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**Promoting a Level Playing Field for Energy Options:
Electricity Alternatives and the Case of the Indian Point Energy Center***

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Promoting a Level Playing Field for Energy Options: Electricity Alternatives and the Case of the Indian Point Energy Center

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Abstract

The Indian Point Energy Center, with two operational nuclear reactors, sits in a densely populated region just 40 miles north of midtown Manhattan. It is a vital part of the electricity supply system for the New York City region, but its propinquity to the largest city in the United States has raised public concerns about its safe operation, particularly in the event of a terrorist attack. Such concerns prompted the U.S. Congress to request a study of potential options for replacing the 2,000 MW of power provided by Indian Point. This paper assesses the potential for electricity alternatives in the Indian Point service area. It documents that increased investments in energy efficiency, combined heat and power facilities, and solar photovoltaics could cost-competitively reduce peak demand in the Indian Point service area by 1 Gigawatt (GW) or more by 2010 and by 1.5 GW by 2015. If the cost of solar photovoltaics can be brought to near-competitive levels over the next decade, these totals could be raised to 1.7 GW by 2015, approaching the capacity of the Indian Point Energy Center. This result challenges the conventional focus of system operators and policymaker on supply-side solutions.

Key Words: Demand-Side Management, Energy Efficiency, Demand Response, Solar Photovoltaics, Combined Heat and Power

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1. Introduction

Numerous energy resource and infrastructure challenges await the United States and the world. If the global demand for energy continues to grow at the projected rate of roughly 2% annually, the world will require 721 quadrillion British Thermal Units (quads) of energy production in 2030, 71% more than the 421 quads consumed in 2003 (EIA, 2006, p. 1). Given that the energy technologies we choose to deploy today will shape the future energy landscape and its environmental emissions for many decades, it is critical that energy industries and policymakers select the best options and that the infrastructure siting concerns of local communities not trump the larger need for expanding energy supplies.

Considering one such challenge in the United States, the state of New York could lose 2,000 megawatts (MW) of base-load power within the next ten years. The Indian Point Energy Center, owned and operated by Entergy Nuclear Northeast and located on the east bank of the Hudson River in Buchanan, New York, currently provides base-load electricity to the area surrounding New York City. At that facility, Entergy manages two nuclear reactors, one in operation since 1974 acquired from Consolidated Edison and another operated since 1976 acquired from the New York Power Authority. The licenses for both of these reactors on file with the U.S. Nuclear Regulatory Commission are set to expire in 2013 and 2015. Authorities are already scrambling to find ways to displace this power well before their licenses expire, one scenario including a rapid shut down by 2008

(National Academies, Committee on Alternatives to Indian Point for Meeting Energy Needs, 2006).

In one way, the downstate New York challenge is unique in that it includes the nation's largest metropolitan area and is part of a region that is already stressed with low electricity reserve margins and major energy infrastructure limitations. Yet, in a different sense, the energy situation faced by downstate New York is a microcosm of what other areas might confront as the potential shutdown of nuclear base-load resources draws nearer. With 40% of the U.S. nuclear power plant capacity scheduled to retire by 2020, the challenges facing the region served by the Indian Point Energy Center could be replicated in many other parts of the country (Sovacool and Hirsh, 2007; Sovacool, 2005). Even if each of the existing U.S. nuclear units were to receive a 20-year license renewal, as is forecast by the U.S. Energy Information Administration, at least four units are likely to be retired by 2030 when their 20-year license extensions expire (EIA, 2007, p. 84).

Consequently, a discussion of the process used to evaluate alternatives to Indian Point exemplifies the type of broad assessment of technology options needed to foster a positive public dialogue. It offers a useful case study for system operators, utility managers, and policymakers in other parts of the country where licenses for nuclear, hydroelectric, and fossil fuel generators may expire. Moreover, an investigation of the alternative energy options for Indian Point can help inform energy policymakers anywhere current power options are constrained because of climate change, environmental regulations, urban congestion, or public opposition.

For example, in the Pacific Northwest of the U.S., global warming is expected to induce a dramatic loss of snow-pack as more precipitation falls as rain. As a result, numerous studies have suggested that the hydrology of the region will be fundamentally altered with increased flood risks in the spring and reductions of snow in the winter (U.S. Global Change Research Program, 2004; Goodstein and Matson, 2004). As a result, power retailers in the region have expressed concern that large hydroelectric and nuclear facilities will have to be retired prematurely due to lack of adequate water for electricity generation and cooling (Palmer and Hahn, 2002; Fazio, 2003).

Additionally, American power providers expect significant constraints concerning the retention and expansion of existing coal plants. Most U.S. coal plants operating today are 20 to 50 years old. Built to last 30 years or more, many components (boilers, turbines) will have to be overhauled or replaced entirely in the next 10 to 20 years (Morgan, et al., 2005, p. 55). Anticipation of possible future greenhouse gas regulations or taxes in the United States has tended to defer much-needed investment in coal facilities, as international companies are reluctant to authorize expenditures in a technology that may soon become less competitive due to carbon restrictions (International Energy Agency, 2003). Worldwide, the International Energy Agency (2004) expects more than half of current fossil-fueled capacity in Europe to be retired by 2030.

Indeed, the National Commission on Energy Policy (2006) recently pointed to delays and difficulties faced by policymakers trying to deploy almost every form of electricity supply, from nuclear and coal to wind turbines and transmission lines. Prominent examples they cite include the Yucca Mountain nuclear repository, the Cape

Wind project in Nantucket Sound, landfill gas generators proposed in many urban regions, liquid natural gas terminals proposed in Maine and New Jersey, and the proposed underwater transmission line from Connecticut to Long Island.

And so, as policymakers hasten to fill the void left by potentially constrained hydroelectric, fossil fuel, nuclear plants, and other fuel sources with their associated infrastructures, the question remains: what measures can be counted on to provide firm or reliable power in the same way that Indian Point does? The benefits of "firm" power are numerous and well documented. According to the Tennessee Valley Authority (2005), "firm power is electricity that is available twenty-four hours a day." This type of electricity is widely used by commercial and industrial customers who need reliable service. To ensure high levels of reliability, firm power is typically sold by contract, making the utility obligated to provide uninterruptible service (and often through a combination of electricity from centralized plants supplemented with on-site combined heat and power systems in the form of natural gas turbines and diesel generators).

In New York, for instance, Entergy relies on Indian Point and an assortment of other generators to provide firm power to its customers. The provision of electricity from large generators distributed over a vast and complex transmission and distribution network is viewed by many as the best and most reliable method of producing power. In contrast, policymakers have tended to view energy efficiency, distributed generation (DG), and intermittent renewable generators as important, but somehow less reliable than the construction of new fossil fuel and nuclear generators. System operators often note that efficiency can serve as a cost effective and noteworthy alternative to supply-side measures, but they do not know who to hold accountable if efficiency measures fail to work. Others believe that the United States has already maximized its energy efficiency potential, based on the significant reduction in U.S. energy intensity since 1970 (Brown, Sovacool, and Hirsh, 2006). Similarly, system operators and utilities in the U.S. tend to view DG and renewable energy generators as more expensive and difficult to manage than centralized facilities. Many forms of DG technologies are cheaper to buy and operate, but mostly run on expensive fuels such as natural gas.

Thus, perhaps incongruously, past accomplishments in energy efficiency, DG, and renewables – combined with confusion and complexity about contemporary efficiency measures – allow myths and misperceptions about them to persist. Some of the more pervasive include: (a) energy efficiency improvements have already reached their potential; (b) energy efficiency is impossible to measure and enforce; and (c) key barriers to further penetration are primarily "technical" (Sovacool and Brown, 2007).

To help place these myths about energy alternatives in context, this paper holds that efficiency measures, DG, and renewables can be as reliable as the construction of new power plants and the purchase of power via long-term contracts and spot markets. After defining electricity alternatives, the manuscript characterizes the portfolio of options available to policymakers in the New York region, with an emphasis on efficiency practices, CHP, and solar PV. The paper ends with a discussion of how participatory and comprehensive energy planning approaches such as this could be deployed to address other energy infrastructure challenges facing the nation.

2. Defining and Conceptualizing Electricity Alternatives

For the purposes of this study, *energy efficiency* refers to long-term reduction in electricity consumption as a result of the increased deployment or improved performance of energy-efficient equipment. By reducing electricity consumption, energy efficiency is a low-cost contributor to system adequacy – the ability of the electric system to supply the aggregate energy demand at all times – because it reduces the base load as well as the peak power demand. This reduction in peak power requirements can also contribute to system security – the ability of the system to withstand sudden disturbances – by reducing the load and stress at various points in the power distribution system, thereby decreasing the likelihood of failures. As one influential report on efficiency put it, "energy-efficiency opportunities are typically physical, long-lasting changes to buildings and equipment that result in decreased energy use while maintaining constant levels of energy service" (Rufo and Coito, 2002, p. 1)

A close corollary of energy efficiency, *demand-side management,* refers to programs that allow utilities to better match their demand with their generating capacity. By changing the load curve for utilities, system reliability can be enhanced and new power plant construction can be avoided or delayed. Current programs tend to aim at limiting peak electricity loads, shifting peak loads to off-peak hours, or encouraging consumers to change demand in response to changes in the utilities' cost of providing power (Gillingham et al., 2004).

Another variant is *demand response*, which refers to curtailment or other immediate steps that are aimed at reducing the peak megawatts (MW) of load. Real-time demand-response programs allow consumers to respond to electricity prices directly, offering mechanisms to help manage the electricity load in times of peak electricity demand to improve market efficiency, increase reliability, and relieve grid congestion. Significant consumer benefits also accrue from real-time demand-response programs, chiefly in the form of cost savings due to lower peak electricity prices, less opportunity for market manipulation by electricity providers, and additional financial incentives to induce their participation in these programs. In electricity markets, consumers have the capability to ease tight capacity situations, mitigate reliability concerns and discipline the markets by reducing power consumption, or choosing not to purchase power when prices rise. Demand-response programs focus on consumers' actions to change the utility's load profile. They are not aimed at saving energy so much as shifting the time at which it is demanded, as shown in the middle set of curves in Figure 1.

<Insert Fig 1>

Demand-response programs allow consumers to respond to electricity prices directly, offering mechanisms to help manage the electricity load in times of peak electricity demand to improve market efficiency, increase reliability, and relieve grid congestion. Significant consumer benefits can also accrue from real-time demand-response programs, chiefly in the form of cost savings due to lower peak electricity prices, less opportunity for market manipulation by electricity providers, and additional financial incentives to induce their participation in these programs. Security response programs enable utilities to drop loads in response to electric system contingencies. They can be implemented quickly and inexpensively, usually with the agreement of large users of electricity, who receive lower rates in return for relying on interruptible power. They have no impact on the load except with the contingency occurs during peak periods, as shown ion the right side of Figure 1.

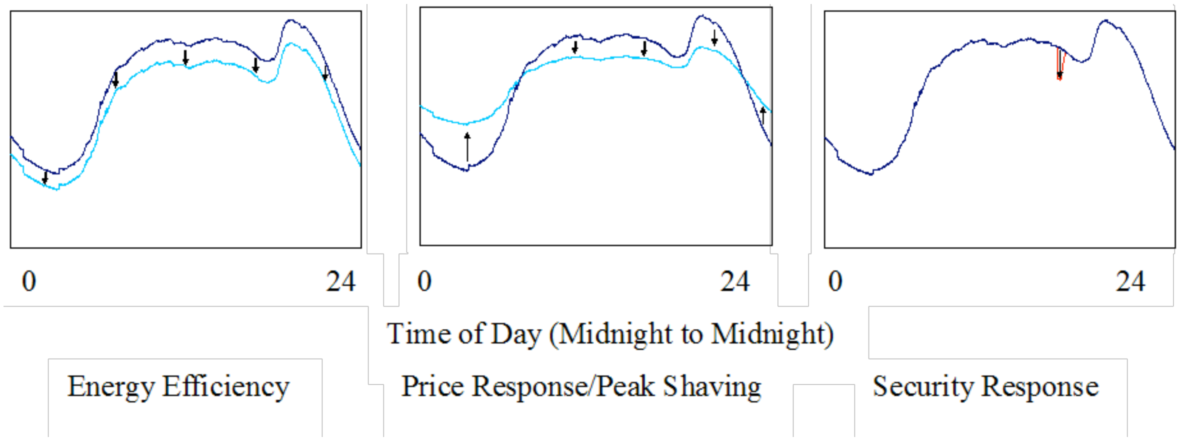

Fig. 1. Effect of Demand-Reduction Programs on Daily Power Demand (Adapted from Kirby, et al., 2005)

Distributed generation (DG) is the production of electricity at or close to its point of use. DG is usually installed on the customer side of the meter and is not dispatchable by the utility (Sovacool and Hirsh, 2007). *Combined heat and power* (CHP), a subset of DG, generally involves reciprocating engines or turbines to drive electric generators, with the waste heat captured and used for other purposes. Most CHP systems in the U.S. remain fueled by wood, natural gas, oil, and coal, but their efficiency has improved over time. Typically, CHP systems generate hot water or steam from the recovered waste heat and use it for process or space heating. The heat can also be directed to an absorption chiller where it can provide process or space cooling. CHP systems may offer economic, security and reliability benefits. Siting generation close to its point of use enables greater use of a device's overall energy output (including waste heat).

Historically the average efficiency of central station power plant systems in the U.S. has been approximately 33%, and has remained virtually unchanged for more than a half century. This means that almost two-thirds of the energy in the fuel cannot be converted to electricity at most power plants in the United States and is released to the environment as low temperature heat. CHP systems, by capturing and converting waste heat, achieve effective electrical efficiencies of 50% to 80%. Furthermore, centrally located facilities typically lose 5-8% of their rated output through transmission and distribution losses. CHP systems, by being at or near the point of use, avoid most of these line losses (Casten and Ayres, 2007; Lovins, 2007).

Finally, *renewable energy technologies* consist of generators that create electricity from sunlight, wind, falling water, sustainable biomass, waste, and geothermal sources. The three most common types of renewable energy systems are wind turbines, solar (photovoltaic) modules, and dedicated biomass generators. This study primarily focuses on p*hotovoltaic technology* (PV) that generates electricity from sunlight in a system with no moving parts. PV units can be mounted on rooftops and left largely untended. It is a distributed generation option that, when installed for the end-user, competes against retail, not wholesale electricity rates. Since its production profile is nearly coincident with the summer peak demand it can contribute significantly to grid stability, reliability, and security. From a planning perspective PV should be valued at a rate closer to the peak power rate than the average retail rate. PV power usually peaks around midday, when sunlight is strongest. Air conditioning loads peak several hours later as buildings heat up, when a PV system would still be generating a high fraction of its peak output (Sobin, 2007).

The cost of PV generated electricity is expected to decline considerably over the next decade as large-scale production contributes to continuing cost declines. PV costs are expected to fall from a current cost of 20-40 cents/kWh to a projected cost 10-20 cents/kWh by 2016 (SEIA, 2004), less than the retail price of electricity in New York City.[1] Thus PV may be in the economic interests of New York customers sooner than others in sunnier parts of the country. From 1999 to 2004, the growth in the PV market has averaged 42%, with the grid-connected residential and commercial segments growing most rapidly.

3. Assessing Peak Reduction Potential in the Indian Point Service Area

To give a bit of necessary background, New York State has an integrated bulk power system known as the New York Control Area (NYCA). Within NYCA, the New York Independent System Operator (NYISO) operates the high-voltage transmission system and provides a match of load requirements to generation sources. Using locational-based marginal pricing (LBMP), the NYISO supplies price signals to providers of new generation and transmission and carries out a power-dispatching role on a statewide level using auctions to select the lowest-cost suppliers consistent with transmission constraints. In 2005, NYCA's generating capacity was 35% gas and oil, 15% natural gas, 15% hydro, 14% nuclear, 10% coal, 10% oil, and 1% other (although it should be noted that nuclear produced 30% of all MWh). Peak demand generally occurs during hot summer afternoons when air conditioning loads are highest. Demand on July 26, 2005, was 32,075 MW, a record for the NYCA. Indian Point is a major baseload contributor to the power supply in New York State and especially in the New York metropolitan area.[2]

In order to manage their power grid, NYISO has divided NYCA into 11 zones to assist in pricing and monitoring load flows on the transmission system. The key zones for this analysis are:

- H, which includes the northern portion of Westchester County, where Indian Point is located;
- I, the rest of Westchester County;
- J, New York City; and
- K, Long Island, outside of New York City.

Existing statewide studies were evaluated to assess the peak reduction potential of energy efficiency, demand response, combined heat and power, and solar photovoltaics in the territory served by Indian Point (i.e., zones I, J, and K).

When evaluating the potential for any electricity alternative to be deployed in future years, four types of estimates are generally used.

- *Technical potential* refers to the complete penetration of all applications that are technologically feasible, regardless of economic cost-effectiveness.
- *Economic potential* is defined as that portion of the technical potential that is judged cost-effective.
- *Maximum achievable potential* is defined as the amount of economic potential achievable over time under the most aggressive program scenario possible. It takes into account administrative and program costs as well as market barriers that prevent 100% market penetration.
- *Program potential* is the amount of penetration that would occur in response to specific program funding measures (Rufo and Coito, 2002; NYSERDA, 2003).

Our focus is on the demand reduction potential that could be achieved above and beyond the reductions expected to materialize as a result of programs, policies, codes, and standards already in place. The "base case" used in this analysis is the "business-as-usual" forecast published in the New York State Energy Research and Development Authority's *2002 Energy Plan* (NYSERDA, 2002a). Since additional increments of demand reduction above and beyond the business-as-usual "base case" would require the creation of new programs and/or the expansion of others, we defined an additional category called "phased-in programmable potential" to reflect the time required to deliver these additional reductions. Further methodological details for each type of demand reduction (from energy efficiency, demand response, combined heat and power, and solar photovoltaics) are described in the sections below.

3.1 Energy Efficiency

To assess the potential for energy efficiency programs to reduce peak demand in the Indian Point service area, the authors used the results of an evaluation of energy efficiency potentials conducted in 2002 by a team of analysts led by Optimal Energy Inc. (NYSERDA, 2003). This study estimates the maximum achievable potential for energy efficiency improvements for Zones J and K in three years – 2007, 2012, and 2022 – for numerous technologies in the residential, commercial, and industrial sectors separately. For example, in the residential sector, 50 technologies and four end-uses were assessed in three market segments (i.e., new construction, retail product sales, and retrofit) and for two building types (single-family and multifamily). In the commercial sector, 87 technologies and practices were examined applicable to nine end-uses in four markets and for nine building types (such as office complexes, retailers, hospitals, and so on).

The study's estimates of economic potential included capital, fuel, operation, and maintenance expenses. Where appropriate, associated benefits such as reductions in water, natural gas, and oil consumption were also included. Furthermore, future changes in technology costs were estimated for the 20-year time horizon.

To improve the accuracy of forecasts even further, the study's analysis of achievable potential added administrative costs of energy efficiency programs and policies. The value of the electricity savings were assess in terms of the electricity resource costs they would avoid – that is, at wholesale electricity costs and not the retail rates paid by households and businesses. The long-range projection of avoided electric energy and peak capacity costs for each of the load zones came from the *2002 Energy Plan* (NYSERDA, 2002a).

A number of novel insights emerged. The results suggest that most of the economic potential for energy efficiency improvements is concentrated in the commercial and residential sectors and not in the industrial sector. For instance, 3,726 GWh of economic potential would exist by 2007 in the residential sector of New York City, growing to 4,461 GWh by 2012. The residential efficiency measures that hold the most promise include:

- *lighting* (compact fluorescent light bulbs, fluorescent light fixtures, outdoor light controls, LED nightlights, ceiling fans with fluorescent lights, multi-family common areas with specular reflectors, motion sensors, and LED exit signs);

- *cooling* (efficient central air conditioners, air source heat pumps, ground source heat pumps, duct sealing, duct insulation, room air conditioners, humidifiers, new construction HVAC systems);
- *refrigerators* (upgrades to more efficient refrigerators, removal of second refrigerators or freezers);
- *electronics* (computer monitors, computer CPUs, laser printers, fax machines, exhaust fans, power supply, waterbed mattress pads, and waterbed replacement);
- *space heating* (efficient furnace fans, programmable thermostats, ENERGY STAR® windows, blower door guided air-sealing, attic insulation, wall insulation, foundation insulation, heating controls, heat recovery ventilators, and improved baseboard systems); efficient clothes-washers; efficient televisions, VCRs, and DVD players; and
- *domestic hot water* (upgrade heat pump water heater, upgrade efficient well pump, GFX heat exchanger, hot water conservation measure package, desuperheater off ground source heat pump).

In the commercial sector of New York City, the data suggests that 12,567 GWh of economic potential would exist by 2007 and that this would grow to 13,712 GWh by 2012. The commercial efficiency measures that hold the most promise include:

- *indoor lighting* (lamp ballasts, fixtures, specular reflectors, compact fluorescent light bulbs, high efficiency metal halides, occupancy sensors controls, daylight dimming, LED exit signs);

- *refrigeration* (high efficiency vending machines, vending misers, high efficiency refrigerators, high efficiency reach in coolers, high efficiency ice makers, walk in refrigeration retrofit package, heat pump water heater);
- *cooling* (high efficiency air conditioning, high efficiency heat pumps, high efficiency chillers, optimized HVAC systems, optimized chiller distribution and control systems, water source heat pump, ground source heat pump, emergency control, dual enthalpy control, high efficiency stove hoods, high performance glazing);
- *ventilation* (energy management system control, premium efficiency motor, variable frequency drive);
- *office equipment* (high efficiency CPU, high efficiency monitors, low mass copiers, high efficiency fax, high efficiency printer, high efficiency internal power supply);
- *whole building controls* (retrocommissioing, commissioning, integrated building design, high efficiency transformers);
- *water heating* (high efficiency tank-type water heater, point of use water heater, booster water heater, heat pump water heater);
- *outdoor lighting* (LED Traffic lights, LED Pedestrian signs, pulse start metal halides, compact fluorescent bulbs, improved exterior lighting design); miscellaneous (high efficiency clothes washer, water and wastewater optimization); and
- *space heating* (high efficiency heat pumps, water source heat pump, ground source heat pump, optimized HVAC systems, optimized chiller control systems,

emergency management control, high efficiency stove hood, high performance glazing).

To convert these estimates of energy savings potential to estimates of peak capacity reduction potential—a different metric altogether— we utilized an assessment of maximum achievable potential for New York City (Zone J) provided Gupta and Plunkett (2004), which was based on the results of the NYSERDA (2003) study. Their analysis determined that New York City could benefit from a maximum achievable potential of 502 MW for 2007 at an avoided levelized cost of 3.3 cents per kWh. Further calculation procedures are explained in detail in the footnote below.[1]

In addition to reporting estimates of maximum achievable potential, Table 1 provides estimates of total program potential (based on a rule of thumb developed by the National Academies' Committee on Alternatives to Indian Point for Meeting Energy Needs that 50% could be delivered through programs), and estimates of phased-in programmable potential. It was concluded that programs established or expanded in 2006 would have very limited effect in 2007. Therefore the program potential of 420 MW in 2007 is reduced to 100 MW. The phased-in programmable potential is assumed to grow rapidly to 450 MW in 2010 and to reach the level of the full program potential of 550

[1] Continuing on in our analysis (and using data on the economic potential for residential and commercial buildings efficiency (in MWh) from NYSERDA [2003[), we estimated that Zone K has 0.451 of the maximum achievable potential of Zone J. Therefore, Zone K potential would be 226 MW. Estimating Westchester County at half the maximum achievable potential of Zone K, its potential in 2007 would be 113 MW. Adding these up across all three zones equals 842 MW by 2007. Again using the data from residential and commercial economic potential from the appendix in NYSERDA's 2003 report, we can see estimates for Zones J and K for 2007, 2012, and 2022. Plotting these estimates, one can interpolate the "missing years" of 2008, 2010, 2013, and 2015. Assuming a linear relationship, the maximum achievable potential for Zone J would be 502 MW in 2007, 529 MW in 2008, 563 MW in 2010, 624 MW in 2013, and 658 MW in 2015. Assuming the same relationship in the above paragraph between Zone J and Zone K (Zone K is 0.451 the size of Zone J), potential for Zone K would be 239 MW in 2008, 253 MW in 2010, 281 MW in 2013, and 297 MW in 2015. Assuming Zone I is half the size of Zone K, potential for zone I would be 119 MW in 2008, 127 MW in 2010, 140 MW in 2013, and 148 MW in 2015.

MW by 2015. In addition, the committee expects that high fuel prices will increase the incentive to improve efficiency. Therefore, the estimated phased-in programmable potential in 2015 is increased to 575 MW (Table 1).

Table 1

Potential Peak Reduction from Energy Efficiency in Zones I, J, and K (MW)

	2007	2008	2010	2013	2015
Energy Efficiency Programs:					
Maximum Achievable Potential					
Zone I (Westchester County)	113	119	127	140	148
Zone J (New York City)	502	529	563	624	658
Zone K (Long Island)	226	239	253	285	297
Total Maximum Achievable Potential	842	887	943	1,046	1,103
Total Program Potential (50% of Achievable)	420	440	470	520	550
Phased-In Programmable	**100**	**200**	**450**	**525***	**575***

*Note that the "phased-in programmable" estimates exceed the "total program potential" in these years. This reflects the fact that more efficiency investments are cost-effective with the increased price of fuels today, and this is likely to be the case well into the future. These figures are based on historic (and low, by today's standards) EIA price forecasts to calculate cost-effective energy efficiency.
Source: Derived from NYSERDA (2003).

Table 1 is consistent with other estimates of energy efficiency potential. From the broadest perspective, the estimates summarized in this table are within the range of estimates identified in a review of U.S. studies, which found that the median level of estimated achievable potential was 1.2% per year for electricity (Nadel, Shipley, and Elliott, 2004). From a New York State perspective, the Energy $mart review expected a reduction of peak demand of 880 MW within two years (statewide) as a result of program activities. Finally, a study of the energy efficiency potential in the New York City area, sponsored by the Pace Energy Project and the Natural Resources Defense Council, concluded that savings of 1,163 MW to 3,032 MW peak demand could be achieved by aggressive energy efficiency programs within two years (Komanoff, 2002).[3] To accomplish such reductions, the study suggested applying the rapid "crash efficiency" techniques—targeting the deployment of more efficient lighting, air conditioners, and appliance standards—employed by the state of California after their energy crisis in 2001. The extreme conditions associated with California's 2001 programs are not the context within which options for Indian Point are being evaluated, but they do illustrate a higher bound of possibilities if energy efficiency were to become a political salient issue in New York City.

3.2 Demand Response

The estimated potential for demand response programs to reduce peak demand in the Indian Point area is based on the experience to date with three NYSERDA programs that avoided 700 MW of peak demand in the state of New York in 2004. These programs illustrate the ability for demand-response to reduce peak electrical loads for costs per KW that are far lower than the cost of installing new peak capacity. Three of these programs alone have already avoided the need for over 700 MW of peak capacity:

- The Peak Load Reduction Program avoids between 355 and 375 MW
- The Enabling Technology for Price Sensitive Load Management Program, which avoids 308 MW
- The Keep Cool Program avoids between 38 and 45 MW

Each of these three programs is described in more detail below. In describing these programs, the prices reflect capacity costs and expenses for the downstate and urban areas. The underlying analysis uses avoided costs based on wholesale electricity bid prices (rather than production costs). Energy efficiency load profiles are used to differentiate savings by time of day.[4] Finally, the studies evaluating NYSERDA programs also distinguish between proposed MW (demand target), enabled MW (coincident demand reduction), pledged MW (based on self-reporting), and delivered MW (averaged hourly reduction). Most of the estimates below (unless otherwise noted) refer to pledged MW. When some of the evaluations listed the delivered MWs, they were typically only half the pledged rate. On the other hand, the estimated cost per MW of demand reduction is generally much lower than that of new supply options.

Peak Load Reduction Program (PLRP)

New York created the PLRP program in 2000, focusing on four different program segments:

1. Permanent demand reduction efforts, that result in reduced demand through the installation of peak demand reduction equipment
2. Load curtailment and shifting, enrolled in NYISO demand-response program
3. Dispatchable emergency generator initiatives allows owners of backup generators to remove their load from the grid in response to NYISO requests
4. Interval meters reduce peak demand at the site of consumption

The program avoids between 355 - 375 MW of peak demand. However, 340 MW of this is callable, and only around 15-20 MW are permanent. Participants that are "callable" receive annual capacity payments and are required to perform when called. The program costs around $42.7 million per 8 years or approximately $120/kW of peak load reduction.

Enabling Technologies Program (ETP)

New York created the he ETP program in 2000 as well, and it supports innovative technologies that enhance load serving entities (LSEs), curtailment service providers (CSPs), and the NYISO. It directs customers to reduce load in response to emergency or market based price signals. The technologies used include advanced meters, transaction management software, networking and communication solutions. As of 2003, the EPT has saved 308 Enabled Peak MW. The program costs around $34.4 million per 8 years or approximately $110/kW of peak load reduction.[5]

Together, PLRP and ETP saved 174 MW in 2001, 311 MW in 2002, and 288 MW in 2003.[6]

Keep Cool Program

The Keep Cool program was started in 2001 and ended in 2003. It encouraged the replacement of old, inefficient air conditioners with new ENERGY STAR® rated room air conditioners and through-the-wall units. The program has two main components: it includes rebates and incentives for customers, and uses a significant marketing campaign that encourages customers to shift appliance use to non-peak periods. As a result of the wide scope of its multi-media marketing program, the Keep Cool Program resulted in approximately 361,000 units being replaced of which 141,000 units were given incentives through the program.

The program is estimated to have avoided approximately 41 MW of peak demand in every year of the program. The program costs around $19.9 million over 8 years or approximately $490/kW of peak load reduction.[7]

Using the efficacy of these three programs as a template, the next step in the estimating the peak reduction potential for demand response programs in the Indian Point service territory involved apportioning the 700 MW of peak reduction from the above programs to zones I, J, and K. The *Comprehensive Reliability Planning Process Draft Reliability Needs Assessment* (NYISO, 2005) was used as the basis for the apportionment. It provides the approximate summer peak loads by zone in New York State, but aggregates three zones (G, H, and I) into the "Lower Hudson Valley." After apportioning that value to Zone I, it is estimated that zones I, J, and K have 17,697 MW of peak load, or 55% of the statewide total (31,770 MW). Thus, it can be estimated that zones I, J, and K could account for 55% of the 700 MW of peak reduction from demand response programs in 2004, or 385 MW.

The final step involves adjusting the 385 MW to reflect what might be achieved if the three 2004 demand response programs were doubled in budget. We assume diminishing returns such that a doubling of budget only delivers a 50% increment. This brings the estimated potential for expanded summer peak reduction to approximately 200 MW. We assume that these load reductions could be achieved by the year 2010, since experience with other programs suggests that demand reductions can be achieved quickly when necessary.

As with efficiency, it takes time to expand demand response program activities, to attract more program participants, and to purchase and install new demand response equipment. Therefore, we assume that only 50 MW of additional peak reduction could be achieved in 2007, increasing to 200 MW by 2010. We also project increases in potential for the years 2013 (275 MW) and 2015 (300 MW). Thus, assessment of these three programs indicates the potential for further investments in NYSERDA's demand response programs to cost-effectively reduce peak loads by 50 MW in 2007, rising to 300 MW in 2015 (Table 2). Comparing these results with those in Table 1 suggests that the phased-in programmable potential for demand response is roughly half the magnitude of the phased-in programmable potential for energy efficiency.

Table 2

Potential Peak Reduction from Demand Response Programs in Zones I, J, and K (MW)

	2007	**2008**	**2010**	**2013**	**2015**
Total Program Potential (50% of Achievable)	200	200	200	275	300
Phased-In Programmable Potential	**50**	**100**	**200**	**275**	**300**

*Note that the "phased-in programmable" estimates exceed the "total program potential" in these years. This reflects the fact that more efficiency investments are cost-effective with the increased price of fuels today, and this is likely to be the case well into the future. These figures are based on historic (and low, by today's standards) EIA price forecasts to calculate cost-effective energy efficiency.
Source: Derived from NYSERDA (2003).

3.3 Combined Heat and Power

Based on data from a study of the *Combined Heat and Power Market Potential for New York State* (NYSERDA, 2002b), it is clear that CHP is already an important generating resource in New York. This study, led by the Energy Nexus Group of Onsite Energy Corporation, concluded that in 2002, 5,070 MW of CHP was installed at 210 sites across the State of New York. Most of this capacity was concentrated in a few large "merchant" facilities in commercial and institutional settings such as government complexes, colleges and universities, and hospitals. Gas turbine based technologies dominate this existing high-efficiency power resource.

The technical potential for new CHP was based on an estimation of remaining market size constrained only be technological limits—that is, the ability of CHP technologies to fit existing customer needs. Based on this approach, NYSERDA (2002b) estimates a technical potential of nearly 8,500 MW of new CHP in New York at 26,000 sites. Close to 74 percent of this remaining capacity is below 5 MW in size and is primarily at commercial and institutional facilities. The largest proportion of this capacity is within the Consolidated Edison service territory. Almost 3000 MW of this technical potential resides with Consolidated Edison commercial customers, the largest opportunities being office buildings, hotels/motels, apartments, schools and colleges/universities. An additional 300 MW of CHP technical potential was identified among Consolidated Edison industrial customers, the largest opportunities being chemical plants, food plants, textiles, and paper.

The economic potential of CHP depends on many additional factors including the financial advantage of CHP over separately purchased fuel and power, the sites with economic potential, and the speed with which the market can ramp up in the development of new projects. A general economic analysis of CHP was performed by NYSERDA (2002b) for five CHP system size ranges, using both current and advanced technology. Net power costs were estimated based on a range of assumptions: 80-90% load factor, 70-90% thermal utilization, and natural gas fuel costs of $5.00-6.00/MMBtu. Smaller systems were assumed to have lower load factors and higher fuel costs. Since standby tariffs proved to be so critical to the economic competitiveness of CHP, separate scenarios were developed to reflect alternative policy approaches. In the Base Case it was assumed that the standby charges would remain at current levels, while for the Accelerated Case, it was assumed that standby charges would be further reduced by one-third to one-half to levels consistent with states such as Illinois and Texas.

In the Base Case NYSERDA (2002b) an additional 764 MW of CHP is projected to be installed in New York State by 2012. Nearly 70 percent of this capacity (or 535 MW) is in the downstate region that includes Indian Point. In the Accelerated Case, cumulative market penetration reaches nearly 2,200 MW statewide. About 60 percent (1,320 MW) of the penetration is projected in the downstate region in 2012 (NYSERDA, 2002b, p. ES. 9).

Using a similar trajectory of market expansion for CHP as for energy efficiency and demand-response programs, the Base Case estimate of 535 MW in 2012 could be phased into the marketplace along the lines of Table 3, expanding to 600 MW by 2015.

Table 3

Potential Peak Reduction from Combined Heat and Power in Zones I, J, and K (MW)

	2007	2008	2010	2013	2015
Phased-In Programmable Potential	100	200	450	550	600

Source: Derived from NYSERDA (2002b)

3.4 Solar Photovoltaics

Solar PV can provide high-value peak-time power in a distributed fashion and with minimal environmental emissions. Thus PV could contribute significantly to grid stability, reliability and security (Perez et al., 2004). Rapidly declining PV costs could make it a significant contender for replacement power within the timeframe of this study even though it is an intermittent source of electricity. Throughout the period of 2006-2015, installations would have to be subsidized, but the end result could be an important new energy source with many desirable attributes and a thriving industry.

Unlike the options discussed above, projections of PV installations on the scale envisioned here cannot be based on current prices or U.S. programs and progress.[8] Rather, the accelerated PV deployment scenario described here is modeled on the Japanese program which provided a declining subsidy to residential PV systems over the past decade. Residential PV installations expanded in Japan from roughly 2.0 MW in 1994 to 800 MW in 2004 (Ikki, 2005). Results are presented in Table 4.

Table 4

Potential Peak Reduction from Photovoltaics in Zones I,J,K

	2007	2008	2010	2013	2015
Installed System Cost ($/W)	7.36	7.02	6.34	5.40	4.80
Subsidy Rate (%)	47	44	38	27	19 (declining to 0 in 2019)
Annual Subsidy (million $)	29	36	56	74	72 (declining to 0 in 2019)
Annual Installations (MW)	8	12	23	50.	79
Cumulative Installations (MW)	19	30	70	193	335
Reduction in Peak Demand (MW)	14	23	52	144	250

Our analysis of PV potential is based on solar insolation data from NREL's National Solar Radiation Data Base, which has data from seven sites in New York State including one site in New York City. Further suggesting that solar PV systems have significant amounts of untapped potential, California recently announced a solar initiative with a goal of 3000 MW of photovoltaics by 2017 (California PUC, 2006). This initiative is designed to harness the effective load carrying capability of solar PV—that it provides power, on hot and sunny days, precisely when demand for electricity is at its highest (to satiate air conditioners and compensate for higher T&D losses during warmer weather).

4. Conclusions

Additional cost-effective investments in energy efficiency, demand response, combined heat and power, and solar PV facilities can significantly offset peak demand in the Indian Point service area. These new initiatives (beyond those currently anticipated) could reduce peak demand by 1.0 GW or more by 2010 and 1.5 GW by 2015. If the cost of distributed photovoltaics can be brought to near-competitive levels over the next decade, demand-side measures could contribute 1.7 GW by 2015, thus approaching the capacity of Indian Point (about 2.0 GW).

The effectiveness of electricity alternatives in downstate New York, to date, has been variable due to numerous obstacles to deployment, and forecasted program performance is always uncertain. However, there is a growing body of evidence from NYSERDA, California, and other states and communities that demand-side options can be implemented swiftly and cost effectively. We have summarized conclusions for each of four demand-side opportunities in Figure 2.

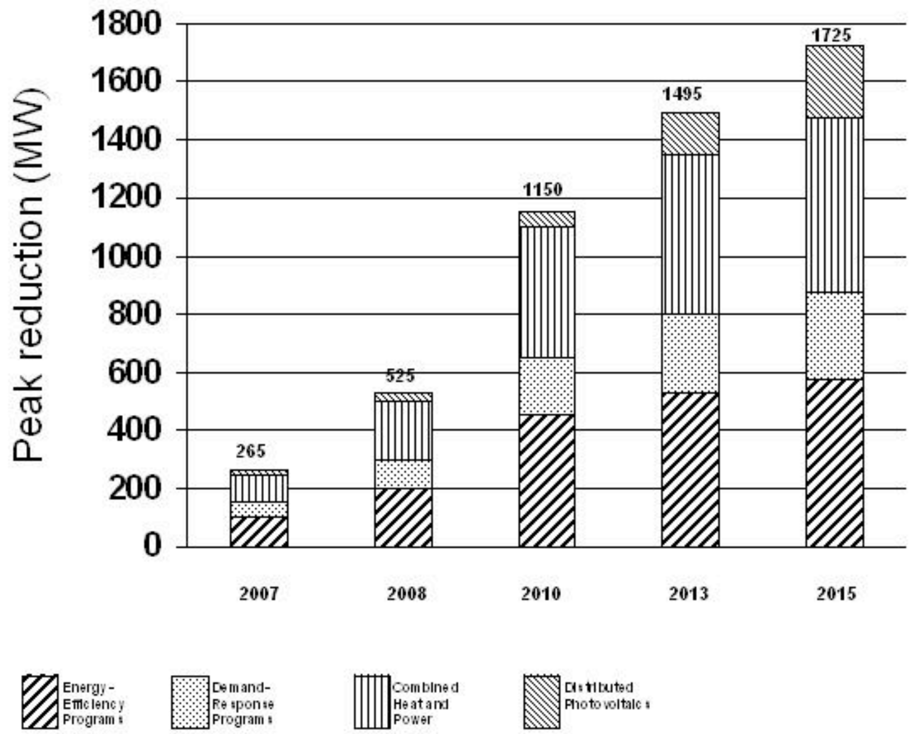

Fig. 2. Phased-In Programmable Potential for Expanded Demand-Side Options in the Indian Point Service Territory (in MW of Peak Reduction)

With regards to the problems facing policymakers in New York concerning the Indian Point Energy Center – and, for that matter, wherever nuclear plant licenses will expire, or the construction of new generators or transmission networks is constrained – the focus has too consistently centered on only one end of the problem: building new centralized generation. Such devotion unintentionally obscures the other simple yet equally obvious solution: energy efficiency and demand-side measures, DG, and renewables can provide significant peak load reductions under numerous circumstances.

We must introduce two caveats when advancing this conclusion, however. Our claim should not be interpreted as saying that all non-dispatchable electricity alternatives will blindly succeed. Programs that are poorly designed, haphazardly implemented, and inadequately evaluated will achieve meager results. However, when implemented in a well-designed, comprehensive, and sustained manner, demand-side measures may be one of the most reliable (and cost-effective) options for meeting new demand for electricity in the United States. In this sense, electricity alternatives are just as "firm" as building new generators or transmission lines, relying on the vagaries of river flow to supply a hydroelectric plant, using natural gas turbines susceptible to price spikes, or the transmitting power generated from nuclear reactors through vast transmission and distribution networks under the stress of vegetation and severe weather.

Furthermore, the diverse power markets that exist in today's U.S. electricity industry make it difficult for best practices in demand-side programs to take hold. Across the country, different procedures are used to evaluate the value of energy efficiency programs, and different mechanisms are used to recover their costs. The benefits from electricity alternatives will not automatically occur in most electricity markets, which remain kaleidoscopic and distorted through a lack of clear price signals and government subsidies. Alternative measures must be rigorously promoted by aggressive policies if they are to thrive. There are unique barriers and drivers for such alternatives that are a function of building stock, industrial base, climate conditions, energy prices, and grid conditions. This variability is a further obstacle to the identification and replicability of best practices. Without greater information sharing about which energy efficiency, DG, and renewable energy strategies work best, such efforts will continue to be considered by many utilities to be unpredictable, unenforceable, and hard to measure.

Fortunately, there is a diverse portfolio of demand-side mechanisms to draw from, and because supporting programs can be launched and altered rapidly (unlike capital-intense and centralized plants), they can respond quickly to changing market and regulatory conditions. Demand-side measures and practices should be seriously evaluated and embraced by system operators, utilities, and policymakers, where appropriate, to help meet growing demand – especially in areas where traditional forms of electricity supply remain constrained by technical, political, economic, and cultural impediments.

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[1] There is wide variation in retail rates across New York State, but a New York City resident may pay over 20 cents per KWh. See http://www.dps.state.ny.us/bills.htm. Commercial and industrial customers would pay less.

[2] The nuclear facility's propinquity to the largest city in the United States has raised public concerns about its safe operation, particularly in the event of a terrorist attack. Such concerns prompted the U.S. Congress to request a study on potential options for replacing the 2,000 MW of power provided by Indian Point. The request, initiated by Representative Nita M. Lowey of New York's 18th District, was directed to the U.S. Department of Energy, which in turn commissioned a study by the National Research Council of the National Academies. The NRC established the Committee on Alternatives to Indian Point for Meeting Energy Needs to conduct the study (National Academies, 2006). See the Acknowledgement for further details.

[3] This "lowest" estimate included adjustments for climate, forecast uncertainties, and consumptive patterns.

[4] See NYSERDA (2004), "New York Energy $mart Program Cost-Effectiveness Assessment," submitted by Heschong Mahone Group, p. 1.

[5] An updated program evaluation report (Heschong Mahone Group, 2005) evaluated the Peak Load Reduction and Enabling Technologies Programs together. It estimates peak reductions of 178 MW (p. 25), costs of $28.8 million (Table 3-9, p. 24), for a cost per peak reduction of $163/KW.

[6] See NYSERDA (2004), "New York Energy $mart Program Cost-Effectiveness Assessment," submitted by Heschong Mahone Group, p. 34.

[7] An updated program evaluation report (Heschong Mahone Group, 2005) estimates peak reductions of 19.7 MW (Table 3-1, p. 16), costs of $18.4 million (Table 1-3, p. 4), for a cost per peak reduction of $934/KW.

[8] There is evidence that solar PV costs have increased in recent years in the U.S. due to a firming of the silicon market and increased demand stimulated by various subsidies and renewable portfolio standards.