Synapse
Energy Economics, Inc.

Analysis of selected Maine hydro plants on the Androscoggin and Kennebec Rivers and their importance to the New England electricity system

Opinion of Maximilian Chang

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1. Introduction

I have been asked by the Plaintiffs to evaluate the contribution of seven Maine dams to the New England electric grid. Four of the dams are located on the Kennebec River: Lockwood (owned by NextEra and Merimil Limited Partnership), Shawmut, Weston, and Hydro-Kennebec (owned by Brookfield Power US Asset Management). The other three dams are located on the Androscoggin River: Brunswick (owned by NextEra), Pejepscot (owned by Topsham Hydro Partners), and Worumbo (owned by Miller Hydro Group). Maine has classified these seven dams as "run-of-the-river," meaning that they have limited or no storage reservoirs that would regulate water flow across the turbines (Maine 2010).

My opinion, expressed herein, is based on my professional experience and is informed by (a) a review of documents and statistics prepared by the Department of Energy's Energy Information Agency and the New England Independent System Operator, (b) relevant industry analyses, and (c) information provided by the Defendants through interrogatories. Where appropriate to support my opinion, I have cited these documents, and they are listed in the Bibliography at the end of this opinion.

My analysis evaluates the impact on the New England electric grid if the seven dams individually or collectively were to shut down seasonally to accommodate migrating anadromous fish.

In preparing my opinion, I have been asked by the Plaintiffs to consider the following questions:

1. What is the energy and capacity contribution of the seven dams to the New England electric grid?
2. What would be the impact upon the New England electric grid if the seven dams shut down seasonally?
3. What would be the impact upon the dam owners of seasonally shutting down the seven dams?

To answer these questions, I have organized my opinion in the following manner. First, I provide a brief overview of the New England electric grid, including historical supply and demand for the six New England states and Maine alone; the markets for electric energy and capacity that operate in the region; and the role that run-of-the-river hydropower plays in the regional market. Next, I look specifically at the seven dams in question to identify the percentage of energy and capacity they provide in New England and within Maine, alone. I then evaluate whether these contributions are necessary in order to meet average and peak demand in New England or within Maine, alone. Finally, I discuss possible impacts on dam owners' revenues if these dams were to shut down seasonally to accommodate migrating anadromous fish.

In summary, it is my opinion that neither the New England's electric power grid nor the local electric system within Maine would be adversely impacted by a seasonal shut-down of the dams. The seven hydro dams contribute to the electric grid; however, the seasonal shut-down of these units would not result in a significant impact on the region or the state. Both Maine and New England have adequate supply capacity to offset the loss of these dams.

Based on historical energy prices, lost revenue to dam owners would be in the range of roughly $1.5 – $2 million in aggregate for the seven dams for each month that turbines are fully shut down from April through June, and roughly $1.5 – $1.75 million in aggregate for each month that turbines of the seven dams are fully shut down from October to November. Monthly energy revenue losses for each dam would range roughly from $100,000 to $360,000 depending on the individual dam and time of year.

Based on regional capacity prices, the lost capacity revenue to dam owners would be in the range of roughly $130,000 in aggregate for the seven dams for each month that turbines are fully shut down from April through June, and roughly $210,000 in aggregate for each month that turbines of the seven dams are fully shut down from October to November. Monthly capacity revenue losses for each dam would range roughly from $7,000 to $43,000 depending on the individual dam and time of year.

2. Qualifications and Experience

I hold a Bachelor of Arts degree in Biology and Classical Civilization from Cornell University, and a Master of Science degree in Environmental Health from the Harvard School of Public Health. In my current position at Synapse Energy Economics, I conduct analyses on issues relating to electricity markets, avoided costs, energy efficiency, capacity markets, and the economics of energy supply resources. Synapse works for a wide range of clients throughout the United States, including environmental groups, public utility commissions and their staff, governmental associations, public interest groups, attorneys general, offices of consumer advocates, foundations, and federal governmental organizations such as the Environmental Protection Agency and the Department of Energy.

As part of my work at Synapse, I co-authored the two most recent *Avoided Energy Supply Costs in New England* reports (2009 and 2011), which are used by the New England energy efficiency program administrators to quantify the value of energy efficiency programs. I have also co-authored a recent report investigating the economics of proposed nuclear power plants and alternatives in the Southeast United States. Additionally, I have testified in front of the Massachusetts Department of Public Utilities on behalf of the Cape Light Compact in support of its three-year energy efficiency programs.

The Plaintiffs are compensating me for my work on this case at a rate of $140 per hour. I have been engaged in this case on their behalf since December 2011.

In preparing this report, I supervised the work of a Senior Consultant who assisted me in preforming the analysis consistent with Synapse Energy Economics' in carrying out such practices.

A copy of my resume is included as Attachment One.

3. General Explanation the New England Electric Grid

A. Brief Overview of New England's Electric Power System

The New England electrical power system spans the six states of New England, and serves the 14 million people living therein. This system includes: more than 300 generating units, representing approximately 32,000 megawatts (MW) of generating capacity; more than 5,000 demand assets, representing 2,500 MW of demand resources; and more than 8,000 miles of high-voltage transmission lines. These resources work together to meet the New England regional load, regardless of state boundaries (ISO-NE 2011c).[1]

The New England Independent System Operator (ISO-NE) is the non-profit entity that manages and coordinates the generation and transmission of power across New England to meet demand. ISO-NE has operational, market, and planning responsibilities to balance supply (capacity) and demand (load) of electricity across New England (Giaimo 2011). ISO-NE's operational responsibilities include ensuring minute-to-minute reliable operation of the New England power grid, ensuring the dispatch of lowest-priced resources, and coordinating operations with neighboring power systems. ISO-NE's market responsibilities include the administration and monitoring of wholesale electricity markets, which include energy and capacity. ISO-NE's planning responsibilities include administering requests to interconnect generation and transmission resources, and conducting transmission needs assessments to meet current and future power needs in New England.

Measuring Electrical Output

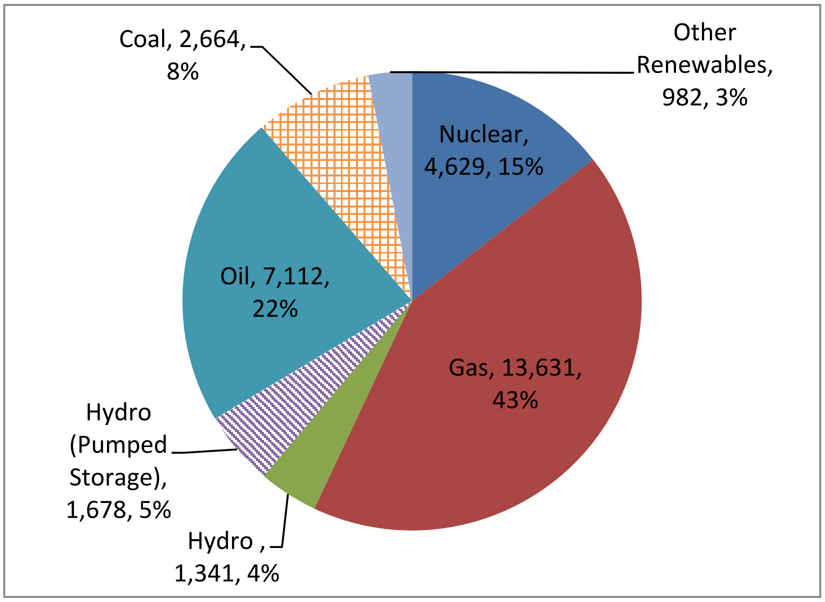
All electric generating units measure their electrical output in two different but related ways. Amounts of electric energy used or produced (e.g., in a year) are measured in megawatt-hours (MWh). When discussing an amount of electric energy produced (e.g., the number of MWh produced in a given year), the terms "generation," "generated," or "electric output" will be used. The amount of electric power produced or consumed at a given moment will be referred to as "load" or "demand," respectively, while the amount that *can be* produced at a given moment will be referred to as "capacity." Capacity is measured in kilowatts (kW) or megawatts (MW). The amount of energy that *is* produced by a generator in a given period is often compared to the amount it *could* have produced if running at full capacity 100 percent of the time. That ratio, expressed as a percent or as a number between zero and one, is called the plant's capacity factor (CF) (Steinhurst 2008).

B. Overview of New England Supply and Demand

The approximately 32,000 MW of generating capacity in New England can be broken out by fuel type, as shown in Exhibit 1 (ISO-NE 2011a).

[1] One megawatt is the equivalent of one million watts.

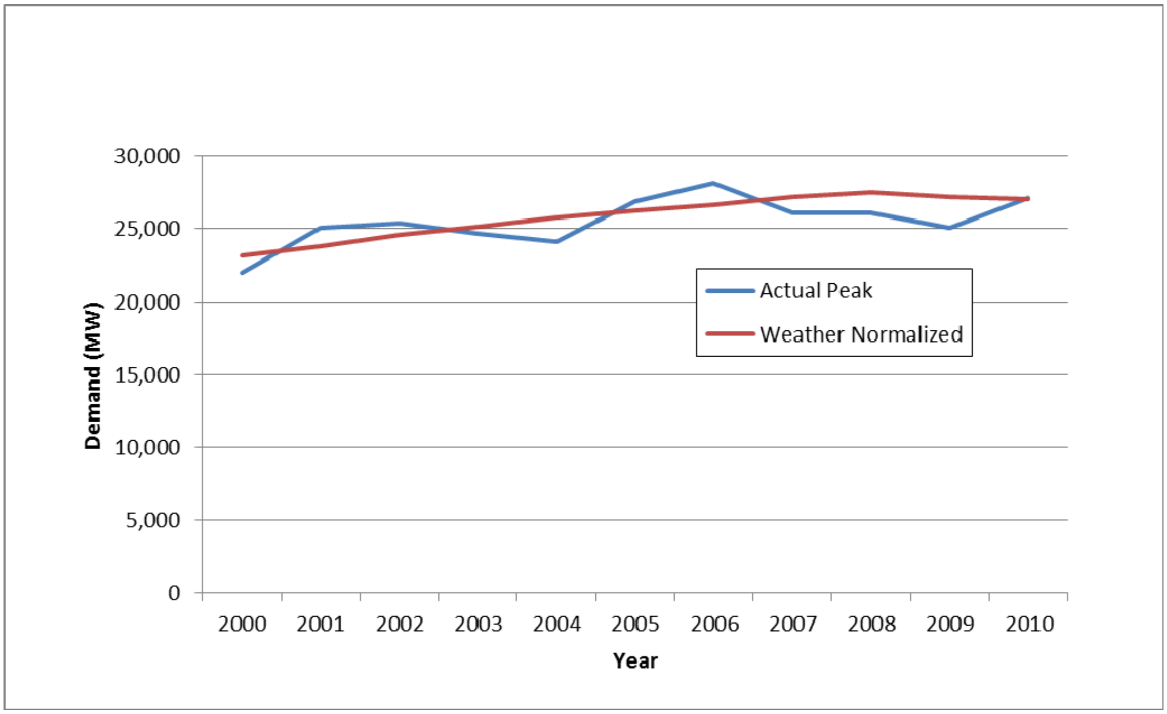
Exhibit 1. 2011 Expected Summer New England Capacity by Energy Source (MW)



By far the most dominant form of generating capacity in New England is natural gas combustion units, which represent 43 percent (13,631 MW) of New England's total generating capacity. Oil combustion generating capacity follows at 22 percent (7,112 MW), nuclear units provide 15 percent (4,629 MW), and hydro resources represent 4 percent (1,341 MW) (ISO NE 2011a). Pumped storage facilities (which represent 5 percent, or 1,678 MW, of New England's capacity in Exhibit 1) pump water into storage ponds during periods of low demand and then pass the water through turbines to generate electricity during periods of high demand.

The New England region is a summer-peaking region, meaning that the demand for power is greatest in the summer. According to ISO-NE, actual peak load in 2010 was 27,102 MW. The historical trend in peak load is shown in the following exhibit for both actual and weather-normalized peaks.

Exhibit 2. 2000-2010 New England Actual and Weather-Normalized Summer Peaks (MW)



The 2010 peak load of 27,102 MW was balanced against a resource capacity of 32,431 MW, which included non-generation demand resources (e.g. energy efficiency and demand response) and imports from outside New England. The excess capacity of 5,329 MW represents a reserve margin of approximately 20 percent (ISO-NE 2011a). Each year, ISO-NE projects the future installed capacity requirement (ICR) for the New England region (ISO-NE 2011b). The ICR represents the capacity plus reserves needed to meet New England's future capacity needs. ISO-NE projects reserve margins in future years through 2020 at a range of 12.6 to 14.6 percent (ISO-NE 2011c).

Data for 2003-2010 indicate that New England has added 4,382 MW of new capacity, as shown in the following exhibit.

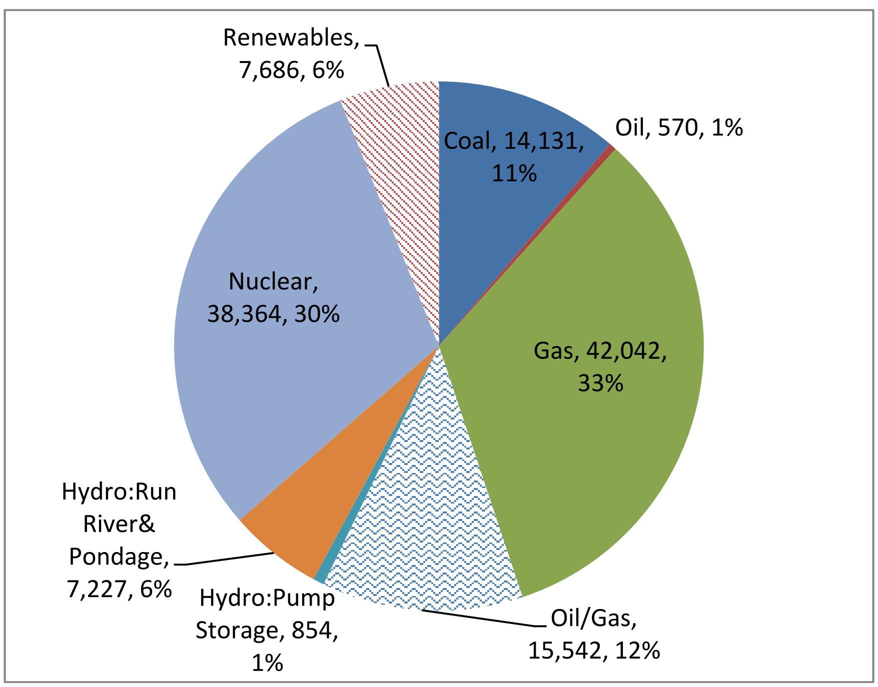
Exhibit 3. New England New Capacity Additions (Summer Capacity in MW)

Year	Summer Capacity (MW)
2003	2,757
2004	578
2005	6
2006	31
2007	142
2008	142
2009	367
2010	359
Total	4,382
Notes	
Data from EIA Form 860	

These data show that New England continues to add additional capacity to meet future load. According to ISO-NE, an additional 11,816 MW of new capacity is currently in the interconnection queue (ISO-NE 2011c). However, it is important to note that not all of the projects in the interconnection queue will actually be built. The ISO-NE historical attrition rate is 69% (ISO-NE 2011c). Using this attrition rate suggests that 3,663 MW of the 11,816 MW of new capacity in queue may actually be added.

Total annual energy requirements in 2010, the most recent full year of available data, were 130,771 gigawatt-hours (GWh) (ISO-NE 2010). The following exhibit shows the distribution of energy production by generating source for New England.

Exhibit 4. 2010 New England Generation by Energy Source (GWh)



On an energy basis (i.e., the amount of electric output of New England generation for 2010), 33 percent (42,042 GWh) of New England's electricity generation was from natural gas combustion units. Nuclear units provided 30 percent (38,364 GWh) of electricity generation in New England, and hydro resources represented 5.5 percent (7,227 GWh).

C. Overview of Maine Supply and Demand

Although New England's electric grid operates at a regional level, it is useful to view the electric system through the context of Maine. Maine represents approximately 9 percent of population and 8.9 percent of electricity consumption in New England (ISO-NE 2011d). In terms of capacity for the 2011 – 2012 period, Maine has 3,244 MW of in-state generation and 287 MW of in-state non-generation resources, for a total capacity of 3,531 MW. According to ISO-NE, Maine's 2011 actual peak demand was 1,964 MW. Maine currently exports electricity to other New England states, since Maine's capacity exceeds demand.

ISO-NE reports that, within Maine, 1,300 MW of new supply capacity are in the process of connecting to the regional transmission grid. While it is likely that not all of these projects will be completed, the number suggests proposed projects are in place that could meet the shortfall of generation resulting from the seasonal shut-down of the dams (see Section 4 for quantification of the dams' contributions to the grid).

While the grid operates on a regional basis, there are situations where local generation is required to meet specific reliability needs of the transmission system. In western Maine, ISO-NE had identified the need to maintain local generation in order to maintain voltages across transmission lines (ISO-NE 2011c). However, the dams in question have not been specifically identified by ISO-NE to maintain voltages in western Maine, as other local generation options are adequate to fulfill this requirement.

Additionally, ISO-NE has indicated that two current transmission projects (the Maine Power Reliability Project and the Rumford-Woodstock-Kimball Road) will alleviate this reliability constraint in western Maine once they are operational (ISO-NE 2011c).

D. Energy and Capacity Markets

Energy Markets

ISO-NE manages and coordinates the wholesale energy markets through two primary markets: (1) the Day-Ahead Market, where the majority of the transactions occur; and (2) the Real-Time Market, where the remaining energy supplies and demands are balanced. These two markets represent the bulk of electricity transactions, and their prices on average are very close to each other. However, there is greater volatility in the Real-Time Market, since it reflects real-time requirements.

The Forward Capacity Market

ISO-New England's Forward Capacity Market (FCM) is a market-driven approach designed to ensure that there is enough generation on the electrical grid to meet the peak demands each summer and winter. Under the FCM, ISO-NE acquires sufficient capacity to satisfy the installed capacity requirement (ICR) that it has set for a given power-year; this is accomplished by way of a forward-capacity auction (FCA) for that power-year, which sets the price for capacity. The FCA for each power-year is conducted roughly three calendar years in advance of the start of that power-year. ISO-NE has held five FCAs to date; FCA 1 was held in 2008 for the power-year starting June 2010, and, most recently, FCA 5 was held in 2011 for the power year starting June 2014.

At the most basic level, there are four steps to the forward capacity market:

1) The ISO-NE forecasts the peak demand that will need to be met three years ahead of time, hence a forward market.
2) ISO-NE then asks for a show of interest from owners of new or existing generation units, energy efficiency programs, or distributed generation projects who may be interested in providing capacity during this future year.
3) Next, ISO-NE puts those potential market participants through a qualification process to ensure each is a viable source of providing energy or reducing demand during peak load hours.
4) Finally, ISO-NE runs a descending clock auction for all qualified participants. Those who own the most cost-effective resources are given a capacity obligation, and are guaranteed revenue for the capacity they provide.

E. Role of Hydro in New England Energy and Capacity Markets

Like wind and solar energy resources, run-of-the-river hydropower is to some extent dependent on uncontrollable conditions, in this case river flow. As a result, ISO-NE categorizes wind, solar, and run-of-the-river hydro as “intermittent” resources. This affects the role that run-of-the-river hydropower plays in both the energy and capacity markets.

As noted earlier, ISO-NE works to ensure that capacity is available to meet New England’s peak demand, which occurs during the summer months. ISO-NE rates the summer and winter capacities for intermittent resources based on historical output (ISO-NE). For the summer rating of an existing run-of-the-river hydro resource, ISO-NE uses a formula based on the resource’s median output from 1 p.m. to 6 p.m., from June through September, for the last five years. The winter rating is the median output from 5 p.m. to 7 p.m., from October through May, for the last five years. Thus, ISO-NE’s summer and winter ratings for a hydro resource may differ, depending on historical river flow conditions. This means that the hydro resource’s value in the capacity market may also differ from season to season.

4. Power Produced from the Identified Dams

Exhibit 5, below, summarizes the energy and capacity characteristics of the seven hydro plants analyzed in this study. The generating capacity is represented both by nameplate values (the technical rating) from Energy Information Administration (EIA) and by the seasonal load-carrying capacity as determined by ISO-NE. Note that the summer capacity is much less than both the nameplate and winter capacities, due to summer river flow conditions that impact each dam’s summer rating for capacity revenues. These are all run-of-river facilities with minimal reservoir storage. Exhibit 5 also presents the 2010 generation for each facility as reported to the EIA, and an equivalent capacity factor (representing how much the plant runs) based on the nameplate capacity.

Exhibit 5. Hydro Plant Capacity and Generation Summary

Facility	Owner	Nameplate Capacity (MW)	Summer Capacity (MW)	Winter Capacity (MW)	2010 Electric Generation (MWh)	Capacity Factor
		1	2	3	4	5=4÷(1*8760)
Hydro Kennebec Project	Brookfield	15.0	3.8	7.9	50,337	38%
Worumbo Hydro Station	Miller Hydro	19.4	4.7	10.2	90,947	54%
Brunswick	NextEra	20.0	5.9	14.7	98,844	56%
Lockwood Hydroelectric Facility	NextEra, Mermil	7.2	2.5	4.8	32,371	51%
Shawmut	NextEra	9.2	9.5	9.5	52,001	65%
Weston	NextEra	13.2	13.2	13.2	65,685	57%
Pejepscot Hydroelectric Project	Topsham	13.7	4.3	10.7	74,823	62%
Total		97.7	44.0	71.0	465,008	54%

Notes
1 Nameplate capacity based on EIA Form-860 data for 2010
2,3 Summer and winter capacity based on ISO-NE 2011 CELT data
4 2010 electric generation based on EIA Form-923 data for 2010

A. The Seven Dams as a Percent of 2010 New England Energy and Capacity

As reported by ISO-NE, the 2010 total net energy requirement for New England was 130,767,000 MWh (ISO-NE 2011a). The electric generation at the seven Maine dams, presented in Exhibit 5, represents 0.36 percent or a small fraction of one percent of that total. The New England summer claimed capability for generators in 2010 was 31,435 MW, of which the above generators, at 44 MW, represent 0.14 percent or a small fraction of one percent of New England's summer claimed capability.

Based on EIA data for 2010, the seven dams generated approximately 465,000 MWh of electricity (EIA 860 Data). I have been asked to evaluate the effects of seasonal shutdowns of the dams' turbines during the spring Atlantic salmon smolt and kelt downstream migration period (which I have been told to assume lasts from April through June) and the fall kelt downstream migration period (which I have been told to assume lasts from October through November).

One simple approach to examine how New England could make up the shortfall of generation resulting from a seasonal shut down of the dams in the spring and/or fall months is to identify other, existing units that could be operated more often. While this analysis ignores specific generating unit limitations or transmission limitations, it provides a high-level indication of whether or not there is existing under-utilized electric generation capability. Using an EPA database generation sources in Maine, we analyzes generation from Rumford Power Associates, a 270 MW gas combined cycle plant located in Rumford, Maine (EPA). In 2010, this plant generated approximately 520,000 MWh, which translates into a capacity factor of 22 percent. Increasing the capacity factor of the plant to 40 percent would result in an increase in electricity generation of 425,000 MWh, nearly the equivalent electricity generation of the seven dams for the entire year.

Another approach of viewing the dam's role in the New England capacity market is to compare the nameplate capacity of the seven dams, which is 97.7 MW as shown in Exhibit 5, against ISO-NE's excess capacity, which for 2010 was 5,239 MW. The nameplate capacity of the seven dams that would be replaced represents less than 2 percent of the 2010 excess capacity. The summer capacity of the seven dams, which would be a more appropriate comparison to the summer excess capacity, are less than one percent of the 2010 excess capacity.

B. The Seven Dams as a Percent of Maine Energy and Capacity

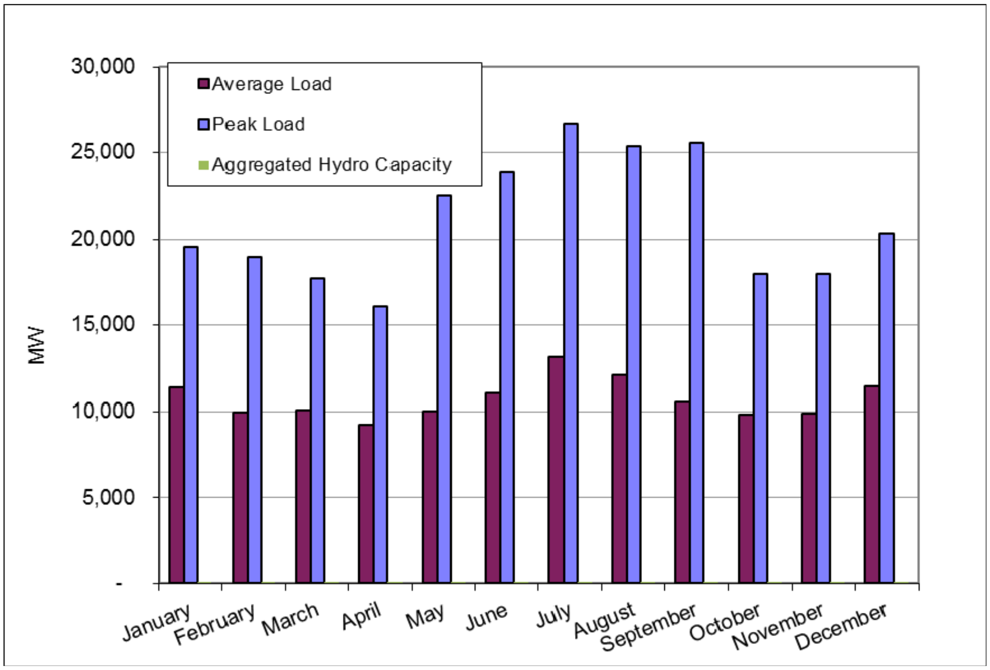
Although ISO-NE does not report a specific net energy requirement for Maine, electricity consumption in Maine in 2010 represented 8.9 percent of the New England total. Thus, electric generation of these hydro plants represented approximately 5.5 percent of Maine's total generation in 2010 based on ISO-NE and EIA data. Similarly, these hydro plants represented 2.3 percent of Maine's 2010 summer generating capability, which totaled 3,071 MW (ISO-NE 2011d).

5. New England and Maine Monthly Loads

A. Overview of New England Loads

Exhibit 6, below, shows the monthly average and peak loads in 2010, with the summer capacity (44 MW) and winter capacity (71 MW) associated with the seven dams. The highest loads in New England occur during the summer period. However, as noted above, ISO-NE rates the summer capacity of the seven dams as 44 MW, based on historical output during peak summer periods. The capacity of the seven dams is barely visible on the graph below.

Exhibit 6. New England 2010 Average and Peak Load by Month with Summer and Winter Capacity of the Seven Dams (MW)

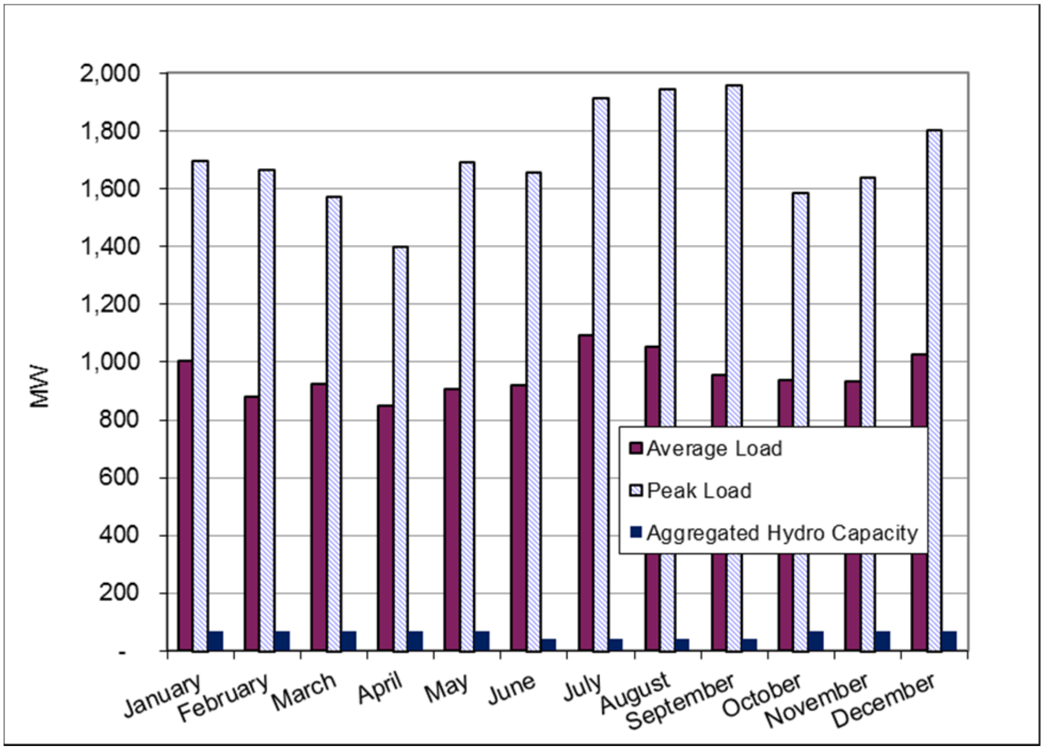


This exhibit shows that the seven dams meet an imperceptibly small fraction of New England's total load.

B. Overview of Maine Loads

Even though the New England electric system operates on a regional basis, looking at Maine's load provides a useful examination. As indicated earlier, Maine represents about 8.9 percent of total New England loads. Exhibit 7, below, shows the monthly average and peak loads in 2010 for Maine from ISO-NE data. Like the rest of New England, the highest loads in Maine occurred during the summer period. The aggregated summer and winter capacities of the seven dams are also included, in order to show their contribution to meeting Maine's load throughout the year.

Exhibit 7. 2010 Monthly Loads in Maine (MW)



This exhibit shows that the seven dams meet only a small fraction of Maine's load.

C. Monthly Hydro Generation

Exhibit 8, below, shows the monthly generation from the studied hydro plants, as well as Maine's monthly and total electricity demand in 2010. Hydro generation is greatest in April, both in absolute terms and as a percentage of load, but this is also one of the lowest load months, as shown in Exhibit 7. For the five-month period of April through June plus October and November, these hydro plants represent an average of 6.1 percent of Maine's electricity demand. As noted earlier, other available resources are more than sufficient both in New England and within Maine to make up this generation if the dam turbines do not operate in April, May, June, October, and November.

Exhibit 8. 2010 Monthly Hydro Generation from Seven Dams and Maine Electricity Consumption

Month	Hydro Generation (MWh)	Maine Electricity Consumption (MWh)	Hydro Percentage of Maine Electricity Consumption
	1	2	3=1÷2
January	45,375	748,464	6.1%
February	40,607	590,688	6.9%
March	46,451	686,712	6.8%
April	51,002	610,560	8.4%
May	40,087	675,552	5.9%
June	32,366	663,840	4.9%
July	31,055	813,936	3.8%
August	29,196	784,920	3.7%
September	29,112	688,320	4.2%
October	39,727	698,616	5.7%
November	40,087	672,480	6.0%
December	39,941	764,832	5.2%
Year	465,008	8,398,920	5.5%

Notes
1 Hydro generation from EIA-923 data
2 Maine load from ISO-NE data

D. Impact of the Loss of Capacity and Generation

In aggregate, the capacity from these hydro plants represents 1.43 percent of Maine's summer capacity and 2.12 percent of its winter capacity. Available capacity in Maine exceeds the state's peak load by a significantly larger amount than these dams' aggregate capacity.

These dams represent a larger fraction of the total capacity in the April to June period, when their generation is greatest and the loads are the lowest. However, partial or full loss of their output could easily be covered by other available resources at all times of the year.

Maine currently has a renewable portfolio standard (RPS) that requires 30 percent of electricity sales to come from eligible renewable resources, and hydropower is one of the eligible resources to help meet this goal. While electricity generation from hydropower will vary year-by-year, 2010 data from EIA indicates that Maine hydropower plants generated 45.4 percent of Maine's electricity demand. Reducing the generation from the seven dams even by the **full** year would reduce the Maine's hydro generation percentage to 39.9 percent, still well above the 30 percent threshold, even before the inclusion of other eligible resources in Maine. Reducing the generation from the seven dams for only April through June and October through November, would only reduce Maine's hydro generation from 45.4 to 42.9 percent.

6. Possible Impacts on Dam Owners

A. Loss of Revenues

Although I do not have access to actual revenue or operating cost data from the dam operators, it is possible to estimate a reasonable range of annual gross revenues based on publically available data. This data includes the monthly generation for each plant from the U.S. Energy Information Administration (EIA), monthly energy prices by period from ISO-NE (ISO-NE 2012), and capacity prices from ISO-NE.

Energy Revenues

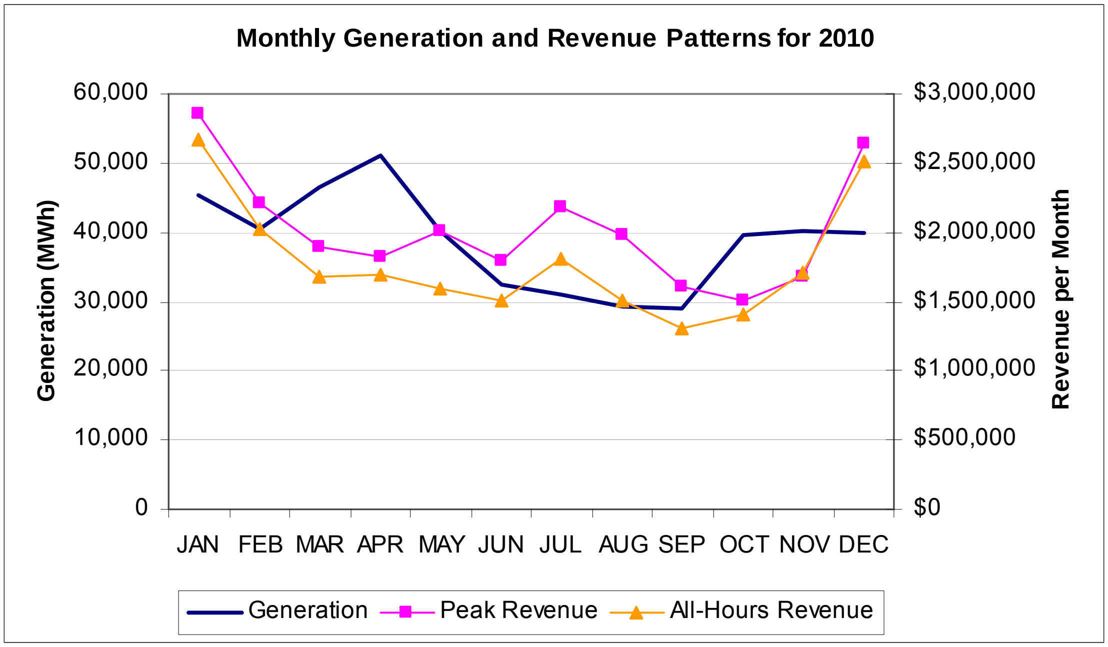
For energy revenues, I estimate a range of possible revenues based on the peak period prices for the upper bound, and the all-hours prices for the lower bound. Although these plants are run-of-the-river, they are identified by ISO-NE as “daily cycling,” given that there is likely some flexibility in scheduling generation to match daily peak hours.

The following exhibit summarizes the 2010 generation and my estimates of gross energy revenues based on wholesale market prices. The energy revenues for the seven dams aggregated together run a little below $2 million per month, and are greatest in the winter. Summer revenues are a little above the average, even though generation is lower in those months, because energy prices are higher.

Partial or full shutdown of these hydro units would have energy revenue impacts proportional to the monthly loss of generation. Monthly revenues for all seven dams together in 2010 were in the $1.5 to $2 million range from April through June, and in the $1.5 to $1.75 million range for October and November. For each individual dam, the revenues from April through June range from approximately $100,000 to $350,000 and from October and November range from approximately $97,000 to $360,000, depending on the individual dam and month.

Electric energy wholesale prices (and revenues) may be a little higher in future years. But the primary determinant of electric wholesale prices in New England is natural gas prices, which are forecast to be relatively stable (Hornby 2011).

Exhibit 9. Monthly Generation and Energy Revenues for all Seven Dams



Capacity Revenues

ISO-NE provides and pays for capacity through the Forward Capacity Market (FCM) and annual auctions for capacity three years in the future. As mentioned earlier, five Forward Capacity Auctions (FCA) have been held to date to provide capacity up through May 31, 2015. In recent FCAs, there has been a capacity surplus and the auctions have cleared at their floor prices.

There are big differences between winter and summer capacities for these hydro plants. New England's peak load period is summer. Capacity prices have dropped considerably in New England and stopped at the floor level because of capacity surpluses. Capacity payments for these hydro plants will be at their winter capacity values for eight months (October through May) and at summer capacity values for four months (June through September). Total capacity revenue for the seven dams for the next several years may be over $2 million per year. If they do not run or have their capacity reduced in a given month, their monthly payments will be proportionally reduced. For example, if all of the studied hydro plants were totally shut down during the month of June in 2013, the capacity revenue loss would be about $130,000 in aggregate for the seven dams. For each individual dam, the loss of capacity revenue will vary by the capacity obligation of each dam. For the June 2013 example, this range is approximately $7,300 for the Lockwood dam to $39,000 for the Weston dam. Exhibit 10, below, shows the total expected capacity revenue for the seven dams based on each of the five Forward Capacity Auctions.

Exhibit 10. Expected Capacity Revenues for All Seven Dams

Capacity Auction	Period (June 1 start)	Capacity Price ($/kW-month)	Summer Capacity (MW)	Winter Capacity (MW)	Summer Capacity Revenue	Winter Capacity Revenue	Annual Capacity Revenue
		1	2	3	4=1*2*(4)*(1,000)	5=1*3*(8)*(1,000)	6=4+5
FCA-1	2010-2011	$4.500			$792,000	$2,557,000	$3,349,000
FCA-2	2011-2012	$3.600			$633,000	$2,046,000	$2,679,000
FCA-3	2012-2013	$2.951	43.99	71.30	$519,000	$1,677,000	$2,196,000
FCA-4	2013-2014	$2.951			$519,000	$1,677,000	$2,196,000
FCA-5	2014-2015	$3.209			$565,000	$1,823,000	$2,388,000

Notes
Values may not sum due to rounding
Summer: June through September
Winter: October through May
Capacity prices based on ISO-NE data for Forward Capacity Auction (FCA)
Capacity values based on CELT 2011

7. Summary

Based on the analysis provided above, it is my opinion that neither the New England electric power grid nor the local electric system within Maine would be adversely impacted by a seasonal shut-down of the seven dams. The seven hydro dams contribute to the electric grid; however, the seasonal shut-down of these units would not result in a significant impact on the region or the state. Both Maine and New England have more than adequate supply capacity to offset the seasonal loss of these dams.

I estimate that the lost energy revenues to the dam owners would be in the range of roughly $1.5 – $2 million in aggregate for the seven dams for each month that turbines are fully shut down from April through June, and roughly $1.5 – $1.75 million in aggregate for each month that turbines of the seven dams are fully shut down from October to November. I estimate that the lost capacity revenues to the dam owners would be roughly $130,000 in aggregate for the seven dams for the month of June, and roughly $210,000 in aggregate for each month that turbines of the seven dams are fully shut down during the months of April, May, October, and November.

Maximilian Chang
January 12, 2012

8. Bibliography

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