January* 1998.

## Effects of Petroleum Fuel Price Fluctuations

Auto-dependent households see their transportation costs increase much more when gasoline prices rise, while households using transit and alternative modes are less impacted. On average, VMT per capita in rural areas is much higher than in metropolitan areas. For example, outside of New York City, the majority of the work commute occurs by driving alone (76.6 percent). The data shows that these residents tend to have lower incomes and they are more affected by gasoline price spikes. Further, rising fuel prices increase the operating costs of transit services, resulting in either increased subsidies to support such service, increased fares, or pressure to reduce service. Rising fuel prices in general increase the cost of transporting goods, which places pressure on the price of goods and can further lower disposable income.

Nationally, gas prices have fluctuated dramatically. The average national gasoline price in January 2007 was $2.24 per gallon. During July 2008, gasoline was $4.11 per gallon. Then, prices dropped from the July 2008 peak to $1.61 by December 2008. In early May 2011, the average national gasoline price was $3.97 per gallon, and in July 2013, $3.68 per gallon.[8] These fluctuations have sensitized the public to the impact of fuel price changes.

The American Public Transportation Association (APTA) reported that public transportation ridership in the third quarter of 2008 increased by more than 6.5 percent compared with the same quarter of the previous year.[9] According to APTA, ridership levels from 2006 through 2010 were the highest since 1956. In 2011, total transit ridership was an estimated 10.3 billion, unlinked trips with bus ridership 5.2 billion, heavy rail ridership 3.6 billion, and other modes combined ridership 1.5 billion.[10]

The effects of volatile gas prices are magnified by the transportation sector's lack of alternatives to petroleum. As described above, this affects the public (whether drivers or users of public transportation), transportation providers, and various sectors of the economy, such as gas station retailers, automobile dealers, and automobile manufacturers. The State is evaluating options for a more diverse supply of fuels in

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**8.** EIA. *Weekly U.S. Regular Retail Gasoline Prices*. Gasoline and Fuel Updates. May. 2011. http://www.eia.gov//petroleum/gasdiesel

**9.** American Public Transportation Association. *Transit Ridership Report*. December 2008. http://www.apta.com/resources/statistics/Documents/Ridership/2008_q3_ridership_APTA.pdf

**10.** American Public Transportation Association. *Public Transportation Fact Book*. October 2013. http://www.apta.com/resources/statistics/Pages/transitstats.aspx the transportation sector, e.g. electric and natural gas, as well as other strategies to improve the efficiency of the transportation system, to reduce the dependency on petroleum, and mitigate the impact of future price spikes.

## Current Fiscal Conditions Impacting Funding

The State's ability to meet its diverse transportation obligations, its transportation energy efficiency goals, and its desire to transition away from a heavy reliance on petroleum is highly dependent on available financial resources. Although it is widely recognized that increased investment in transportation infrastructure is critical, in today's challenging fiscal climate, identifying the resources necessary to sustain or increase transportation investment is a major hurdle. At the federal level, the federal Highway Trust Fund, funded largely through federal gas taxes, has supported federal investment in surface transportation for more than half a century. In recent years, however, as the nation makes progress on reducing gasoline consumption, the fees flowing into the fund have not been sufficient and it has required more than $55 billion in general fund transfers and other budget offsets since 2008 to maintain current spending.

The State faces similar challenges. The revenues flowing into the State's Dedicated Highway and Bridge Trust Fund (DHBTF) are no longer sufficient to support current levels of highway and bridge investment. In 2013, the fund required more than a half billion dollars from the State General Fund to support the transportation budget.

New York's transportation infrastructure is among the nation's oldest, most heavily utilized and also subject to some of the harshest weather conditions. Consequently, infrastructure needs continue to grow. Thirty-two percent of the State and local bridges are currently deficient, meaning they need investment to return to their original design capabilities – it does not mean bridges are unsafe. The average bridge age in New York is 46 years and many bridges are reaching the end of their useful life. The State's pavement shows similar challenges. Forty percent of our highway pavements are in fair or poor condition. New York ranks 46$^{th}$ among states in terms of pavement condition. On the transit side, non-MTA transit systems have more than 1,000 buses that have exceeded their federally-rated service life, making them inefficient and expensive to maintain. Continued investment is essential to sustain and enhance system capacity to maintain the energy efficiency benefits New York derives from public transportation. Furthermore, the demands on our State's transportation infrastructure continue to rise in support of a growing economy.

While the State continues to invest in transportation, the reality of growing needs and the absence of significant new sources of revenues challenge the State to meet its energy, economic, and quality of life goals. In recognition of this reality, DOT has made significant changes in its investment strategy. The current focus is on preservation of the existing system. Under a preservation investment strategy, the emphasis is on preserving the infrastructure before it becomes deficient, that is, investing in less costly treatments while the infrastructure is in good or fair condition to maximize what can be achieved with limited resources, and to extend the overall life of the existing infrastructure.

## Transportation Efficiency Considerations

Although efficient relative to the rest of the nation, New York's transportation sector is heavily dependent on petroleum as a source of energy. To become more energy efficient, the State will promote and encourage more energy efficient travel - that is, travel where there is an opportunity to switch from a less efficient method such as a single-occupant vehicle to ridesharing or transit, or where there are opportunities to improve freight energy efficiency. The State will also focus on improving system operations, utilizing emerging technologies for better vehicle and travel information, and other actions that can entice the use of more energy efficient vehicle and alternative fuels.

Overall, the transportation system should operate as a multi-modal integrated system, enabling travelers and drivers to make informed decisions about traveling options that are cost-effective and efficient. The transportation sector should continue to diversify its fuel sources and expand its use of energy efficient technologies, not only in vehicles that operate on the system but also informational and operational technologies that make transportation usage more efficient.

In discussing these considerations, transportation options have been divided into four focus areas, each with unique influences on its energy usage:

- Personal Mobility at the Regional and Local Level: This section covers topics including public transportation, commuter rail, vehicle, pedestrian and bike travel, and operational and land use choices related to more local travel concerns
- Long-Distance Passenger Travel: This section includes options related to passenger rail, aviation and long distance vehicle travel
- Goods Movement: This section discusses current issues and opportunities related to transporting freight
- Vehicle Technology and Alternative Transportation Fuels: this section discusses the current status of alternative vehicles and technology within the sector and issues related to expansion and impact on other energy sources.

## Personal Mobility at the Regional and Local Level

Personal travel at the regional and local level describes movement between locations undertaken to conduct daily and routine activities. In New York, more than 66 percent of person trips (people moving by any form of travel) are five miles in length or shorter. These trips offer opportunities to consider walking, taking a bus or train, bicycling or other forms of transportation (modes) as available. Urban centers generally offer more mode options from which a person may choose.

Overall, transportation energy efficiencies within local/regional travel can continue to be improved by:

- Shifting travel from single-occupied vehicles to more efficient modes of travel
- Increasing roadway travel efficiencies to address congestion and delays

## Shifting from Single Car Ridership to More Efficient Modes of Travel

To entice drivers to leave their single-occupancy vehicles for more efficient modes of travel, the alternatives must be safe, convenient, cost effective, reliable, and time-competitive relative to making the same trip alone in an automobile. The out-of-pocket cost, condition, convenience and time-competitiveness of the transit system; the safety and connectivity of the pedestrian network; and the ease of accessing useful information on travel choices (such as navigating the transit system or finding a carpool match) all contribute to the viability of alternatives. There is a multitude of benefits in shifting more transportation to walking, bicycling, and public transportation including well-documented public health benefits of improved air quality and increased exercise. Options and their challenges are discussed in greater detail below.

## Increasing Roadway Travel Efficiencies – Addressing Bottlenecks

Efficient roadway travel is essential for many New Yorkers whose only option is traveling by car. The smooth functioning of the transportation system is supported by both the management of transportation demand and capacity. Some localized and recurring constrictions in traffic flow, also referred to as "bottlenecks," cannot be effectively managed by active Transportation Demand Management (TDM) measures alone and require localized capacity improvements. Unresolved bottlenecks can increase travel time, and result in higher fuel consumption and operating costs. Improvements can include well-designed turning lane additions, geometry corrections, or access management strategies. As improvements are made, consistent with the newly enacted Complete Streets Law, project design will also consider, as appropriate, modal options such as improved transit, pedestrian, Americans with Disabilities Act (ADA), and bicycle functions.

Traffic and energy consumption is also an issue during construction. The State, through Governor Cuomo's "Drivers First" initiative, is undertaking comprehensive strategies to prioritize the convenience of motorists and ensure that construction-related travel disruptions are as minimal as possible to drivers. Examples of such strategies include minimizing closures during peak travel times, coordinating with local and regional events, use of social media, and 511NY updates to drivers and travelers with real-time condition information.

## Investment in Transit

Transit includes public transportation such as subways, rail, buses, and ferries. High transit ridership levels within the densely developed New York City Metropolitan area occurs because it is safe, convenient, frequent, and service is reliable. With convenience and competitive travel times, transit is often a better option than driving. Outside of the greater New York City metropolitan area, transit ridership levels are more comparable to those of the rest of the nation. While it is not feasible to expect a comparable level of ridership in all areas of the State, knowing what considerations sway travelers to use public transportation is essential. A significant factor influencing travelers' usage is the reliability of transit service, which depends, in part, on the age and condition of the transit fleet, subway, and commuter rail assets. Older fleets are increasingly costly to maintain, and breakdowns and missed trips become more prevalent resulting in a perception that reliability of service is compromised.

Frequency of transit service and ease of connections to get to a final destination, i.e. number of transfers, are determining factors in how much additional time it will take to complete a trip by transit relative to driving. Maintaining or enhancing transit service frequency requires increasing efficiencies in service provisions and/or increases in the level of equipment and operating assistance needed to cover the expense of additional frequencies. The longer the travel time of public transit relative to automobile travel, the more challenging it is to entice use of transit by travelers who have access to a car. There are operational initiatives and practices that can improve the relative travel time of transit, such as Bus Rapid Transit and Priority Treatment Networks, which often require significant upfront investment. Ongoing capital and operating assistance is required to maintain and increase service frequency. For service to be viable, sufficient population densities are necessary to provide a stable client base.

## Pedestrian Network

Walking is used for a significant percentage of travel, approximately 22 percent, statewide. Coincidentally, approximately 22 percent of vehicle trips are one mile in length or shorter. Walking is among the critical mode choices for the 41 percent of New York's residents who do not drive for reasons such as age, by choice, the high cost of driving, license restriction, or disability. Non-drivers rely on non-motorized or public transportation or must be driven by someone else. The frequency of short trips taken in cars suggests an opportunity to enhance pedestrian networks in order to shift short travel movements to non-motorized, more efficient transportation modes such as walking. However, land use context and densities must be appropriate.

Several current policies support pedestrian linkages to transit and local land use. Among these is the recently adopted New York State Complete Streets Law. As 90 percent of the non-highway roadways in New York State are under local jurisdiction, most decisions regarding pedestrian infrastructure such as sidewalks and pedestrian crossings are made at the local level. Municipalities need to consider land use and zoning regulations that support sidewalk installation where population density thresholds can support their use.

## Bicycle Network

Providing safe on-road bicycle accommodations, connected where possible to trail networks, linking to local development and the public transit network of buses and trains, can help increase the share of the travel market using bicycle transportation. New York's transit carriers have made a significant commitment to equipping their bus fleets and train stations with bike racks.

Where there is convenient access to public transit for bicycles, usage can increase dramatically. Bicyclists travel four times faster than pedestrians, and convenient access by bicycle can increase the geographic catchment area served by a transit station 16-fold.[11] Recently, several cities have introduced Bikeshare programs including Buffalo, New York City, and Ithaca. New York also has approximately 3,000 miles of signed bike routes plus approximately 5,000 miles of trails and byways, many of which can be used by bicycle riders.

Effective bicycle use is highly location specific depending on many variables including connectivity, safe and operationally effective lanes and street crossings, adequate lane width, wide curb lanes, shared use paths, bicycle network friendliness, roadway congestion, trip length, density of population, and employment as well as income and transit quality of service. Bike lane and shared use pathways when linked with popular origins and destinations result in higher levels of cycling use.

**11.** Rails to Trails Conservancy. *Active Transportation for America: The Case for Increasing Federal Investments in Bicycling and Walking*. October 2010. http://www.railstotrails.org/resources/documents/whatwedo/atfa/ATFA_20081020.pdf

## Improve the Network Connectivity Among Modes

Effectively improving network connectivity among modes is enhanced by viewing and managing transportation as a network of options to get from point A to point B. Transportation funding categories and mode specific organizational missions create challenges, as each modal organization tends to focus on its direct needs, assets, and issues.

Improved connectivity makes public transportation more accessible. Networks of lighter modes, such as BRT or streetcars, can provide easier access to heavy rail-based commuter rail networks, such as MTA Long Island Railroad and MTA Metro-North Railroad. Many suburban stations are constrained not by capacity on the trains but by capacity in the parking lot. Multi-tier parking structures, though expensive, can increase usage. Lighter transportation modes coordinated with train arrivals and departures can be an effective means of making public transportation more accessible. Greater access to public transportation encourages usage which, in turn, can alleviate congestion on surrounding roadways.

## Informed Drivers and Travelers

To facilitate energy-efficient travel decisions, clear and easy to access travel information is needed. 511NY is a free comprehensive traveler information system provided by the DOT that provides users with a variety of transportation information including real-time traffic and travel conditions on the roadways, transit, rideshare options, and incident information. With the rapid growth in smart phone and mobile technologies and the increasing availability of open data, the private sector has entered this arena, presenting public travel information through a variety of attractive consumer applications, including mobile “apps.”

## Active Transportation Demand Management

DOT has supported Transportation Demand Management (TDM) programs in the New York Metropolitan region since the early 1990s to promote ridesharing, vanpooling, transit use, bicycle/pedestrian, and telecommuting with the dual objectives of air quality improvement and congestion mitigation. TDM measures alleviate traffic problems through improved management of vehicle trips, such as by providing real-time traffic information and allowing more predictive operational decisions.

In less densely populated suburban regions, the economical provision of transit service is more difficult due to the dispersed origins of travelers. The provision of park-and-ride lots can encourage travelers from multiple origins to share rides or access transit services. DOT, and many of New

York's transit operators, have established and invested in networks of park-and-ride facilities to provide effective access to transit in suburban and rural areas.

Other TDM measures include emerging back-up options for those who choose to travel by alternative mode such as carpool, rideshare, or vanpool. These back-up options provide critical linkages where and when an alternative mode or public transportation is not available. Guaranteed ride-home programs allow registered participants to get a limited number of emergency rides per year if they need to leave work to attend to an emergency matter.

### Human Service Transportation Coordination

There are growing personal mobility needs among aging, disabled, and various population segments currently served by a diverse array of multi-agency services such as the Office of Aging, Transit Agency's Para-transit, and others. Coordination of overlapping services and fleets is a long-standing effort aimed at achieving fiscal economies and improved service quality. The objectives of this coordination support more energy-efficient transportation, providing more efficient transportation for the many routine trips for non-emergency medical purposes, job access and training, and others made every day. This is particularly important in the rural areas of the State, where populations without access to an automobile rely on these services. These vital services do not just provide basic transportation needs, but enable persons to remain engaged in their communities and the broader economy.

## Long-Distance Passenger Travel

Long-distance travel occurs on a variety of modes, including personal vehicle, intercity bus, intercity passenger rail, and aviation. The State is pursuing several strategies to make long distance travel more energy efficient:

- Maintain "state of good repair" on the highway network to ensure efficient vehicle operations
- Improve connectivity and access between modes of travel
- Provide accurate, multi-modal, and real-time travel information to maximize opportunities for multi-modal travel and efficiency
- Improve frequency, speed, and reliability of intercity rail passenger service and intercity buses to encourage alternatives to driving

- Engage State, local, and federal partners and take advantage of mutual goals for energy and system efficiency, supporting aviation and broader multi-modal strategies
- Encourage development and use of energy-efficient vehicles and fuels

A long distance trip is generally defined as one of 50 miles or more from home to the farthest destination traveled. Three-quarters of long distance travel in New York is completed via personal vehicles, typically for trips shorter than 500 miles. Air travel accounted for 18 percent of long-distance trips, typically for trips longer than 1,000 miles, 2.5 percent used train and 1.4 percent used intercity bus services. Nearly 40 million visitors traveled long distance to New York State.

As these statistics indicate, the backbone of the transportation system that will serve these long-distance travelers is the State's system of roads and bridges. The State's overall transportation investment strategy focuses on safety and "preservation first" – placing priority on investments that will keep the existing system in a "state of good repair." This strategy is intended to both maximize system life, and support overall energy efficiency goals by providing better overall travel conditions. In addition to preservation, it will be important to make strategic investments that provide intermodal connections, and support an efficient, balanced, multi-modal network.

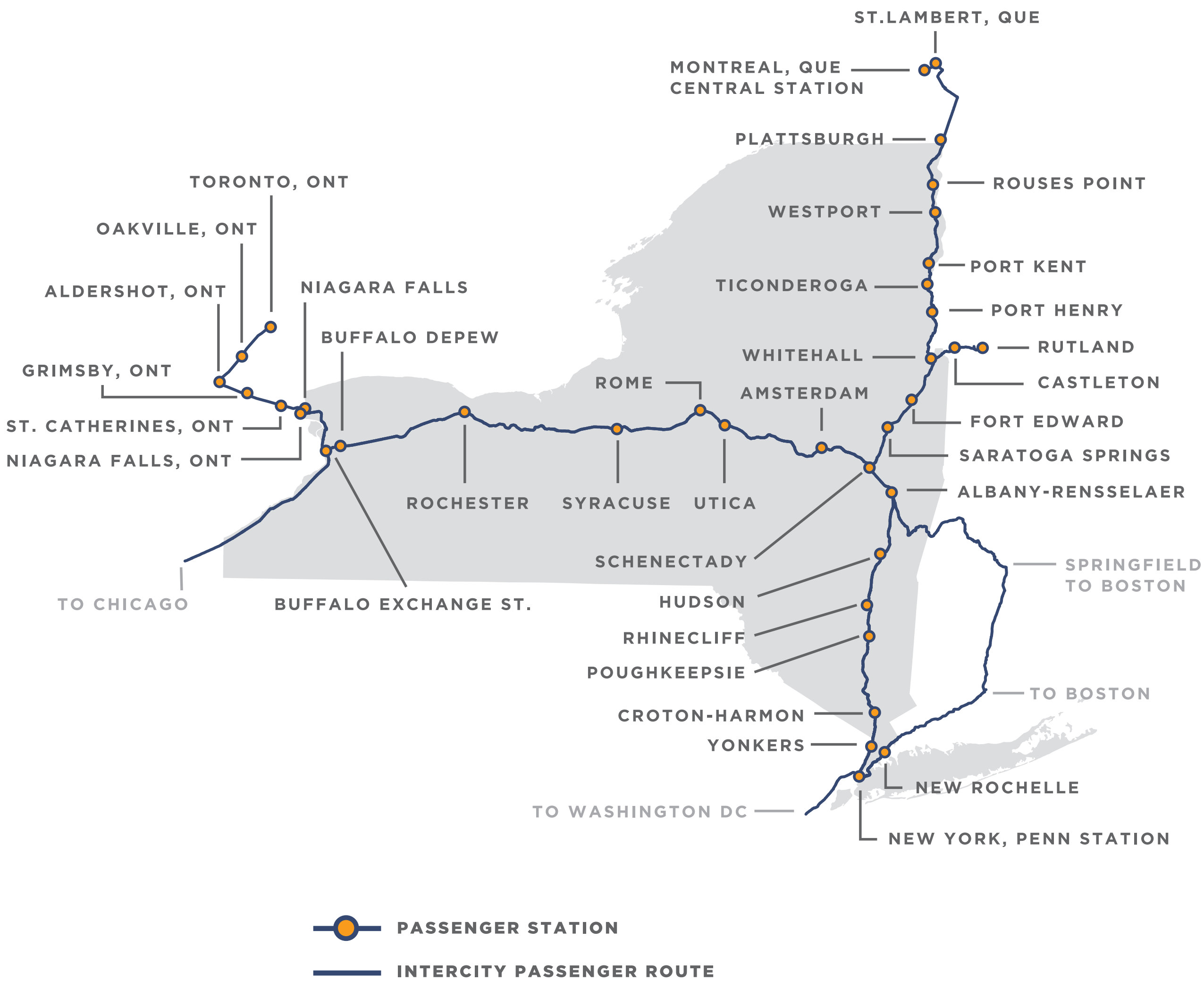
While infrastructure condition is important, system information is also critical. Access to accurate multi-modal information allows long-distance travelers to better plan trips, use all available transportation modes, and potentially avoid problem areas affected or closed due to construction, special events, accidents, or weather-related events. While travel on the roads accounts for the largest share of long-distance travel, information, as well as multi-modal strategies and investments, are also essential to support alternative, less energy intensive travel.

## Intercity Passenger Rail

New York has one of the largest and most diversified rail systems in the nation. The system carries both passenger and freight over more than 4,100 miles of operated rail, providing energy-efficient mobility for passengers and contributing to the economic vitality of the State and the nation. As shown in the map in Figure 6 below, intercity passenger rail service in the State is provided between New York City and Niagara Falls (Empire Service), and between, Albany and Plattsburgh (Adirondack Service). Service in New York includes connections east to Boston and

Rutland, VT, and west to Chicago, and two international crossings, serving Toronto and Montreal. In addition, New York City at Penn Station is a critical connection to the Northeast Corridor (NEC) which connects New York City with Washington DC, Boston and other major Northeast cities. Additional ridership growth in the NEC is constrained by capacity – both infrastructure and rolling stock.

**Figure 6 | New York State Passenger Rail Map (Amtrak)**




Source: DOT.

Intercity passenger rail travel in the State is significant. Penn Station in New York City is the nation's busiest rail station, serving nearly 400,000 passengers daily, and serving approximately 8.4 million Amtrak passengers annually. Total New York Amtrak station usage for FFY 2011 was up 7 percent from the previous year, and all corridor services set records for ridership. In FFY 2011, nearly three quarters of all trips on the

Empire Corridor either started or ended at Penn Station.[12] There are a number of factors that drive mode choice and favor rail in this market:

- Ease of Use – Utilizing rail helps avoid congested auto travel in the New York City Metropolitan area
- Connectivity – At Penn Station, travelers can connect with the NEC service, New Jersey Transit and Long Island Railroad (LIRR) Commuter trains, the New York City Subway System, buses, and taxis, and the many destinations that are within walking distance

Building on the inherent benefits of rail within the State and through its connecting service, the State continues to pursue rail investment. Improving frequency, reliability, and on-time-performance will make travel times more competitive with automobiles and airplanes and increase ridership. Investments are also being made to revitalize stations to improve comfort and access.

New York is engaged in efforts within all of its rail corridors. To continue the development of world-class service along the NEC, Amtrak, FRA, NEC states, and connecting States are working to improve service on the corridor by increasing speeds (up to 160 mph) and expanding capacity (both infrastructure and rolling stock). Further, New York State is making key investments in infrastructure improvements that will support development of NEC service. For example, in Midtown Manhattan, New York is leading the transformation of the historic Farley Post Office Building into Moynihan Station, across the street from today's Penn Station. When completed, the project will provide upgraded passenger facilities for Amtrak's NEC and Empire Corridor passengers and improve circulation and amenities for the commuter rail services sharing the station.[13]

Within the Empire Corridor, New York is completing an Environmental Impact Study (EIS) and plans to upgrade its rail system by providing residents, businesses, and travelers with high-speed passenger

**12.** This includes all five service routes heading north from Penn Station: New York Penn to Albany Empire Service, New York to Niagara Falls and Toronto on the Maple Leaf Service, New York Penn to Montreal on the Adirondack Service, New York Penn to Rutland via the Ethan Allen Service, and New York Penn to Chicago via Lake Shore Limited Service.

**13.** The project is advancing in phases with a 2012 construction start for an initial phase that will add more vertical circulation for the station platforms that extend under the Farley Building, enhance sidewalk and station access, and improve ventilation.

rail. Travelers and businesses will be attracted by fast, frequent, reliable, and comfortable passenger rail service. The investments will also improve on-time-performance and reliability, making service along the 463-mile rail corridor between New York City and Niagara Falls more competitive and attractive.

The State is also actively engaged in pursuing changes that will reduce the trip time and increase reliability on the State's Adirondack service to Montreal. One of the key challenges for this service is reliable border crossing processing times. The "Beyond the Border" action plan between the U.S. and Canada calls for a framework for preclearance in the land, rail, and marine modes. Preclearance authority would open up options to significantly improve the Adirondack service. Construction of a new facility at Montreal's Central Station and preclearance authority would reduce trip times by at least an hour in each direction on New York's State's Adirondack service.

## Aviation

The aviation system in New York includes both public and private use airports and other aviation facilities. As of 2010, there were approximately 460 aviation facilities in the State. The system has approximately 135 public-use airports, which include 18 commercial service airports and five heliports. The remaining airports are private-use airports. Public-use airports can be town, county, or privately owned; private-use airports can be owned by private individuals/entities or corporations. The State of New York owns two airports: Stewart International, in Newburgh (leased to and operated by the Port Authority of New York and New Jersey), and Republic Airport in Long Island.

Air travel demand continues to show growth. However, passengers at busy airports such as JFK International and LaGuardia are experiencing significant delays. Delays and congestion waste fuel and cause excessive emissions. Delays also affect the State's and nation's economic competitiveness and quality of life. Technology upgrades and capacity improvement plans are needed to manage congestion.

In response to these needs, Congress established the Joint Planning and Development Office (JPDO) to plan and coordinate the development of the Next Generation Air Transportation System (NextGen). Implementation is expected to take place across the U.S. between 2012 and 2025. NextGen will use satellite-based technologies instead of less efficient ground-based radar systems to determine the most efficient routes, save energy, and ease congestion. NextGen technologies will help safely accommodate increased levels of commercial, military, and general aviation travel. The State is working with the federal government and other stakeholders to continue timely and efficient implementation of the NextGen system.

There are opportunities to explore strategies, engage State, local, and federal partners, and take advantage of mutual goals for energy and system efficiency. Current efforts include:

- Extending transit services to airports where demand exists to reduce automobile travel
- Identifying opportunities to improve access to airports to reduce congestion when undertaking highway projects near airports. The State is coordinating with localities and Metropolitan Planning Organizations (MPOs) to look for those opportunities.
- For the private sector, airlines and aircraft manufacturers continue to test the feasibility of using biofuels to power jet engines

## Intercity Bus

While intercity bus ridership accounts for a relatively small percentage of long-distance travel (approximately 1.4 percent in 2001), this bus service provides an important intercity transportation option for more than two million intercity bus travelers in the State, especially those without access to an automobile. Intercity bus service can be a lifeline to the many smaller communities without access to intercity passenger rail service.

The State provides support to intercity bus carriers through the State Operating Assistance (STOA) Program. In 2012, New York provided almost $19 million in State and federal support for primarily rural intercity bus service provided by nine companies, from large operators such as Adirondack Trailways to small operators such as Blue Bird Coach Lines/Coach USA in Western New York. Greyhound, Megabus, and other regional carriers that provide urban-to-urban services do not participate in DOT's Intercity Bus Program. Subsidized intercity services include 120 routes throughout the State that total 11.2 million miles and carry 2.6 million passengers annually, an increase of 2 percent over the previous year.[14] Continued investments in STOA, which provides support to approximately 130 public transportation providers throughout the State will be of critical importance to the State's transportation energy goals.

**14.** These statistics include miles and routes operated and passengers carried by other carriers (intercity and charter/tour) in New York State.

DOT holds regional round-table meetings with rural and intercity bus operators to better coordinate services and discuss marketing and maintenance improvements. Preserving rural intercity service is a continuing priority for DOT. DOT also reviews services and works with operators to adjust services as needed, to expand or contract frequency, and improve modal connections throughout the local transit and intercity networks. Intercity buses are efficient. One bus has the potential to remove 55 cars from the highway. Figure 7 below provides information on where intercity bus services are supported by State and federal programs.

**Figure 7 | New York State Intercity Bus Service [Supported by State and Federal Funds]**


Source: DOT.

## Energy-Efficient Goods Movement (Freight)

The demands on the State's infrastructure will grow as a result of the increase in freight movement from the globalization of the economy. According to the 2007 Commodity Flow Survey, more than 335 million tons of goods valued at nearly $550 billion were transported to, from or within New York. Longer-term forecasts indicate tremendous future growth in freight shipments. The Federal Highway Administration (FHWA) forecasts that freight tonnage will nearly double from 2002 figures by 2035. According to this forecast, trucks will see a 98 percent increase in freight tonnage, while freight rail tonnage is expected to grow by 88 percent by 2035.

This section outlines the freight transportation issues as they relate to energy efficiency, and discusses energy-related goods movement initiatives to support growing the State's economy.

### Freight Highway Movements: Trucking

Nationally, trucks carry approximately 80 percent of all U.S. goods. Further, while long-distance movement may be undertaken in other modes, movements are typically completed by truck to reach their final destination, the "last mile" (and in many cases the "first mile"). In New York, more than 90 percent of the ton-miles are handled by trucks, while approximately 70 percent of the value of goods is shipped via truck-only movement. Goods movement will continue to be dominated by trucks, although rising and fluctuating costs of fuel are expected to make long-haul trucking and other types of freight movement significantly more expensive and possibly force the redesign of some sourcing, supply chain, and distribution center strategies. How goods are transported is largely a function of economics and private market decisions, as private businesses make decisions to maximize their ability to remain competitive. The overall cost of transportation will be a critical factor facing shippers and receivers. Energy is one factor. Travel time, reliability of the system, and the overall regulatory environment will also affect costs. Public sector strategies that improve the condition and reliability of the system affect the cost of shipping. Similarly, regulations such as truck size and weight restrictions, hours of service, and safety compliance issues for carriers impact productivity. Operating costs, such as overall fuel efficiency requirements, will have an impact on the overall economic outlook for trucking.

Efficient freight movement is supported by several highway system efficiency and reliability approaches:

- Infrastructure investment to support "state of good repair" of the roadways and bridges
- Strategic investments to reduce bottlenecks and congestion
- Review and development of strategies that encourage more efficient use of the existing system, such as pricing policies, managed use lanes, and incentives for off-peak deliveries
- Continued development of travel information addressing the specific needs of the trucking industry
- Continued development and deployment of emerging commercial vehicle technologies that will improve industry productivity and improve fuel efficiency. For example, real-time information on traffic and equipment conditions can provide better routing information and indicate equipment deficiencies sooner. Such technologies can also provide weather and bridge clearance information – reducing accidents and improving system efficiency.

## Rail Freight

While goods delivery will continue to be dominated by truck, rail freight, particularly for heavier, long-haul bulk commodities, will continue to be important. Rail movements currently account for 5.4 percent of the freight ton-miles in the State.[15] As freight continues to grow in the coming years, investments and supportive policies help maintain the current share of freight transported via rail. Rail has important energy efficiency benefits over many other modes, particularly trucking. For example, on average, trains are four times as fuel efficient as trucks, and one train can carry as much freight as several hundred trucks. It is estimated that 111 million gallons of fuel per year are saved for each one percent of long-haul freight movement that is transported by rail instead of truck.

**15.** U.S. DOT Research and Innovative Technology Administration. *2007 Commodity Flow Survey: Bureau of Transportation Statistics.* 2010. http://www.bts.gov/publications/commodity_flow_survey/

The 2009 New York State Rail Plan recognizes the efficiencies of freight rail, and sets a goal of increasing rail market share by 25 percent by 2020, reducing the growth in truck traffic and energy consumption. However, to reach this goal, significant challenges in the rail freight system continue to be addressed. Issues include:

- Competition for limited rail infrastructure: Rail passengers and freight frequently travel on the same infrastructure.
- No major rail crossings across the Hudson River exist south of Albany resulting in goods off-loading in Pennsylvania and New Jersey before delivery in NYC, Long Island, New England, and Connecticut.
- Rail infrastructure is old (in some cases, more than a century) and much of the infrastructure does not meet current industry standards. Insufficient vertical clearances and weight bearing capacity are key issues that limit rail access to New York City and Long Island to 1 percent of its freight, compared to approximately 20 percent for other metropolitan areas in the nation.

Beyond the infrastructure issues, the declining use of coal as an energy source will have secondary impacts on the rail freight network. Although coal represents only 4.4 percent of the State's total primary energy use, coal is transported almost exclusively (95.4 percent) by rail.[16] Coal comprises a significant portion of the rail traffic base nationally, and is an important rail freight commodity within New York. In 2010, coal was the top commodity by weight delivered by rail in New York, comprising 27 percent of the tonnage and 15 percent of the carloads. Further, coal transported to New England travels almost exclusively through New York. While the market for other rail freight commodities will grow over time, the loss of the coal base and the revenue it provides will have impacts on the freight system. Those carriers that rely heavily on coal shipments for their revenue base will be strained and less viable as the market shifts away from coal.

Addressing rail needs will require significant resources. New York State's Rail Plan identifies $10B in investment needs on the freight and passenger rail systems over a 20-year period to achieve a "state of good

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**16.** EIA. *Domestic Distribution of U.S. Coal by Destination State, Consumer, Origin and Method of Transportation*, 2010.

repair" and provide for needed capacity expansion. There is no dedicated source of federal funding for rail.

### Air Freight

Freight by air constitutes a small fraction of goods movement, approximately 2 percent of shipments by value and tends to involve high value, time sensitive freight. DOT has limited jurisdiction over aviation facilities in the State, but can and does look for opportunities to improve air freight. For example, highway projects near airports can offer opportunities to improve access to airports for freight carriers. Increasing access for 53 foot trailer operations could also improve airport access to JFK.

### Freight Movement by Inland Ports and Waterways

Goods movement by inland ports and waterways currently constitutes a negligible fraction of the goods moved in New York (less than 1 percent). However, shipping by water could be explored to diversify goods routes and move shipping away from congested highways. The U.S. DOT's Maritime Administration recently designated "Marine Highway Corridors" as "routes where water transportation presents an opportunity to offer relief to landside corridors that suffer from traffic congestion, excessive air emissions or other environmental concerns and other challenges."[17] New York is home to segments of Marine Corridors including M-87 extending along the Hudson River from New York City to Albany, M-90, which includes the Erie Canal and connects to the Great Lakes, and M-95, which is located downstate. As federal funding becomes available for waterway projects, it can be directed to projects that are located on Marine Highway Corridors.

The State has explored strategies aimed at avoiding landside road congestion at ports by utilizing water or rail shipments destined to less congested inland transshipment points. In 2005, a Port Inland Distribution Network pilot project provided subsidized barge service from Port Elizabeth, New Jersey to the Port of Albany. However, the service had trouble competing with trucks during a time of inexpensive diesel prices. While the conditions were not right at the time of the pilot, such strategies, and other Marine Highway-related strategies could be reconsidered if the economics of water-based freight movements are such that reliable,

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**17.** U.S. DOT Maritime Administration. *American's Marine Highway Corridors.* August 2011. http://www.marad.dot.gov/ships_shipping_landing_page/mhi_home/mhi_home.htm cost-competitive service could be a viable alternative. Furthermore, the New York State Canal Corporation has been exploring opportunities for increased freight movement along the Canal system.

## Coordinated Freight Planning

There have been many freight studies completed within the State, but none that are comprehensive and multi-modal. The Port Authority of New York and New Jersey is completing a Comprehensive Long-Term Regional Goods Movement Plan in close cooperation with both DOT and the New Jersey Department of Transportation. The New York State Rail Plan addresses freight rail, and in terms of interstate corridor-based efforts, the I-95 Corridor Coalition has done significant work to implement long-distance traveler information, develop interoperable commercial vehicle technologies that promote safety and mobility, provide freight education and support rail, and marine freight planning efforts in the Corridor extending from Maine to Florida.

The 2009 New York State Rail Plan outlines freight options to be pursued by ongoing coordinated planning efforts:

- Develop strategic rail connections to facilitate efficient and effective interchange of rail cars
- Improve rail access to and within ports, freight terminals, and intermodal freight facilities
- Evaluate the existing rail and port multi-modal program to address local freight transportation infrastructure needs
- Increase investments, including looking for public-private opportunities in rail freight transfer yards, tracks, and intermodal freight facilities to serve multiple customers and shippers within a community and region

## International Border Crossing Issues

Following the events of September 11, 2001, there has been an increased focus on security at international border crossings and entry points for international goods, with additional security requirements placed on people and goods. Processes that cause additional delay for people and goods movement have an impact on the efficiency of the system, and overall energy consumption. The 2011 United States-Canada joint declaration, *Beyond the Border: A Shared Vision for Perimeter Security and Economic Competitiveness,* articulates a shared approach to security in which both countries have agreed to work together to address threats within, at, and away from the borders, while expediting lawful trade and travel. Numerous components of the Action Plan address freight efficiency at international crossings and ports of entry. As one example, Canada and the U.S. agreed to develop a harmonized approach to screening inbound cargo arriving from offshore that will result in increased security and the expedited movement of secure cargo across the Canada-U.S. border. Implementing this goal will require the development of an integrated, multi-modal customs and transportation security regime, to reduce duplication, move activities away from the Canada-U.S. border, and enhance the security and ensuring the integrity of the "screened" cargo through to its destination. New York State will monitor and participate in these activities, as appropriate.

## Vehicle Technology and Alternative Fuels

Widespread penetration of more efficient vehicle technologies and alternative fuels will contribute to reduction of petroleum usage within the transportation sector at a relatively low cost when compared with other transportation and land-use options.[18]

Nearly 90 percent of the 10.6 million registered vehicles in State are light-duty passenger vehicles that use gasoline. Due to advanced technologies, today's gasoline engines are 60 percent more efficient than the engines in the cars of 1980. And yet, fuel efficiency has only increased by approximately 15 percent as cars today are on average heavier and have more horsepower.[19] Light-duty short-wheel base (WB) vehicles, which include passenger cars, light trucks, vans, and sport utility vehicles with a WB equal to or less than 121 inches, could travel approximately 23.5 miles per gallon (mpg) in 2010, compared to approximately 16 mpg in 1980.[20] New York can continue pursuing policies and developing technologies that improve the efficiency of these vehicles. The number of alternative fuel vehicles has been expanding and New York aims to build on this momentum through strategic investments and policies. By July 2012, alternative fuel vehicles represented 5.8 percent of the registered vehicles in the State; this percentage had grown by 2.2 percentage points in just two years.

**18.** New York State Climate Action Council. *Interim Report Executive Summary*. December 2010. http://www.dec.ny.gov/docs/administration_pdf/irexecsumm.pdf

**19.** Knittel, C. *Automobiles on Steroids. American Economic Review*. 2011. 101: pg. 3369. http://pubs.aeaweb.org/doi/pdfplus/10.1257/aer.101.7.3368

**20.** USDOT Bureau of Transportation Statistics. *Average Fuel Efficiency of U.S. Light Duty Vehicles.* http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_04_23.html

## Fuel Economy Standards and Emission Standards

Corporate Average Fuel Economy (CAFE) standards are intended to raise fuel economy of vehicles. CAFE standards for passenger cars have been steadily raised over the years. Currently, model year 2012 passenger cars have an established CAFE standard of a minimum 32.8 mpg. In April 2010, the U.S. Environmental Protection Agency (EPA) in conjunction with the U.S. Department of Transportation (U.S. DOT), developed a joint rule to establish standards to reduce GHG emissions and improve fuel economy for light-duty vehicles ranging from model year 2012 to 2016.[21] Subsequently, additional rulings brought up the average fuel economy for model years through 2025. The average fuel economy for a model year 2025 vehicle is estimated to be 54.5 mpg.

New York's vehicle emission standards are based on rules established in California. In December 2011, California proposed low emission vehicle (LEV III) standards applicable to 2015 to 2025 model year passenger cars, light-duty trucks, and medium-duty passenger vehicles. The zero emission vehicle (ZEV) program applies to passenger cars and light-duty trucks and is expected to result in ZEVs accounting for 15 percent of all new vehicle sales by 2025. Further, in October 2013, California, New York and six other states signed a Memorandum of Understanding on implementing ZEV programs.

In August 2011, EPA and the National Highway Traffic Safety Administration (NHTSA) announced a first-ever program to reduce GHG emissions and improve the fuel efficiency of heavy-duty trucks and buses. The joint proposal covers model years 2014 to 2018, and is projected to save 530 million barrels of oil over the life of the affected vehicles.[22]

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**21.** EPA. *EPA-420-F-10-014: EPA and NHTSA Finalize Historic National Program to Reduce Greenhouse Gases and Improve Fuel Economy for Cars and Trucks*. April 2010. http://www.epa.gov/otaq/climate/regulations/420f10014.pdf

**22.** EPA. *EPA-420-F-11-031: EPA and NHTSA Adopt First-Ever Program to Reduce Greenhouse Gas Emissions and Improve Fuel Efficiency of Medium- and Heavy-Duty Vehicles*. August 2011.

## Alternative Fuels and Vehicles

The U.S. Department of Energy (DOE) currently recognizes alternative fuels such as electricity, natural gas, propane, ethanol, biodiesel, and hydrogen.[23] Alternative fuels have gained some traction in New York in niche markets, and broader audiences are starting to consider these options. Each fuel has benefits and drawbacks compared to traditional motor fuels, as detailed in Table 21 (A-C), and many of the barriers to using alternative fuels are dissolving. Most alternative fuels offer lower operational costs, both from fuel savings and lower maintenance costs, but require larger initial investments for the vehicles or supporting fueling infrastructure. Some fuels, such as electricity, are better suited for light-duty vehicles while others, such as natural gas, are better suited for heavy-duty applications.

**Table 21A | Benefits and Drawbacks of Electric Fuel Vehicles**

| ALTERNATIVE FUEL/VEHICLE | BENEFITS | DRAWBACKS | FUELING INFRASTRUCTURE/ INCENTIVES |
|---|---|---|---|
| **Electric Vehicles (EV); Types:**<br><br>Hybrid EV's (HEV) operate on gasoline/diesel.<br><br>Plug-in Hybrid EV's (PHEV) - use electricity and gas/ diesel.<br><br>Battery EV's (BEV) – operate on electricity only.<br><br>Extended Range EV's (EREV) - have back-up gasoline generator. | Reduce average fuel use and GHG emissions by 15-50% over conventional engines.<br><br>Low, stable operating cost.<br><br>No tailpipe emissions when running on electricity.<br><br>Domestic fuel source.<br><br>New York is a major manufacturing center for heavy-duty hybrid trucks and buses. | Higher initial vehicle price. Batteries can add $10,000 or more to cost.<br><br>BEVs' ranges vary from 75 to 250 miles, with most under 100 miles. PHEVs' and EREVs' ranges vary from 10 to 40 miles before they run on gasoline. | 3 levels of charging infrastructure:<br><br>**Level 1**<br>Standard 120 Volt AC; 12 to 20 hours for a full charge of 80 miles.<br><br>**Level 2**<br>240 Volt AC; 4 to 7 hours for a full charge for 80 miles; standard connection (SAE [1772); requires EV supply equipment (charging station).<br><br>**DC Fast Charge**<br>DC power: 80% in 20 minutes; SAE standards needed; competing standards; expensive charging infrastructure; may cause strain on local grid.<br><br>**Incentives**<br>A New York tax credit of 50% of the cost of electric vehicle recharging property up to $5,000 through 2017. |

23. DOE. *Energy Efficiency and Renewable Energy Alternative Fuels Data Center*. March 2012. http://www.afdc.energy.gov/laws/key_legislation#epact92

**Table 21B | Benefits and Drawbacks of Natural Gas/Propane Fuel Vehicles**

| ALTERNATIVE FUEL/VEHICLE | BENEFITS | DRAWBACKS | FUELING INFRASTRUCTURE/ INCENTIVES |
|---|---|---|---|
| **Compressed Natural Gas Vehicles (CNG):**<br><br>CNG is a natural gas stored at high pressure up to 3,600 pounds per square inch (psi).<br><br>CNG vehicles have combustion engines and store CNG in large tanks onboard.<br><br>Vehicles can be dual-fuel (always use both gasoline/diesel and CNG), bi-fuel (use either gasoline/diesel or CNG) or dedicated (run on CNG only).<br><br>Natural gas is readily available in NY through utility gas pipelines. | Lower operational cost for fleets.<br><br>Ideal for fleets with medium and heavy trucks that drive fixed routes.<br><br>CNG can power trucks of all sizes.<br><br>Several companies convert conventional cars to CNG; | Higher initial vehicle price: $25,000 to 60,000 per medium and heavy-duty truck; $7,000 to 20,000 per light-duty vehicle.<br><br>Limited manufacturing of light-duty CNG vehicles.<br><br>Limited infrastructure availability. | Expensive charging infrastructure: $500,000 to 2,000,000 for large stations.<br><br>New York has 111 fast-fill CNG stations, of which about 1/3 are open to the public.<br><br>Slow fill stations are less expensive, but take up to 12 hours to fill a vehicle.<br><br>**Incentives /Income Tax Credits:**<br><br>Federal: 30% of fueling station cost until end of 2013 (up to $30,000 for large, up to $1,000 for home).<br><br>New York: 50% of refueling property (up to $5,000); |
| **Liquefied Natural Gas (LNG)**<br><br>LNG is a condensed natural gas cooled to -162° C.<br><br>LNG vehicles have combustion engines and store LNG in large tanks onboard.<br><br>Options include dual-fuel (always use both gasoline/diesel and LNG) or dedicated (run on CNG only). | Practical for long haul tractors or heavy-duty trucks.<br><br>Higher energy density than CNG. | Could be stored in heavy tanks as it is extremely condensed.<br><br>Only practical for very large trucks. | In September 2013, DEC proposed rule making to implement safe siting, operating, and transportation requirements of LNG. |
| **Propane (LPG) Propane, or liquefied petroleum gas, is stored at 300 psi.** | Relatively low upfront costs.<br><br>Slightly lower operating costs than gasoline or diesel.<br><br>CARB-certified conversion kits available for pick-ups, cars, vans. | Limited use for heavy-duty vehicles.<br><br>Limited public fueling infrastructure suited for vehicles. | LPG fueling stations costs approximately $50,000.<br><br>New York has 31 refueling stations for vehicles. |

**Table 21C | Benefits and Drawbacks of Alternative Fuel Vehicles**

| ALTERNATIVE FUEL/VEHICLE | BENEFITS | DRAWBACKS | FUELING INFRASTRUCTURE/ INCENTIVES |
|---|---|---|---|
| **E85 Flex Fuel (Bio-Fuel)**<br><br>E85 is a fuel blend of 85% ethanol and 15% gasoline.<br><br>E85 flex fuel vehicles can operate using either gasoline or an E85 blend.<br><br>Most ethanol used in New York is produced from corn. New York produces its own ethanol and is developing technologies for cellulosic ethanol production. | Effectively equal in fuel cost and initial cost to gasoline.<br><br>E85 vehicles can also use gasoline.<br><br>Corn-based ethanol provides a pathway towards cellulosic ethanol from non-food crops. | Limited fueling infrastructure in parts of the State.<br><br>Relatively small cost savings for drivers.<br><br>Corn-based ethanol provides fewer energy and GHG benefits than more advanced biofuels. | New York has more than 100 E85 stations located at retail gas stations.<br><br>Infrastructure installation cost ranges from $70,000 to $150,000.<br><br>E85 vehicles continue to grow in market share. US automakers have committed that half of 2015 vehicles will be flex fuel. |
| **BioDiesel**<br><br>Most bio-diesel is produced from soybeans. Animal fats and waste oil can also be used.<br><br>Standard diesel engines can run on biodiesel; no special vehicles or equipment is needed. Common blends include B5 (5% biodiesel) and B20 (20% biodiesel). | No incremental vehicle costs.<br><br>Reduces some emissions. | Higher blends can gel up in colder weather, causing engine problems.<br><br>Biodiesel contains less energy per gallon than diesel.<br><br>Biodiesel is more expensive than diesel. | There are a limited number of public biodiesel fueling stations available in the State as most fleets maintain their own fueling facilities. |
| **Hydrogen Gas**<br><br>In vehicles, hydrogen gas is either burned in an internal combustion engine, or made to react with oxygen in a fuel cell to run electric motors.<br><br>Fuel cell vehicles are currently being driven in small quantities, primarily in California. | Fuel cell vehicles have longer ranges than EVs.<br><br>Hydrogen can be produced from carbon-free sources (wind, solar, nuclear). | Fuel cells are very expensive and may have shorter lifespans than other vehicles.<br><br>No vehicles operating with hydrogen are currently for sale in State.<br><br>Very limited fueling infrastructure.<br><br>Hydrogen is most frequently made from fossil fuels. | New York has 10 hydrogen refueling sites. |
| **Other**<br><br>Hydraulic and pneumatic hybrid systems recapture energy as pressurized fluids or air. | Pressurized systems provide starting power boosts and are ideal for heavy-duty vehicles that start and stop frequently.<br><br>Vehicles require no alternative fuels and can reduce fuel use by up to 20%. | Hydraulic and pneumatic hybrid systems are expensive additions to vehicles.<br><br>Few applications are well-suited for these systems. | |

## Current Electric Vehicle (EV) Support Policies, Programs and Grid Capacity

In his 2013 State of the State address, Governor Cuomo announced the Charge NY Initiative, a major effort to lay the groundwork for the introduction of up to 40,000 plug-in electric vehicles (PEVs) in New York by 2018. Charge NY aims to achieve this goal by making the State EV-ready, including the installation of up to 3,000 public and workplace charging stations. The Charge NY Initiative will total $50 million over five years. In addition to creating a network of charging stations, the Initiative is examining New York's regulatory regime to make it easier for the private sector to invest in EV infrastructure.

Charge NY supports the efforts of the Transportation Climate Initiative (TCI), a collaboration of 11 Northeast States and Washington, DC to accelerate the introduction of a network of EV charging stations throughout the Northeast and Mid-Atlantic regions. By creating consistent rules and standards across the entire region, TCI seeks to attract private-sector investment and encourage the development of an EV market.

A number of studies have investigated the effects of widespread EV use on the current electric grid and have generally found that the electric grid has enough capacity to supply electricity to EVs without major new investments beyond regularly planned upgrades to the local distribution system. Smart grid and technologies built into EVs or Electric Vehicle Supply Equipment (EVSE) can enable smart charging and or charging during off-peak hours when there is excess grid capacity. EVs can potentially help ease electrical demand further by providing vehicle-to-grid (V2G) power where EV owners can "sell back" electricity acquired from the grid when their vehicles are plugged in. Further demonstrations, business models, and smart grid upgrades are needed before V2G becomes a reality.[24]

**24.** NYSERDA. *Transportation Electrification in New York State*. June 2011. http://www.nyserda.ny.gov/Publications/Research-and-Development/~/media/Files/Publications/Research/Transportation/epri-phev.ashx

## New York's Role in Deployment of Clean Vehicle Technologies

NYSERDA administers programs that support fleet purchases of Alternative Fuel Vehicles (AFV) and alternative fuel infrastructure. Federal and State sources have provided funding for these programs. New York has also offered tax credits to induce installation of alternative fuel infrastructure. New York State has purchased more than 7,000 AFVs for its own fleet and has installed accompanying infrastructure. DOT alone built nearly 50 CNG fueling stations. State and municipal fleets have demonstrated to private fleets that alternative fuels are viable options for fleets that require reliability. New York has supported AFVs by educating fleets and policymakers about the benefits and proper deployment of AFVs.

### Public Transportation Fleets

The incorporation of alternative fuel buses into public transportation fleets statewide has steadily increased. In 2011, of the nearly 10,300 buses owned by public transportation operators, 10 percent were powered by CNG, while 19 percent were diesel-electric hybrid buses.

### Clean Fuels Standard

A clean fuels standard (also known as a low carbon fuel standard) would require a reduction in the overall carbon intensity of the region's transportation fuels. An analysis by the Northeast States for Coordinated Air Use Management (NESCAUM) suggests that a gradual transition to low carbon intensity fuels such as electricity and advanced biofuels could be expected to enhance the region's energy independence, and to strengthen the regional economy, while lowering GHG emissions.

### Ways to Engage the Private Sector

The six Clean Cities Coalitions in the State are public-private partnerships to educate stakeholders about alternative fuels. These groups, sponsored by the DOE, help fleets meet peers who are already using AFVs, providing valuable first-hand experience and best practices to those considering making a change. Work will continue on addressing regulatory barriers that might hamper investments in AFVs, such as the uncertainty about the legality of the resale of electricity through electric vehicle charging stations. New York has been working with fire marshals and other local officials to ensure that they understand the safety requirements of alternative transportation fuels. Simplifying the rules for permitting the installation of alternative fuel infrastructure can make these stations viable investment opportunities.

### Transportation Energy Research, Development and Demonstration

The State has encouraged the deployment and increased utilization of innovative, energy efficient transportation energy technologies and products through Research, Development and Demonstration (RD&D). Examples include the development of heavy-duty hybrid–electric drive systems for transit buses and energy storage products designed to capture train-braking energy in electrified rail and subway applications. Examples of multi-party efforts involving State, regional, and local parties include diesel idling reduction technologies such as fuel-fired school bus heaters, hybrid-electric trailer refrigeration systems, and high-speed commercial vehicle inspection technology.

# 4 Growing the Clean Energy Economy

## Stimulate Growth of the Clean Energy Economy

Today, an energy revolution is occurring – New York is poised to capitalize on it. The global clean energy market[1] is currently estimated at $350 billion and projections estimate it could expand to more than $680 billion during the next decade.[2]

**1.** In the context of this report, the clean energy economy is defined as "economic activity that produces goods or delivers services designed to increase energy efficiency or generate renewable energy."
**2.** Data for renewable energy from Clean Edge. *Clean Energy Trends 2012*. Information related to energy efficiency from Pike Research. *Energy Efficient Buildings: Global Outlook*. 2011. Energy storage information from Pike Research and ECG Consulting found in ECG Consulting Group, Inc. *The Economic Impact of Developing an Energy Storage Industry in New York*. 2012. Data related to the smart grid from Frost & Sullivan. *Global Smart Grid Market*. August 2011.

Individual segments are growing even more rapidly. For example, solar photovoltaic, biofuels, and wind power grew at an annual rate of more than 30 percent between 2010 and 2011.[3] These rapidly expanding international markets offer new opportunities for New York's established companies and start-ups to export New York-invented and produced solutions worldwide and create tens of thousands of high-paying jobs in New York. The broad range of transportation, power generation, buildings, and smart-grid related products and services created by these companies will also help to solve key energy and environmental challenges right here at home in the Empire State.

New York is positioned well to compete for a substantial share of the expanding global market for clean energy economy technologies. The State has long been a leader in energy technology innovation and commercialization, with a well-established, world-class research infrastructure, and is home to a major financial and venture capital industry. With a superior higher education system, New York has a productive skilled labor force that can transition readily into new energy industries and markets. New York has an opportunity to build upon these assets and other competitive strengths to create a climate for business and innovation that supports the development and growth of globally competitive clean energy industries that drive economic expansion, job creation, and energy independence.

## Clean Energy Economy Growth Potential

The Clean Energy Economy is a significant emerging sector in New York's economy with three primary characteristics: high job growth, high wages, and significant export potential. A number of studies have categorized clean energy jobs in different ways. However, New York consistently ranks among the highest in the country in its proportion of these jobs. Studies from the Brookings Institute[4] and the New York State Department of Labor[5] identified between 90,000 to 140,000 jobs in New York's clean energy economy in 2010. New York ranked second in the country in the number of green jobs with 10 percent of the U.S. total and New York had a higher proportion of green jobs compared to total

**3.** Clean Edge. *Clean Energy Trends*. 2012.

**4.** Brookings Institution. *Sizing the Clean Economy: A National and Regional Green Jobs Assessment*. 2011.

**5.** Department of Labor. *Quarterly Census of Employment and Wages*. 2010.

employment with 3.0 percent versus 2.4 percent in the U.S.[6] In fact, New York's Capital Region had the highest concentration of clean economy jobs anywhere in the country.[7] These are not isolated recognitions. The Kauffman Foundation has identified New York as one of the top ten states prepared to capitalize on the opportunities provided by a knowledge-based economy.[8]

Clean energy economy jobs are growing rapidly. In 2012, most of New York's clean energy economy jobs reside in mature segments related to building technologies and services (15 percent of total jobs) and public services such as mass transit (62 percent of total jobs). However, the clean energy sector includes some of the fastest growing segments of our economy. Between 2003 and 2010, clean energy economy jobs in New York including scientists and engineers, electricians, machinists and instructors, grew by 50 percent[9] while total jobs grew 1.4 percent.[10] By 2010, the number of people employed in New York's clean energy sector was already twice the 45,000 employed in the traditional energy sector.[11]

Clean energy economy jobs pay well. DOL research identified that goods producing sectors represent approximately 59 percent of total green jobs in the State and 41 percent represent service producing sectors. Goods-producing jobs, which are primarily located in Upstate New York, paid an average $60,000 in 2010 compared to an average Upstate wage of $45,000. Professional and technical industry sector jobs paid even higher with an average wage of $90,886.[12] In addition, many companies sell both goods and services in the clean energy economy. For example, approximately 50 percent of GE's $150 billion in revenues come from services and approximately 85 percent of IBM's $100 billion in revenue was service-related.[13]

## Clean Energy Solutions Increase Exports

The clean energy economy is almost twice as export-intensive as other sectors of the economy. More than $27,000 of exports are sold for every job in the clean energy economy compared to $10,390 in exports for the

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**6.** U.S. Department of Labor. Bureau of Labor Statistics. *Green Goods and Services Survey.* 2010.
**7.** Brookings Institution. *Sizing the Clean Economy: A National and Regional Green Jobs Assessment*. 2011.
**8.** Kauffman Foundation. *2010 State New Economy Index*. 2010.
**9.** Brookings Institution. *Sizing the Clean Economy: A National and Regional Green Jobs Assessment*. 2011.
**10.** New York State Department of Labor. *Quarterly Census of Employment and Wages*. 2010.
**11.** Brookings Institution. *Sizing the Clean Economy: A National and Regional Green Jobs Assessment*. 2011.
**12.** New York State Department of Labor. *Quarterly Census of Employment and Wages*. 2010.
**13.** 2011 Annual Reports from GE and IBM.

average U.S. job.[14] Considering that 95 percent of the world's population lives outside the U.S., tremendous opportunities exist for selling New York invented or manufactured goods and services overseas.

## Future Growth Projections are Significant

The highest growth opportunities in the clean energy economy reside in newer segments such as smart grid, wind, biofuels, solar, energy storage, and energy efficiency. Approximately 25 percent of the 90,000 jobs the Brookings Institute identified in New York's clean energy economy are in these fastest growing segments.[15] A high-level job growth estimate in these segments was developed using information from several sources. Recent estimates concluded that the number of jobs in these sectors could double or triple by 2020.[16]

While all clean energy sectors offer opportunities for significant growth, energy storage may be particularly promising since it is an enabling technology that can help other clean energy technologies be utilized more efficiently. The global marketplace for energy storage is projected to expand rapidly from $11 billion in 2012 to almost $70 billion by 2020.[17] New York, through the New York Battery and Energy Storage Technology Consortium (NY-BEST), in conjunction with State and local partners, is poised to seize this opportunity.

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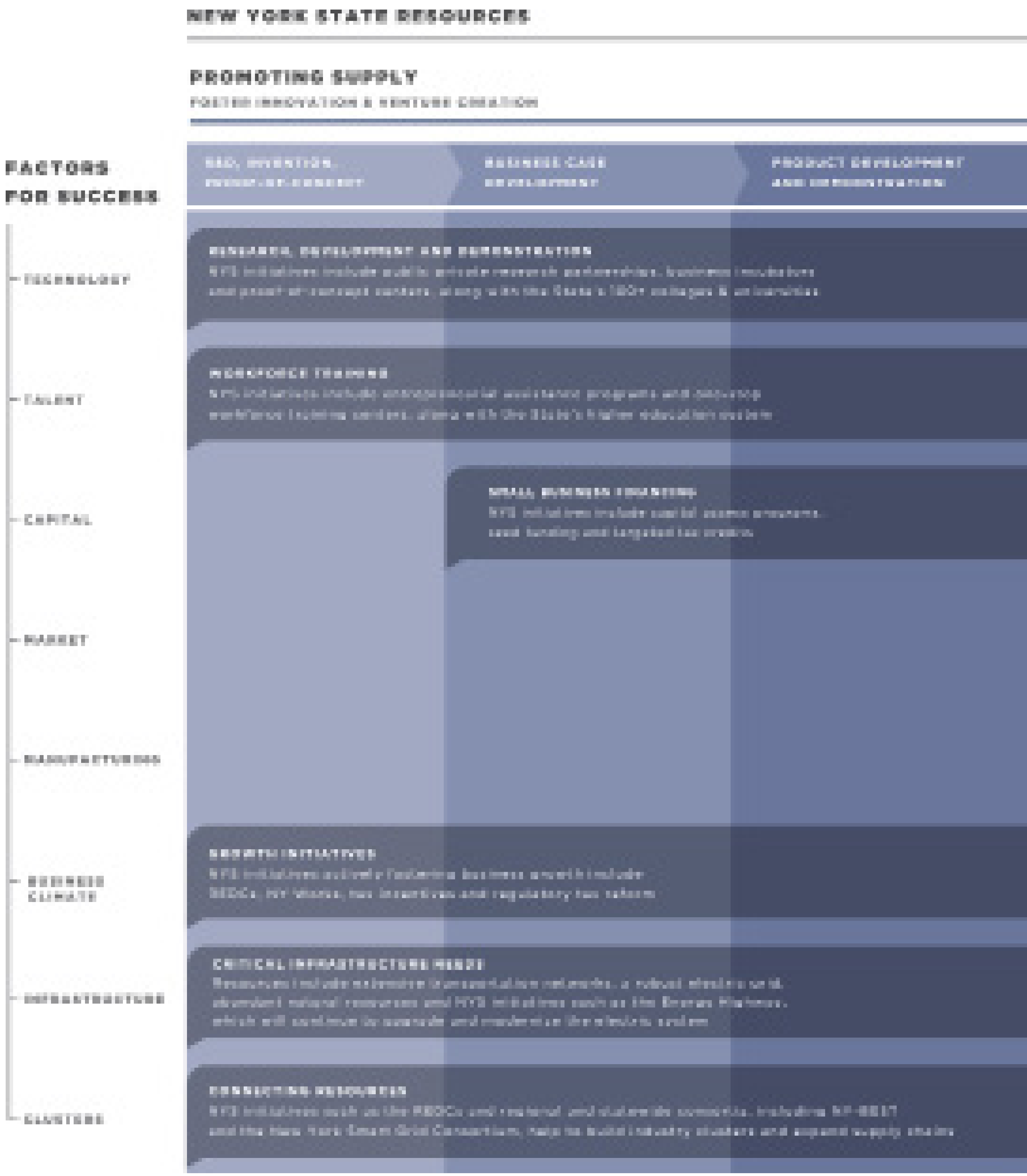
**14.** Brookings Institution. *Sizing the Clean Economy: A National and Regional Green Jobs Assessment*. 2011.
**15.** Brookings Institution. *Sizing the Clean Economy: A National and Regional Green Jobs Assessment*. 2011.
**16.** This preliminary high-level estimate includes information from several sources. ECG Consulting's New York State Energy Storage Economic Impact report included two job growth scenarios related to energy storage; the average estimate of potential jobs in 2020 for those scenarios is used here. Information related to biofuels comes from the Renewable Fuels Roadmap; the average of the "Big Step Forward" and "Giant Leap Forward" scenarios are used above. ICF International's *Economic Development Potential in New York for Selected Clean Energy Technology Areas* white paper includes a pair of job growth scenarios for PV, wind, and smart grid; again, the average job estimate for the two scenarios is used. Separately, an estimate for the advanced building technology segment was created by assuming that the compounded annual growth rates for jobs between 2003 and 2010 in New York from the Brookings Institution's *Sizing the Clean Energy Economy* report continue through 2020. The scope and approach used to develop each of these estimates are different, so outcomes from segment-to-segment are not comparable.
**17.** ECG Consulting, prepared for NY-BEST. *Energy Storage Market Analysis*. July 2012.

## Overall Approach for Growing the Clean Energy Economy

Capitalizing on the clean energy economy requires a sustained comprehensive approach that promotes robust market demand, a vibrant research and commercialization ecosystem, skilled workforce across all levels, and persistent sound policies. Transformations take time and only occur to their fullest potential when all of these elements are present and sustained in the long term. This requires moving forward on multiple fronts simultaneously.

As shown in Figure 8, New York already has a number of initiatives that foster the growth of the clean energy economy across the entire business and commercialization lifecycle. Examples of these policies and programs are described throughout this document. Building upon these investments in the State's clean energy economy will accelerate its growth and lay the foundation for economic payoff for decades to come while cementing New York's leadership in this sector.

**Figure 8 | New York Initiatives That Support the Clean Energy Economy Across the Business Lifecycle**




PROMOTING DEMAND
SUPPORT MARKETING & DEVELOPMENT
SCALE-UP AND COMMERCIALIZATION
PRODUCT ADOPTION AND DEPLOYMENT
MATURE BUSINESS AND TECHNOLOGIES
RENEWABLE AND EFFICIENCY INCENTIVES
NYS initiatives include RPS, SBC, and EEPS as well as programs through NYPA and LIPA
ADVANCED MANUFACTURING INITIATIVES
Resources include shared use facilities and programs to implement more efficient manufacturing processes

## Building on New York's Clean Energy Assets

New York is emerging once again as a national leader in the innovation economy. Reaping the energy, economic, and environmental benefits of the clean energy economy requires a comprehensive approach that encourages robust private-sector investment, market demand, entrepreneurship, a skilled workforce, and positions New York's companies to compete globally. New York has made significant commitments to build upon its clean energy economy. Each of these assets can be further enhanced and leveraged to accelerate job creation and complement sustained State investment in this sector.

### Engaged Regional Participation

The Regional Economic Development Council (REDC) initiative was launched by Governor Cuomo in July 2011 with ten REDCs created to provide a community-based, performance-driven approach that empowered each region to develop a strategic plan that advanced regional solutions to create jobs and economic growth. Through the competitive Consolidated Funding Application process, funding provided by State programs is available for a variety of economic development purposes. The REDC process is proving to be a vital mechanism for helping the State grow its clean energy economy – a sector that was included within each of the ten regions' strategic plans.

In addition, the Cuomo administration has focused on implementing new initiatives like NY Works that is transforming New York's approach to economic development by positioning the State to partner with the private sector to encourage billions of dollars in new investment in high-growth sectors such as nanotechnology and clean technology. Regional participation and education is critical for the clean energy economy since the job opportunities created will span from high-wage technical, manufacturing and installation jobs to engineers and scientists.

With one of the most ambitious clean energy agendas in the U.S., New York's strategic location, proximity to markets, R&D facilities, and unparalleled business incentives programs, offer an ideal reason to locate and conduct business in the State. Collective and inclusive marketing is necessary to promote these and other assets to drive future industry growth. Identifying and fostering a platform that displays regional strengths and attributes is essential to retaining and attracting new companies. Regional collaboration to co-market, share, and maximize resources is necessary to achieve recognition and compete in today's international clean technology marketplace. Combined efforts positioned under the NY Works umbrella will help solidify New York's brand recognition as leader in clean energy markets.

Job growth in the clean energy economy has been significantly faster in regional clusters (organizations in similar or related industries that are in close proximity) than elsewhere.[18] Examples of emerging clean energy clusters across the State include energy storage and smart grid on Long Island; energy information technology in New York City, nanotechnology and energy storage in the Capital Region; building systems in Central New York along with energy storage and fuel cells in the Finger Lakes and Western New York. Although the REDC strategic plans and recent research from the New York Academy of Sciences have identified key assets and strengths upon which the State can grow the clean energy economy,[19] more work is planned to specifically identify clean energy industry clusters and their core competencies, market positions, challenges, and opportunities. Such information will assist each region, and the entire State, in developing supportive policies and programs across such important areas as workforce development and training, R&D, technology transfer, financing, and export assistance.

## World-Class R&D

New York has consistently ranked among the top ten states for its knowledge-based economy[20] and is among the highest states for federal R&D funding received with almost $6.5 billion in FY2009.[21] This is echoed by the number of new innovations that receive patent protection. In 2011, New York was third in the nation with 6,956 patents issued.[22] New York's support of a research and development infrastructure has been widely recognized. In 2011, the American Council for an Energy-Efficient Economy (ACEEE) ranked New York tied for first place in the country for its programs that support public and private research, development, and demonstrations stating that NYSERDA is "the epitome

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**18.** Brookings Institution. *Sizing the Clean Economy: A National and Regional Green Jobs Assessment*. 2011. The Brookings Institute found that job growth has been substantially faster in regional industry clusters than elsewhere: "overall, clustered establishments grew at a rate that was 1.4 percentage points faster each year than non-clustered (more isolated) establishments.

**19.** New York Academy of Sciences. *Innovation and Clean Technology in New York State: A New Economic Engine*. August 2010.

**20.** Kauffman Foundation. 2010 *State New Economy Index*. 2010.

**21.** National Science Foundation and the Bureau of Economic Analysis, data analyzed by the State Science and Technology Institute.

**22.** U.S. Patent and Trademark Office, Patents issued by State, 2011.

of an effective and influential research and development institution."[23] In addition, CNBC ranked New York the top state for technology and innovation in its America's Top States for Business 2012 study.

New York is home to a wealth of public and private research institutions. These include publicly-supported Centers of Excellence and Centers for Advanced Technology, five U.S. DOE-designated Energy Frontier Research Centers, high-performance computing assets, and Brookhaven National Lab. Key university-led research efforts are under way throughout the State including nanotechnology at the College of Nanoscale Science and Engineering (University at Albany), energy storage and smart grid technologies at Stony Brook University/ Brookhaven National Lab, environmental and biomass research at State University of New York (SUNY) College of Environmental Science and Forestry, and energy systems at Binghamton University. In addition, robust corporate research exists with world research facilities at GE, Corning, Bausch & Lomb, General Motors, Xerox, IBM, Phillips, and others and at smaller and mid-sized companies throughout the State. A strong research and development infrastructure is essential in new product development and continues to be an important factor cited by companies in locating new manufacturing plants, reinforcing the desire to locate product development close to manufacturing.

In order to strengthen research and development in New York, the State will establish Smart Energy Technology Hubs, building on tremendous innovation assets and a strong industrial base in this area. This initiative will involve collaboration between various institutions in the R&D chain, such as NYSERDA, NYPA, NYISO, utilities, national laboratories, and universities. The Hubs will offer the opportunity to further develop, demonstrate, and learn from the application of new technologies that provide value to New Yorkers, and can provide a strong energy foundation for a growing economy.

In 2013, Governor Cuomo launched START-UP NY (SUNY Tax Free Areas to Revitalize and Transform Upstate New York), an initiative to transform SUNY campuses and university communities in New York into tax-free communities, including no income tax for employees, and no sales, property or business tax for 10 years. The initiative will attract venture capital, start-ups, and new private sector investments by offering

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**23.** American Council for an Energy-efficient Economy. *2011 State Energy Efficiency Scorecard*. 2012.

new businesses the opportunity to operate tax free while partnering with world-class higher education institutions.

New York is expanding the role of the State's institutions of higher education, including SUNY and CUNY, to integrate industry's needs with the research conducted at leading academic centers. For instance, the SUNY Networks of Excellence program was initiated to support increased research collaborations between SUNY and industry partners to spur commercialization activities in the area of energy, the environment, economics, and education. Each network will assemble scientists and scholars from SUNY campuses across the State to collaborate on topic-specific joint research programs, creating a more focused and efficient research environment in New York. The networks will help lure businesses to partner with SUNY in support of the Governor's START-UP NY initiative.

## Programs That Help Foster Technology Transfer and Venture Creation

The capacity to turn research discoveries into commercially-viable products and services is a key challenge. New York has a number of initiatives to help catalyze innovations by partnering researchers with their engineering and product development counterparts in industry. These include targeted technology development programs through NYSERDA and Empire State Development's (ESD) Division of Science, Technology and Innovation.

An environment that fosters new company formation and growth is emerging in New York. Three key components of the ecosystem are the three Proof-of-Concept Centers (POCC), the six Clean Energy Business Incubators, and the Entrepreneurs-in-Residence (EIR) program. The POCCs are designed to move promising clean energy technology inventions out of the lab and into the market with a focus on the creation of viable start-up companies. Clients receive mentoring and resources to validate their technology and take the next step to commercialization. The incubators are strategically located in the heart of a cleantech cluster. Incubator tenants have ready access to a network of mentors and service providers who understand the start-up and early stage company experience. The NYSERDA EIR program is available to guide early stage companies through specific projects and issues, such as staffing for growth, budget management, strategic partnering and board management. Opportunities to sustain and expand these types of initiatives are being pursued.

For instance, Empire State Development's New York State Business Incubator and Innovation Hot Spot Support Program provides support to incubators to assist businesses in transitioning from the start-up phase to larger-scale commercialization of their products and services. In 2013, a priority for each Regional Council in the State is to identify an Innovation Hot Spot, which is a higher education – private sector high-tech innovation incubator for start-up companies. The incubators will help stimulate innovation by offering inventors and entrepreneurs a low cost, collaborative working environment and access to essential shared business services. The assistance available under the program includes tax benefits, operating grants, technical assistance, marketing, and training opportunities.

In addition, ESD's Innovate NY Fund is a seed stage equity fund program designed to stimulate innovation, job creation, and high growth entrepreneurship throughout New York State. The Fund is a $45 million joint venture equity fund supported by $35 million from ESD and a $10 million investment from Goldman Sachs. Seven leading investment entities – each with a regional and/or industry focus – are participating and investing the funds in start-ups across the State.

Effective policy to promote employment growth in the clean energy economy includes a central consideration for start-up firms. Job creation at start-ups in the U.S. averaged more than three million jobs per year during 1992 to 2005, four times higher than any other yearly age range. These firms include the fastest growing, high-tech companies known as "gazelles" that comprise less than 1 percent of all companies, yet they generate roughly 10 percent of new jobs in any given year.[24] Policies and programs to foster the creation and growth of start-up firms in New York's clean energy economy will continue to be explored.

Consortia such as NY-BEST, the New York State Smart Grid Consortium, the Lighting Research Center, and others have important roles to play in fostering public-private partnerships that bring together the research community, product development teams, supply chains, and customers to support an accelerated product development cycle.

Going one step further, State organizations can assist businesses in pursuing more "open innovation" and shared-use facilities. This concept stresses partnered innovation processes that include less

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**24.** Kauffman Foundation. *High-growth Firms and the Future of the American Economy*. March 2010.

restrictive intellectual property sharing agreements. Leading edge R&D is expensive and risky, and in a dynamic global marketplace, it is not possible for companies to have all of the needed expertise "in house." Open innovation helps organizations partner to contribute expertise in their specific disciplines, to share cost and risk, to define problems more broadly, and to scale up successful innovations to commercialization far more rapidly. To support this shift, businesses are also being encouraged to develop more long-term relationships with research institutions.

To further support the expansion of the innovation ecosystem in New York, universities are being encouraged to increase opportunities for students and faculty to develop entrepreneurial skills. For instance, the SUNY Strategic Plan includes Six Big Ideas to revitalize the economy of New York and enhance the quality of life for its citizens. One of these ideas is titled SUNY and the Entrepreneurial Century and is focused on cultivating entrepreneurial thinking across the entire learning landscape, helping new and existing businesses innovate, prosper, and grow. One component of this approach is called SUNY StartUP, and it will create programs that invite successful local entrepreneurs onto SUNY campuses to advise and serve as mentors for our students and professors. Campuses will also provide courses on entrepreneurship for students and faculty throughout the system in an effort to permeate the State with an entrepreneurial mindset and create a cadre of idea generators and job creators.

Also, NYSERDA recently developed the New York State Clean Energy Technologies Innovation Metrics report that serves as a starting point for tracking the development of the State's clean-tech industrial base and innovation system through a suite of indicators that define and promote New York's strong record of support of existing and emerging clean energy technology companies and an environment conducive to innovation, entrepreneurship, and technology-led growth.[25] This information will be updated annually so it can be used to track and report achievement with these metrics.

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**25.** NYSERDA. *New York State Clean Energy Technologies Innovation Metrics*. 2013. http://www.nyserda.ny.gov/-/media/Files/EIBD/NYS-clean-energy-metrics.pdf

## Linkages to the Financial Community

Access to angel and venture capital and traditional financing is key to new company growth and expansion. New York City is home to the world financial market and home to some of the most active venture capital firms.[26] However, there is significant room for growth in the number of investments made in New York companies and increasing financing in the "Valley of Death" when energy projects using novel, capital-intensive technologies cannot be financed by conventional means because of technology uncertainty. Between July 2009 and March 2011, only $80 million of the $7.4 billion in clean-tech venture investments made in the U.S. were in New York companies.[27] An Excell Partners report found that while New York-based venture capitalists rank third in the nation for capital under management, 91 percent of deployed capital was invested outside the State.[28] While the angel and venture capital community has continued to increase its support of clean-tech companies over time, New York has significant room for improvement in leveraging the financial resources that exist here so that New York-born companies are funded and remain in state.

## Programs That Help Clean Energy Businesses Grow

New York has a number of initiatives that help support business development and expansion. In addition to early-stage business development programs, NYSERDA programs help companies with strategic business plan development, identify intellectual property positions, prepare for venture capital presentations, and scale-up advanced manufacturing techniques and tools. Empire State Development, the State's Regional Technology Development Centers, Small Business Development Centers, and other statewide and local organizations also foster business development and growth.

A growth opportunity exists to locate manufacturing in closer proximity to research assets and create a virtuous feedback loop where the product development timeline is accelerated. One prominent example where this has occurred is with the College of Nanoscale Science and Engineering at the University at Albany, facilitating research partnerships with Sematech, Global Foundries, IBM, and others.

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**26.** Forbes Magazine. *The Midas List: 2011's Top Tech Investors.* 2011.

**27.** CB Insights. *Venture Capital Compilation Data*. 2012.

**28.** Excell Partners. *Venture Capital & Seed Activity in New York State*. February 2009.

New York also has a large industrial machine tool cluster which sells manufacturing equipment to a worldwide market. Opportunities exist to help this cluster design tools that operate more efficiently to save energy and money, design tools to mass produce clean-tech products at scale to meet market price points, design tools that can be re-purposed as product mixes change so factories stay nimble, and design tools for more cost-effective prototyping to help expedite product design.

To further promote the growth of clean energy businesses, New York is investigating opportunities to expand programs that help develop advanced manufacturing methods and tools that enable the efficient commercial-scale production of clean energy technologies. Initiatives that foster energy-efficient production methods and new production techniques are also to be pursued.

Tradable goods provide an opening to pursue a share of national and global markets. In fact, the clean energy economy is twice as export-oriented as the overall economy. Brookings estimates conclude that some $27,412 worth of exports are sold for every job in the clean energy economy, compared to just $10,390 in exports for the average U.S. job.[29] Therefore, New York is pursuing opportunities to help New York's clean energy companies locate new customers and sell products in foreign markets through ESD's international trade activities and leveraging ESD's foreign offices, local World Trade Centers and economic development organizations, and U.S. Department of Commerce programs. While activities to support new product sales are extremely important, opportunities are also being explored to encourage development of high-value tradable services, e.g., energy information services, related to the clean energy economy. Promoting the sale of made-in-New York clean energy products and services outside of the State, may result in commercially viable New York companies that can also serve the global marketplace.

## Policies That Support Market Creation and Development

As noted in the Energy Efficiency and Renewable Energy Chapters, New York helps to foster private-sector demand for clean energy technologies and services through resource acquisition programs, Market Transformation initiatives, and clean energy goals and procurement

**29.** Brookings Institution. *Sizing the Clean Economy: A National and Regional Green Jobs Assessment*. 2011.

requirements at State agencies. These programs help to support nascent renewable energy and energy efficiency technologies as they are vetted by the market as successful technologies gain market acceptance. Key to growing its clean energy economy has been New York's consistent support of the clean energy sector which has given private industry the confidence to make long-term investment decisions to grow their businesses here in New York.

The growth of clean energy economy markets within New York is also linked to the significant market opportunities that arise from developing the State's transportation, electricity, and energy infrastructures. As an example, increased use of electric vehicles and deployment of high-speed rail will change transportation and energy use patterns within the State opening new markets for New York companies. Smart grid technologies and the ability to efficiently store electricity will also create new opportunities for electric usage and operation and efficiency of the electric grid.

In 2012, Governor Cuomo announced major initiatives to address these needs and fuel economic growth through an Energy Highway Initiative to upgrade and modernize New York's electric power system. The Initiative has identified projects and strategies to spur private-sector investment to maintain reliability and capitalize on lower cost energy resources. In addition, the Governor established the New York Works Fund to help create jobs and rebuild the State's transportation infrastructure.

New York is also supporting the growth of the voluntary market for renewable energy through facilitation of trade in renewable energy through creation of an electronic tracking system for renewable energy. This system is anticipated to be in operation in late 2014.

New York continues to explore State and federal regulatory and tax reforms that foster private-sector investment in R&D, encourage investments in growing businesses, and enable wider scale deployment of energy efficiency solutions, renewable resources, and energy storage. In fact, a comprehensive review is already under way through the New York State Tax Reform and Fairness Commission to address long-term changes to the tax system that could spur private sector growth. The federal government could also be encouraged to develop energy initiatives that provides stable, long-term confidence to the industry including examining the tax structure and providing incentives to encourage investments and deployment.

## A Clean Energy Workforce

New York boasts one of the most educated workforces in the country. As an example, 32 percent of those 25 years or older possess a Bachelor's degree compared with 28 percent nationally.[30] With the largest State University (SUNY) and City University (CUNY) systems in the country, almost 100 private colleges and universities, a robust community college system, and dozens of technical schools, New York has one of the most advanced workforce development networks in the world.[31]

However, there continues to be a critical shortage of skilled workers. According to a survey of 20,000 businesses by the New York State Department of Labor in 2010, 34 percent of manufacturers, 17 percent of construction firms, and 17 percent of professional service businesses engaged in energy efficiency or renewable energy cited difficulty in finding workers with the right skill set.[32]

To help bridge this gap, the State will look for opportunities to leverage the REDCs to identify workforce needs and engage industry to help shape curriculum particularly at SUNY, CUNY, community colleges, and technical institutes, including short courses and incumbent worker retraining. This includes jobs in energy efficiency, building retrofit, weatherization, site-based clean and renewable energy resources, power supply and demand, smart grid, codes and standards, manufacturing and operations, and professional services. In addition, New York is pursuing opportunities to increase Science, Technology, Engineering and Math (STEM) training at all levels of primary and secondary education to increase the number of students pursuing clean energy careers.

**30.** U.S. Census Bureau. *State Quick Facts Report*. 2012.
**31.** Carnegie Classification of Institutions of Higher Education. 2010.
**32.** New York State Department of Labor. *New York State Green Jobs Survey*. 2010.

# Acronyms

**AASHTO**
American Association of State Highway and Transportation Officials

**Ag&Mkts**
New York State Department of Agriculture and Markets

**ARRA**
American Recovery and Reinvestment Act

**ASHRAE**
American Society of Heating, Refrigerating, and Air-Conditioning Engineers

**bbl**
Barrel

**Bcf**
Billion Cubic Feet

**Board**
State Energy Planning Board

**Btu**
British Thermal Unit

**CAFE**
Corporate Average Fuel Economy

**cf**
Cubic Feet

**CHP**
Combined Heat and Power

**$CO_2$**
Carbon Dioxide

**CUNY**
City University of New York

**DEC**
New York State Department of Environmental Conservation

**DER**
Distributed Energy Resources

**DG**
Distributed Generation

**DHSES**
Division of Homeland Security & Emergency Services

**DOE**
U.S. Department of Energy

**DOH**
New York State Department of Health

**DOL**
New York State Department of Labor

**DOS**
New York State Department of State

**DOT**
New York State Department of Transportation

**DPS**
New York State Department of Public Service

**Dt**
Dekatherm

**EAG**
Evaluation Advisory Group

**ECL**
Environmental Conservation Law

**ECWG**
Energy Coordinating Working Group

**EEPS**
Energy Efficiency Portfolio Standard

**EIA**
U.S. Energy Information Administration

**EISA**
Energy Independence and Security Act of 2007

**EM&V**
Evaluation, Monitoring, and Verification

**Energy Code**
Energy Conservation Construction Code

**EO**
Executive Order

**EPA**
U.S. Environmental Protection Agency

**ESCO**
Energy Service Company

**ESD**
Empire State Development

**FER**
Federal Energy Regulatory

**GEIS**
Generic Environmental Impact Statement

**GHG**
Greenhouse Gas

**GJGNY**
Green Jobs–Green New York

**GW**
Gigawatt

**GWh**
Gigawatt Hour

**HCR**
New York State Homes and Community Renewal

**Hg**
Mercury

**HVAC**
Heating, Ventilation and Air Conditioning

**IECC**
International Energy Conservation Code

**kW**
Kilowatt

**kWh**
Kilowatt Hour

**LDC**
Local Distribution Company

**LEED**
Leadership in Energy and Environmental Design

**LEV**
Low Emission Vehicles

**LIHEAP**
Low Income Home Energy Assistance Program

**LIPA**
Long Island Power Authority

**LNG**
Liquefied Natural Gas

**Mcf**
One Thousand Cubic Feet

**MMBtu**
Million British Thermal Units

**MMcf**
Million Cubic Feet

**mpg**
Miles per Gallon

**MPO**
Metropolitan Planning Organization

**MTA**
Metropolitan Transportation Authority

**MW**
Megawatt

**MWh**
Megawatt Hour

**NAAQS**
National Ambient Air Quality Standards

**NOx**
Nitrogen Oxides

**NRC**
U.S. Nuclear Regulatory Commission

**NY BEST**
New York Battery and Energy Storage Technology Consortium

**NYCEDC**
New York City Economic Development Corporation

**NYISO**
New York Independent System Operator

**NYPA**
New York Power Authority

**NYSERDA**
New York State Energy Research and Development Authority

**OEM**
Office of Emergency Management

**OGS**
Office of General Services

**OMH**
Office of Mental Health

**PANYNJ**
Port Authority of New York and New Jersey

**PHEV**
Plug-in Hybrid Electric Vehicle

**Plan or SEP**
State Energy Plan

**PM**
Particulate Matter

**PPA**
Power Purchase Agreement

**PSC**
Public Service Commission

**PSL**
Public Service Law

**PV or Solar-PV**
Solar Photovoltaic

**REC**
Renewable Energy Credit

**REDC**
Regional Economic Development Council

**RFS**
Renewable Fuel Standard

**RGGI**
Regional Greenhouse Gas Initiative

**RNA**
Reliability Needs Assessment

**ROI**
Returns on Investment

**RPS**
Renewable Portfolio Standard

**SBC**
System Benefits Charge

**SEQRA**
State Environmental Quality Review Act

**SGEIS**
Supplemental Generic Environmental Impact Statement

**$SO_2$**
Sulfur Dioxide

**SPDES**
State Pollution Discharge Elimination System

**STARS**
New York State Transmission Assessment and Reliability Study

**SUNY**
State University of New York

**SWP**
System-Wide Program

**T&MD**
Technology and Market Development

**TBtu**
Trillion British Thermal Units

**Th**
Therm

**TOD**
Transit Oriented Development

**U.S. DOH**
U.S. Department of Health

**U.S. DOL**
U.S. Department of Labor

**U.S. DOT**
U.S. Department of Transportation

**VMT**
Vehicle Miles Traveled

**VOCs**
Volatile Organic Compounds

**WAP**
Weatherization Assistance Program

# Glossary

## A

### Alternative Fuel Vehicles

Vehicles which use fuels other than gasoline or diesel. Alternative fuels include electricity, natural gas, propane, ethanol, vegetable and waste-derived fuels, and hydrogen. These fuels may be used in a dedicated system that burns a single fuel, or in a mixed system with other fuels including traditional gasoline or diesel, such as in hybrid-electric or flexible fuel vehicles.

### Anaerobic Digestion

A natural process that converts biomass to gas under oxygen free conditions. The resulting gas is principally composed of methane and carbon dioxide and is referred to as Anaerobic Digester Gas (ADG).

### Ancillary Services

Services pertaining to the electricity system that are necessary to support the transmission of electric power from seller to purchaser given the obligations of control areas and transmitting utilities within those control areas to maintain reliable operations of the interconnected transmission system. Ancillary services include reactive power, voltage control, frequency regulation, and blackstart capability, among others.

## B

### Barrel (bbl)

Unit of volume equal to 42 U.S. gallons which is traditionally used to quantify crude oil.

### Billion Cubic Feet (bcf)

Measure of volume commonly used for natural gas.

### Biodiesel

An alternative fuel that can be made from any fat or vegetable oil. It can be used in any diesel engine with few or no modifications. Although biodiesel does not contain petroleum, it can be blended with diesel at any level or used in its pure form.

### Bioenergy

Biomass and its derivative products, such as biogas and liquid biofuels, are organic, non-fossil plant materials initially produced through photosynthesis that are collectively known as bioenergy and may be liquid, solid, or gaseous.

### Biofuels

Liquids derived from biomass, through chemical, thermal, and biological processes. Ethanol and biodiesel are the dominant biofuels currently available and are the focus of this assessment. Biofuels typically are blended with petroleum products, e.g., ethanol with gasoline and biodiesel with diesel, and used as transportation fuels.

### Biogas

The gasified product of biomass or the methane produced from the anaerobic decomposition of biomass from sources such as landfills, wastewater treatment plants, manure and other agricultural byproducts, and food processing facilities.

### Biomass

Solid organic, non-fossil plant materials initially produced through photosynthesis. The types of of biomass are diverse and can include wood and scrap forest materials, waste material from the forestry, food, and pulp and paper industries, specialized energy crops, and crops such as corn, sugar cane, and soybeans.

### British Thermal Unit (Btu)

The amount of heat required to raise the temperature of one pound of water one degree Fahrenheit. This unit provides a common denominator for quantifying all types of energy on an equivalent energy content basis. *See also MMBtu (million Btu) and TBtu (trillion Btu)*.

### Byproduct

A secondary or incidental product of a manufacturing or other process.

## C

### Capacity

The maximum capability of an energy system or component of that system to either produce or move energy at or within a specific time frame. Within the context of electricity, capacity is commonly expressed in megawatts (MW), and means the maximum amount of power that can be generated at any given time. Natural gas capacity usually refers to the maximum cubic feet of gas that can be transported by a pipeline within an hour or within a day. In the context of petroleum, capacity can refer to either the maximum amount of product that can be moved through a pipeline or the maximum product that can be processed in a refinery.

### Carbon Dioxide
A colorless, odorless noncombustible gas with the formula $CO_2$ that is present in the atmosphere. It is predominantly formed by the combustion of carbon and carbon compounds (such as fossil fuels and biomass), by respiration (which is a slow combustion in animals and plants), and by the gradual oxidation of organic matter in the soil.

### Climate Change
As defined by the Intergovernmental Panel on Climate Change (IPCC), climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. It is extremely likely that human influence has been the dominant cause of observed warming since the mid-20th century.

### Coal
A readily combustible black or brownish-black rock composed largely of carbonaceous material. It is formed from plant remains that have been compacted, hardened, chemically altered, and metamorphosed by heat and pressure over geologic time.

### Coke
A solid carbonaceous residue derived from coal by a high-temperature baking process. Coke is used as a fuel and as a reducing agent in smelting iron ore in a blast furnace.

### Combined Cycle Generation
A relatively highly efficient type of generating facility in which a gas turbine generates electricity and waste heat is used to make steam to generate additional electricity via a steam turbine. Most of the new fossil-fueled generation capacity built in the northeastern states over the past two decades has been of this type. Combined cycle generation is contrasted by simple cycle generation, which uses only a single turbine.

### Commercial Sector
The part of the energy-using economy that is associated with the providing of goods and services other than manufacturing. The commercial sector includes both private and public entities, and is made up of offices, wholesale and retail businesses, hotels and restaurants, educational and health care facilities, financial institutions and services, and religious and social organizations.

### Constant Dollars
Values that are adjusted to remove the effects of price changes due to inflation; also referred to as real dollars.

### Crude Oil
The raw material from which petroleum products such as gasoline and heating oil are made by the refining process. Crude oil is a dark liquid fossil fuel comprised of a mixture of hydrocarbons usually found deep in the Earth.

### Cubic Foot (cf)

Measure of volume commonly used for natural gas.

# D

### Dekatherm (Dt)

Unit commonly used to measure amount of natural gas, based on its heat content in Btu rather than its volume in cubic feet. One therm equals 100,000 Btu; one dekatherm equals ten therms or 1,000,000 Btu.

### Demand

In economic terms, demand refers to the amount of any product, including electricity, natural gas, petroleum products, or other fuel, that is required to meet customer needs. Electricity demand is also known as load, and can refer to the amount that is needed by customers within a specific period of time, such as an hour or month or year. In the context of electricity, the term "demand" is also used to refer to the highest amount of electricity that a customer may require within a short period such as a 15-minute interval, for the purpose of determining the demand charge component of electricity rates paid by customers.

### Demand Response

Temporarily reducing electricity usage in response to a request from the system operator to do so, typically to maintain system reliability, and typically in exchange for a financial incentive.

### Deregulation

The elimination of some or all regulations from a previously regulated industry or sector of an industry. Deregulation of the electricity industry refers to the separation in ownership of generation, transmission, and distribution. Prior to deregulation the electricity industry consisted primarily of vertically integrated utilities which owned generation facilities as well as transmission and distribution. Deregulation resulted in utilities selling their generation assets to independent entities such that their primary business became providing distribution services to customers.

### Diesel Fuel

The primary refined petroleum fuel used by heavy trucks, construction equipment and emergency power generators. Diesel fuel, along with heating oil, is a major component of the category of fuels known as distillates.

### Distillate Fuel

A general classification for one of the petroleum fractions produced in conventional distillation operations. It includes diesel fuels and fuel oils. Products known as No. 1, No. 2, and No. 4 diesel fuel are used in on-highway diesel engines, such as those in trucks and automobiles, as well as off-highway engines, such as those in railroad locomotives and agricultural machinery. Products known as No. 1, No. 2, and No. 4 fuel oils are used primarily for space heating and electric power generation.

### Distributed Generation
Small electric generating facilities, either renewable or other, located near the end consumer, such as solar panels installed on residential home roofs, fuel cells located in office buildings or fossil-fuel burning back-up assets.

### Distribution
The delivery of energy to end-users or customers. The distribution component of New York State's electric system is generally used to carry electric power from the transmission component to the locations of end-use consumers. The distribution component of the natural gas system transfers natural gas from the large interstate pipelines through a network of various sizes of "mains" to individual customer locations. The distribution component of petroleum products includes pipelines, barges, railroads, trucks, and service stations.

### Dual-fuel Generation Unit
Electricity generation facilities that are able to run on either natural gas or oil. In some units, only the primary fuel, most often natural gas, can be used continuously; the alternate fuel(s) can be used only as a start-up fuel or in emergencies.

## E

### E85
An alternative motor fuel that contains a mixture of 85 percent ethanol and 15 percent gasoline.

### Emission Cap
Emission cap usually refers to an environmental regulatory system that imposes a cap or limit on the amount of pollution that can be emitted in a state or region over a specific time period. Emissions trading, or cap and trade, is a market-based approach used to control pollution by providing economic incentives for achieving reduction in pollutant emissions, and allowances to comply with emission reductions requirements. Pollution sources can buy or sell allowances on the open market. Sources can choose how to reduce emissions, including whether to buy additional allowances from other sources that reduce emissions. The Regional Greenhouse Gas Initiative (RGGI), which sets an emission cap on carbon dioxide emissions from power plants in nine northeastern states including New York, is an example of an emission cap system.

### Energy
The capacity for doing work as measured by the capability of doing work (potential energy) or the conversion of this capability to

motion (kinetic energy). Energy has multiple forms, which vary widely in their ability to be convertible and to be changed to another form useful for work. A large amount of the world's convertible energy comes from fossil fuels that are burned to produce heat that is then used as a transfer medium to mechanical or other means in order to accomplish tasks. Commonly used forms of energy include natural gas, petroleum, coal, hydro power, nuclear, wind, solar, biomass, and biofuels. Heat energy is usually measured in British Thermal Units (Btu). Energy converted to electricity is usually measured in kilowatt hours (kWh). *See also primary energy, net energy, fossil fuels, renewable energy, Btu, and kWh.*

### Energy Efficiency

Energy efficiency means any technology or activity that results in using less energy to provide the same level of service, work, or comfort to customers. End-use energy efficiency takes place at the customer's location and means that individual customers use less energy to complete the same task. System-level efficiency means that improvements are made in either producing or transporting energy such that less energy is used in the process of providing energy to end-use customers.

### Energy Services Company (ESCO)

In deregulated energy markets, an ESCO is a company other than the local utility company which purchases energy (electricity or natural gas) on the open market and sells the energy to consumers, with the delivery continued to be done through the utility. The term ESCO also refers to a company other than a utility that provides a variety of energy-related services to consumers that may include energy audits, energy management, efficiency projects, renewable energy projects, and financing opportunities.

### Environmental Justice

The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental and commercial operations or policies. Meaningful involvement means that: (1) people have an opportunity to participate in decisions about activities that may affect their environment and/or health; (2) the public's contribution can influence the regulatory agency's decision;(3) their concerns will be considered in the decision making process; and (4) the decision makers seek out and facilitate the involvement of those potentially affected.

**Ethanol**
A colorless liquid that burns to produce water and carbon dioxide. The vapor forms an explosive mixture with air and may be used as a fuel in internal combustion engines.

# F

**Feedstock**
The raw material input to an industrial process. Fossil fuels are often used as feedstocks to industrial processes because of their chemical properties, rather than their energy value.

**Firm Gas**
Natural gas provided to customers under rate structure that guarantees that gas will be delivered at all times, including the times of highest hourly demand which are generally the coldest periods when the largest amount of gas is needed for space heating.

**Firm Power**
Power or power-producing capacity, intended to be available at all times during the period covered by a guaranteed commitment to deliver, even under adverse conditions.

**Fossil Fuel**
Fuels derived from organic material formed by the compression in the Earth's crust of ancient plants and animals over millions of years. The most common fossil fuels are petroleum products, coal, and natural gas.

# G

**Gallon (gal)**
A measure of volume equal to 4 quarts (231 cubic inches), commonly used to measure petroleum products such as gasoline and heating oil.

**Gasoline**
Highly refined petroleum product used primarily to fuel highway vehicles. Gasoline is a complex mixture of relatively volatile hydrocarbons, often containing various additives, that have been blended to form a fuel suitable for use in internal combustion engines.

**Generation**
Generation refers to both the mechanical units and the process of producing electricity by transforming other types of energy, including fossil fuels, hydro, nuclear, wind, photovoltaic, etc. Generation is commonly expressed in kilowatt-hours (kWh) or megawatt hours (MWh).

**Gigawatt-hour (GWh)**
Unit of measure for amount of electricity generated or used. Equals one million kilowatt-hours, or one billion watt-hours.

### Greenhouse Gases (GHG)

A gas in the atmosphere that absorbs or emits radiation within the thermal infrared range. GHG prevent radiant energy from leaving the Earth's atmosphere or trap the heat of the sun producing the greenhouse or warming effect. The primary GHG include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride, as well as water vapor. Greenhouse gases are transparent to short-wave solar radiation but opaque to long-wave infrared radiation, thus preventing long-wave radiant energy from leaving Earth's atmosphere. The net effect is a trapping of absorbed radiation and a tendency to warm the planet's surface gases that trap the heat of the sun in the Earth's atmosphere, producing the greenhouse effect. Increases in the amount of GHG in the atmosphere enhances the greenhouse effect leading to more heat being trapped. This extra heat is causing climate change.

## H

### Henry Hub

The natural gas pipeline hub on the Louisiana Gulf coast that is most frequently used as a benchmark for natural gas commodity prices. It is the delivery point for the natural gas futures contract on the New York Mercantile Exchange (NYMEX).

### Hydraulic Fracturing

Process for extracting natural gas or crude oil. The process produces fractures in the target rock formation by pumping large quantities of fluids at high pressure down the wellbore. The fractures stimulate the flow of natural gas or crude oil, increasing the volumes that can be recovered.

### Hydroelectric Power

Electricity generated by turbines turned by moving water, often shortened to "hydro."

## I

### Industrial Sector

The part of the energy-using economy that is associated with manufacturing, processing, mining, and quarrying.

### Installed Capacity

Refers to the total amount of electric generating capacity installed.

### Interruptible Gas

Natural gas provided to customers under a rate structure at a lower price that allows the provider to curtail the supply during periods of highest demand, such as during cold periods when the greatest amount of gas is needed for space heating.

### Interruptible Power

Power and usually the associated energy made available by one utility to another. This transaction is subject to curtailment or cessation of delivery by the supplier in accordance with a prior agreement with the other party or under specified conditions.

## K

### Kilowatt (kW)

A unit of power, usually used for electricity.

### Kilowatt Hour (kWh)

A measure of electricity defined as a unit of work or energy, measured as 1 kilowatt (1,000 watts) of power expended for 1 hour. One kWh is equivalent to 3,412 Btu.

## L

### Liquefied Petroleum Gas (LPG)

Also known as propane (*see definition*).

### Load

The power and energy requirements of users on the electric power system in a certain area or the amount of power delivered to a certain point.

### Load Serving Entity (LSE)

A legal entity, often a utility, municipal electric system, or electric cooperative, authorized or required by law, regulatory authorization or requirement, agreement, or contractual obligation to supply Energy, Capacity and/or Ancillary Services to meet the electricity needs of retail customers, including an entity that takes service directly from the NYISO to supply its own load. Since the restructuring of the electricity industry, the sale of electricity and/or delivery arrangements may be handled by other agents, such as Energy Services Companies (ESCOs).

### Local Distribution Company (LDC)

A legal entity, often a utility, engaged primarily in the retail sale and/or delivery of natural gas through a distribution system that includes mains (i.e., pipelines designed to carry large volumes of gas) and laterals (i.e., pipelines of smaller diameter that connect the main to end users). Since the restructuring of the gas industry, the sale of gas and/or delivery arrangements may be handled by other agents, such as producers, brokers, and marketers that are referred to as “non-LDC.”

# M

### Megawatt (MW)

A unit of electrical power equal to 1000 kilowatts or one million watts

### Megawatt Hour (MWh)

A measure of electricity defined as a unit of work or energy, measured as 1 Megawatt (1,000,000 watts) of power expended for 1 hour. One MWh is equivalent to 3,412,141 Btu.

### Micro Grid

A group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid and that can connect and disconnect from such grid to enable it to operate in both grid-connected or island mode.

### Million British Thermal Units (MMBtu)

*See British Thermal Unit (Btu).*

# N

### Natural gas

A colorless, tasteless, nonrenewable clean-burning fossil fuel, widely used to generate electricity and also used directly by end-use customers to provide space heat, water heating, and cooking.

### Net Energy Use

The energy consumed by customers at the end-use location (i.e. building or vehicle, including electricity as well as the fuel burned on-site to provide space heat, water heat, etc. Net energy use accounts for electricity based on the heat content of energy at the plug (3,412 Btu per kWh), and excludes the heat losses incurred during generation, transmission, and distribution of electricity. Adding the heat losses associated with electricity to net energy use results in "primary energy use."

### Net Metering

Allowing a customer's electric meter to measure both the reverse and forward flow of electricity, allowing the meter to register when a customer is producing more energy on site than it is using (which will cause the meter to reverse), as well as when a customer is producing less energy than it is using (which will cause the meter to move forward).

The combined effect, or netting, of the reverse and forward flows, results in net metering.

### Nominal Dollars

The price paid for a product or service at the time of the transaction; i.e. values that are not adjusted to remove the effect of price changes due to inflation.

### Non-attainment Areas

Areas that do not meet (or contribute to nearby areas that do not meet) the primary or secondary National Ambient Air Quality Standards (NAAQS) for one of six criteria air pollutants "ozone, particulate matter, carbon monoxide, nitrogen dioxide, sulfur dioxide and lead." Designations are based on measured air quality. Primary standards set limits to protect public health and secondary standards set limits to protect public welfare including decreased visibility, damage to animals, crops, vegetation, and buildings.

## O

### Off-Peak Periods

Periods of time when energy use and the cost to provide energy are lowest. For electricity, this is usually during the night. For natural gas, heating oil and propane, this is usually during the summer.

### One Thousand Cubic Feet (Mcf)

Measure of volume commonly used for natural gas.

## P

### Peak Periods

Periods of time during which energy use and the cost to provide energy are highest. For electricity, this is usually during the hottest hours of the day in summer. For natural gas, heating oil, and propane, this is usually during the coldest periods of the winter.

### Peaking Assets

Electricity generation units that are called on primarily during peak periods. These are often relatively inefficient combustion turbines that have a high cost per kWh, but that can be cycled on and off quickly to meet immediate electricity needs.

### Petrochemicals

Chemicals isolated or derived from "petroleum" or natural gas that are used as feedstocks in the manufacturing of plastics, synthetic fabrics, and a wide variety of industrial and consumer products.

### Petroleum

Generally refers to crude oil or the refined products obtained from the processing of crude oil (gasoline, diesel fuel, heating oil, etc.) Petroleum also includes lease condensate, unfinished oils, and natural gas plant liquids.

### Primary Energy Use

Total consumption of fuels, including the fuels used to generate electricity. Primary energy accounts for electricity based on the equivalent heat content of fuel at the generator. Subtracting the heat losses associated with electricity generation, transmission, and distribution from primary energy use results in "net energy use."

### Propane

Also known as liquefied petroleum gas (LPG). A colorless, highly volatile hydrocarbon that is readily recovered as a liquefied gas at natural gas-processing plants and refineries. It is used primarily for residential and commercial space heating, and also as a fuel for transportation and industrial uses, including petro-chemical feedstocks. Propane is often used at customer locations where natural gas is not available, as it can be easily transported by truck and stored at the customer site.

## R

### Refined Petroleum

Refined petroleum products include but are not limited to gasoline, kerosene, distillates (including No. 2 fuel oil), liquefied petroleum gas, asphalt, lubricating oils, diesel fuels, and residual fuels.

### Refinery

An industrial plant that heats crude oil in a complex distillation process so that is separates into chemical components, which are then made into a wide variety of petroleum products with very specific properties and uses. Refinery products include various types of gasoline, diesel fuel, heating oil, kerosene, aviation fuel, and residual oil.

### Reliability

Bulk electric system (i.e. generation and transmission) reliability consists of a series of very specific engineering-based metrics that measure both resource adequacy and transmission operating reliability. Resource adequacy measures the degree to which system resources are sufficient to be able to meet customer load when and where needed. Transmission operating reliability measures the ability of the delivery system to get the power to the load and its ability to withstand various contingencies such as generators or transmission lines being out of service without dire consequences. Electricity distribution (i.e. service) reliability is measured by utility-filed data on frequency and duration of service interruptions. The term reliability also applies to the performance of natural gas and petroleum delivery systems, but the metrics for measurement and system design criteria are far less formalized by regulatory processes.

### Renewable Energy Resources

Sources which are capable of being continuously restored by natural or other means, or are so large as to be usable for centuries without significant depletion, and include but are not limited to solar, wind, plant and forest products, organic wastes, tidal, hydro, and geothermal. While renewable energy resources are virtually inexhaustible in duration, they may be limited in the amount of energy that is available per unit of time. In contrast, fossil fuels such as coal, natural gas and petroleum take millions of years to develop naturally and are considered nonrenewable.

### Repowering

Repowering refers to the retirement of a power plant and the reconstruction of a new, cleaner, and more efficient plant on the same property.

### Residential Sector

The part of the economy having to do with the places people stay or live. The residential sector is made up of homes, apartments, condominiums, etc.

### Residual Oil

The heavier oils, including No. 6 fuel oil, that remain after the distillate fuel oils and lighter hydrocarbons are boiled off in refinery operations. Residual oil is used for production of electric power, space heating, vessel bunkering, and various industrial purposes.

### Resiliency

Ability of the energy system to reduce the impact and duration of disruptive events. Resiliency encompasses the capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to the energy system, environment, economy, and social well-being.

### Regional Greenhouse Gas Initiative (RGGI)

The Regional Greenhouse Gas Initiative is a mandatory, market-based effort to reduce greenhouse gas emissions in nine Northeastern and Mid-Atlantic States, including New York. It is implemented in New York by DEC and NYSERDA.

## S

### Shale Gas

Natural gas produced from wells that are open to shale formations. Shale is a fine-grained, sedimentary rock composed of mud from flakes of clay minerals and tiny fragments (silt-sized particles) of other materials. The shale acts as both the source and the reservoir for the natural gas.

### Smart Grid

According to the U.S. DOE, Smart Grid generally refers to “a class of technology people are using to bring utility electricity delivery systems into the 21st century, using computer-based remote control and automation. These systems are made possible by two-way communication technology and computer processing that has been used for decades in other industries." Smart grid technology can enable system operators to more quickly identify the location and cause of an outage as well as enable customers to adjust their energy usage patterns in response to pricing information from the grid.

### Smart Growth

Smart Growth is development that serves the economy, community, and the environment. It provides a framework for communities to make informed decisions about how and where they grow. Smart Growth makes it possible for communities to grow in ways that support economic development and jobs; create strong neighborhoods with a range of housing, commercial, and transportation options; and achieve healthy communities that provide families with a clean environment.

### Solar Photovoltaic

A technology that directly converts the energy radiated by the sun as electromagnetic waves into electricity by means of solar panels.

### Solar Thermal

A system that uses sunlight to heat water or create steam, which can then be used directly, stored, or used to generate electricity. Solar thermal energy may be applied to water heating, space heating, or heating pools.

### System Security Constraints

Limitations imposed on the energy system to maintain reliability, such as transmission line ratings and transfer limits across interfaces between zones.

## T

### Trillion British Thermal Units (TBtu)

*See British Thermal Unit (Btu)*.

### Ton or Short Ton

A unit of weight equal to 2,000 pounds, often used to measure amounts of coal and air emissions of various pollutants. A long ton or metric ton is equal to 2,200 pounds.

### Transmission

Transmission refers to the high-voltage, long-distance lines through which electrical power is transported from generation units.

### Transportation Sector

The part of the energy-using economy related to vehicles, fuels, and systems that move people and goods from one place to another. The transportation sector is made up of automobiles, buses, trucks, trains, and ships, and all fuels and systems that power and control them.

### Turbine

A device for producing continuous power in which a wheel or rotor, typically fitted with vanes, is made to revolve by a fast-moving flow of water, wind, steam, gas, air, or other fluid. Typically, the mechanical energy of the spinning turbine is converted into electricity by a generator.

## W

### Watt (W)

The unit of measure for electric power or rate of doing work. It is analogous to horsepower of mechanical power. One horsepower is equivalent to approximately 746 watts. *See also megawatt*.

### Wellhead Price

The price of natural gas at the point of extraction.

### Wind Energy

A renewable source of energy used to turn turbines to generate electricity.

## PHOTO CAPTION LIST

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Vegetables in frying pan on a stove.
Photographer: Tetra Images (Getty Images)

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A home thermostat.
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George Washington Bridge at night.
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Altamont, NY train station at twilight.
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Worker at the Upper Niagara Cooperative in St. Lawrence County, New York.
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Dual fuel train passing a station.
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Solar and wind demonstration project at the New York Power Authority's Blenheim-Gilboa Visitors Center in Schoharie County.
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Albany, NY at night.
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2015 New York State Energy Plan

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