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The Economic Impact of LICAP on New England:

A General Equilibrium Assessment

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DISCLAIMER

EXECUTIVE SUMMARY

Enhanced system reliability is the key factor motivating ISO New England's proposed replacement of its existing Installed Capacity (ICAP) market with a Locational Installed Capacity (LICAP) market, which would create smaller subregional markets for installed capacity. The current scheme relies heavily on Reliability Must Run (RMR) payments to provide local reliability, but these are more costly and less secure than the electricity network structure which could develop through LICAP. In our analysis, we evaluate the relative cost of LICAP as compared with the status quo, purely on the basis of economics.

Even setting aside the benefits from enhanced reliability, we find that LICAP makes economic sense through the elimination of RMR subsidies to aging capacity. When new capacity replaces old capacity, it is more efficient, both because of technological innovations and because new units produce energy more efficiently, and with less pollution, than the old units they replace. Replacing old, costly generators with new, efficient plants would reduce the cost of electricity and, within the economy as a whole, we find that improvements in system efficiency dominate the capital costs of installing new capacity. In short, LICAP is a "win-win proposition," providing both lower electricity prices and improved system security.

Our analysis of LICAP is unlike previous spreadsheet-based accounting studies. First, to assess the potential impact of LICAP on the efficiency of the electricity market and transmission system, we use a security-constrained economic commitment and dispatch model. Second, we feed the electricity market impacts into a dynamic, multisectoral, multiregional general equilibrium model in order to evaluate the economic growth implications of LICAP for the New England states. Our general equilibrium assessment finds that over a period of 20 years, the introduction of improved network security could lead to 15,000 new jobs and an economic benefit on the order of $150 per household per year. These impacts are significant, particularly recognizing that they are obtained in concert with improved network reliability.

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1. INTRODUCTION

The Locational Installed Capacity (LICAP) proposal that is currently pending before the Federal Energy Regulatory Commission (FERC) was designed by ISO New England (ISO-NE), the independent system operator charged with maintaining system reliability, to maintain needed generation facilities and to encourage new investment in power plants when and where needed to ensure reliable supply of power. The initiative intends to minimize ISO-NE's reliance on Reliability Must Run (RMR) contracts by implementing a locational capacity payment based on a "demand curve" that reduces the volatility of the current capacity market design. This LICAP design is very similar to the market currently operating in New York, which has successfully fostered the development of substantial, new generation facilities. Currently, there is less than 1,000 MW of new generation planned in New England, substantially less than the region's needs in the next three to five years, according to the recent Draft Regional System Plan of ISO-NE.

In this analysis, we used CRA's MRN model with feedback from a bottom-up model of the New England bulk power system to assess the costs of adding new capacity in accordance with the price signal under the proposed LICAP regime. Previous analyses of the LICAP proposal have focused narrowly on the rate implications of the proposal using simple accounting models of the new system. These estimates, which ranged from savings of a few billion dollars over the next five years to excess costs as high as $13 billion, considered only the change in payments to generators. These calculations were often flawed, failing to consider increased capacity and energy payments as capacity grew more scarce, increasing RMR payments that would be necessary absent a LICAP market, or the value of consumers' capacity transfer rights. Even setting these shortcomings aside, none considered the benefits from allowing the orderly retirement of expensive, inefficient generation, replaced in competitive markets by new generators producing energy more reliably, at lower cost, and with lower environmental impact.

The present analysis is the first general-equilibrium study of the economic impact of the LICAP system. In our analysis, we first evaluate potential impact of LICAP on the efficiency of the electricity market and transmission system, using GE-MAPS, a security-constrained economic commitment and dispatch model, described in detail in Appendix B. We subsequently feed the resulting electricity market impacts into a dynamic, multisectoral, multiregional general equilibrium model in order to evaluate the economic growth implications of LICAP for the New England states.

2. THE ROLE OF CAPACITY MARKETS AND DIRECT COSTS OF LICAP

Electricity is a vital commodity in the modern economy; reliable delivery of low-cost power is essential to the economic well-being of every New Englander. Since electricity cannot be stored efficiently, however, there must be enough generating capacity installed, year-round, to meet the peak demands that may occur in only a handful of hours. Moreover, to ensure that the system operates reliability, additional generation reserves are required on top of this. Consequently, there are some electric generators that, while necessary to deliver reliable power year-round, rarely, if ever, operate in any given year.

These facts lead to pressing questions: How, if we pay only for energy produced, do these rarely-called units make enough money to stay in service? Who would ever invest in replacements for these units? In the pure theory of electricity market design, these rarely-used units would earn enough by allowing energy prices to rise to very high levels, in the range of $10,000 to $25,000 per megawatt-hour, instead of typical prices in the $30 to $100 range. Such volatility in electricity prices, however, has not been widely accepted. Price spikes of this magnitude are politically unacceptable and create large financial risks for customers. Moreover, since the spikes are infrequent and unpredictable, it is difficult, or perhaps impossible—and expensive—to obtain project financing for generation plants that rely on these earnings. Finally, such a great reward creates a powerful incentive for suppliers to attempt to drive the system towards scarcity to create more price spikes. For all these reasons, all organized electricity markets in the United States have price caps, ranging between $250 and $1000 per megawatt-hour, well below the levels needed for the energy market alone to fund capacity investment.

To address this issue of “missing money,” most of the U.S. markets have implemented a capacity market to provide additional funds to cover the difference between what generators can reasonably earn in the energy markets and the long-run cost of capacity supply. New England has had a capacity market of one form or another since 1999, but all the previous models have failed to function as intended. First, capacity prices have been “bipolar”—if capacity was scarce, prices were very high, but when the balance flipped even slightly, prices fell to near zero. This volatility is undesirable both to consumers and generation owners. Second, capacity prices have been uniform throughout the region, ignoring the large differences in the cost of constructing a power plant in urban areas like Boston or Southwest Connecticut, compared to rural areas with easy gas pipeline access, like Maine. Unsurprisingly, this led the majority of developers to build generators in low-cost areas, creating the need for costly upgrades to the New England transmission system.[1] Lacking any locational aspect to its capacity payments, ISO-NE has had to rely on RMR contracts to prevent the retirement of uneconomic but needed generating resources in Connecticut and

[1] *See* Boston Globe, August 11, 2005, “A $217 Million Blackout Antidote.”

the Boston area. ISO-NE foresees a growing need for RMR contracts, if no changes are made to the capacity market construct.

To address the shortcomings of the current capacity market design, ISO-NE has proposed the LICAP market. This proposal has been accepted, with revisions, in an Initial Decision by an administrative law judge at the Federal Energy Regulatory Commission. This market redesign addresses the problem of bipolar prices by setting the capacity price on a sliding scale: prices move gradually as the supply/demand balance shifts. This “demand curve” is set to return, on average over time, only the additional revenues needed by an efficient capacity resource, but by smoothing the payments out over time, rather than relying on high payments in some years and no payments in others, the demand curve reduces investor risk and, consequently, consumer cost. Secondly, the LICAP proposal allows capacity prices to differ by area within New England, reflecting local scarcity as well as differences in construction and operation costs. As a result of these two features, ISO-NE believes that most of the existing RMR contracts would no longer be needed.

Although the LICAP proposal would likely increase capacity market payments compared to the current capacity market design in the near term, ISO-NE has forecast a rapid increase in RMR payments. At a presentation to the New England Conference of Public Utility Commissioners in June, ISO-NE presented results of its analysis of the direct costs of various alternatives to meeting the reliability needs of the New England system. Of the three alternatives, LICAP was the least costly in direct payments. We understand that other parties have reached different conclusions about the direct costs of LICAP compared to other alternatives; we do not in this study attempt to weigh in on this subject. Instead, we focus on other, consequential benefits of replacing the existing patchwork of ICAP plus RMR with a comprehensive LICAP solution.

3. GE-MAPS ASSUMPTIONS REGARDING GENERATION RETIREMENTS AND NEW ENTRY

Our analysis focuses on the implications of LICAP for accelerated replacement of outmoded capacity in the New England control area. Given the impact of this key element on our findings, in this section we describe the thinking that informed our assumptions for both replacement of uneconomic capacity and addition of capacity required to meet load growth, under both the Status Quo and LICAP scenarios.

Status Quo scenario. We assume that under the Status Quo scenario, no generation capacity will retire between today and year 2010 (the year for which we performed detailed simulations using GE-MAPS were performed). Assets performing poorly in the energy market would likely receive RMR payments and will be kept online for reliability reasons. Given the lack of retirements driven by economics, capacity additions to the existing stock would not be needed until 2010.

LICAP scenario. By contrast, under the LICAP scenario, poorly performing assets will no longer receive financial support through RMR payments, and several of them will likely retire within the next three to four years. For reliability reasons, these assets would have to be replaced before 2010. Additional capacity will also be needed in 2010 to meet load growth in the New England control area.

Given these factors, in our analysis we assumed the capacity retirements and additions shown in Table 1, Table 2, and Table 3. The plants listed in Table 2 have been selected as representative older units. We have no knowledge of precisely which units would actually retire in the face of new entry under a LICAP market, but it is likely to be older units in zones with lower LMP rates.

Table 1. LICAP Scenario Capacity Additions

Technology	Size (MW)	Location
CCGT	500	SE Mass
CCGT	500	Rest of CT
CCGT	500	SW CT
SCGT	250	Norwalk-Stamford

Table 2. LICAP Scenario Capacity Retirements

Unit	Size (MW)	Location
Wyman 4	600	Maine
Canal	600	SE Mass

Table 3. Status Quo Scenario Capacity Additions

Technology	Size (MW)	Location
CCGT	500	Maine

4. ADAPTING THE MRN MODEL TO STUDY LICAP

For analysis of the economy-wide effects under a Locational Installed Capacity (LICAP), CRA used its Multi-Region National (MRN) model. MRN, described in detail in Appendix A, is a computable general equilibrium (CGE) model of region-specific impacts and regional interaction in the U.S. economy. The model is especially useful to analyze such policy as

LICAP where a one-time decision on investment has long term consequences. Thus MRN accounts for general equilibrium effects over the lifetime of the investment. Moreover, under the model, all agents within the economy interact in competitive markets which jointly determine prices and quantities.

The model solves for income, production levels, relative prices, trade, and consumption through a mathematical specification that accounts for behavioral as well as technological responses to changes in policy. The equilibrium is “fully dynamic” in the sense that investment decisions determine the future capital stock which in turn determines future income and consumption. Furthermore, decisions to consume or invest are taken with consistent expectations about future policy and opportunities. Investment today requires foregoing consumption of current output (current GDP). Consumer decisions maximize utility, which implies that an optimal tradeoff is made between consumption today and consumption in the future.

Data that characterize the interrelationships of commodities within the economy are of primary importance in quantifying the impacts from alternative policies. Many of the impacts due to an increase in efficiency and reliability also decrease the cost of electricity and increase electricity consumption. As a starting point for characterizing the inputs and outputs in the economy, we utilize a Social Accounting Matrix (SAM) developed for each state by the Minnesota IMPLAN Group, Inc. (MIG). The IMPLAN database represents the activities in 530 sectors for all 50 states and the District. Adjustments to the original data were necessary to bring them in line with the EIA’s state level energy data, which are more accurate than the corresponding IMPLAN data. The SAM that results from the combination of IMPLAN and EIA data fully tracks the intensities of commodity use for the modeled production and consumption sectors for any regional aggregation of states. In addition, the SAM completes the circular flow with an account of factor incomes, household savings, trade, and institutional transfers.

Conceptually, the SAM is taken to represent a snapshot of the economy along a dynamic growth path. Calibration of the dynamic equilibrium is completed by incorporating growth forecasts for industries, population, and carbon emissions. MRN explicitly models just the U.S economy and is parameterized on the basis of electricity network conditions generated by GE MAPS (discussed in the next section).

4.1. Regions and Sectors

MRN is a regional model of the U.S. economy. In order to focus on the New England states that would be under the purview of LICAP proposal and to portray the electricity market, the model was configured with six New England states and one “rest of the US” region, described in Table 4. In addition, the rest of the non-New England states were aggregated into a single region to simulate the New England states’ key economic relationships with the rest of the nation.

Table 4. The MRN Model's Regions for Analyzing LICAP

Name	Region
CT	Connecticut
MA	Massachusetts
ME	Maine
NH	New Hampshire
VT	Vermont
RI	Rhode Island
RUS	Rest of the US

All of the important energy sectors – coal, gas, oil, crude, and electricity, are contained in the detailed SAM are represented in MRN. We then aggregate the remaining non-energy sectors into eleven categories to capture the diversity in the economic structure of the New England region and electricity-intensity of different industries. Therefore, the model is run with the following sixteen sectors:

Table 5. The MRN Model's Sectors for Analyzing S-3-05

Energy Sectors	Non-Energy Sectors
Coal extraction	Agriculture
Gas distribution	Aluminium
Oil and gas extraction	Chemicals
Oil refining/distribution	Pulp-Paper-Print
Electricity generation	Iron and steel
	Other energy-intensive
	Motor Vehicles
	Other manufacturing
	Construction
	Services

4.2. REPRESENTATION OF LICAP POLICY INSTRUMENT IN MRN

In our comparison of Status Quo and LICAP scenarios in MRN we focus on two inputs: (i) changes in the marginal cost of electricity, and (ii) retirements of extant electricity sector capital. The first of these inputs is based on locational marginal prices from the GE-MAPS calculation for 2010, the values of which are presented in Table 4 below. Our economic model is based on state-level geography, and we therefore must average price impacts from constituent zones in the case of Massachusetts and Connecticut.

Our model runs through a 2050 horizon, and we assume that improvements in system efficiency which are initiated in 2010 continue through 2025 with reductions in marginal costs of energy supply decreasing by 0.5% per annum over that period.

GE-MAPS focuses on economic dispatch decisions for a given electricity network and does not provide a clear assessment of the investment costs associated with LICAP. For this purpose we use an alternative methodology. We begin with data from the U.S. Department of Energy, Energy Information Agency: Form EIA-860 Database (Existing Electric Generating Units in the United States, 2003). These data describe installed capacity by date of installation, fuel type and state. Examining only fossil-fuel plants, we first examine the age distribution of fossil-fuel plants in New England, as is displayed in Figure 1. This figure reveals that a large number of aged generating units are part of the installed capacity in New England. Under LICAP, many of the older plants will be retired as the RMR subsidies are eliminated. We portray this process in our model as an accelerated retirement schedule for extant capital in the electricity sector. In the Status Quo scenario, we assume that fossil-fuel generating units are retired at age 50, whereas in the LICAP scenario we assume that the same units are retired ten years earlier, when they reach age 40. The state-level impact of this assumption is illustrated in Figure 2. This figure portrays the fraction of the initial fleet of fossil generation which is between the ages of 40 and 50 in the specified year. For example, roughly from years 2013 to 2023, over 70% of Vermont's current fleet of fossil-fuel plants will be between the ages of 40 and 50. We assume that with the introduction of LICAP, this generation capacity must be replaced, capturing the idea that phasing out of RMR payments will lead to a more rapid obsolescence of old, inefficient generation units.

The economic cost of retiring an old generator depends on the rents in excess of fuel and operating expenses earned by the plant. We assume as a central assumption that generators between 40 and 50 years of age earn only 20% as much as new generators.[2]

[2] In practice, the oldest generation units in ISO-NE are typically operated on the basis of RMR subsidies, hence our assumption of a 20% earning ratio for old plants is probably conservative.

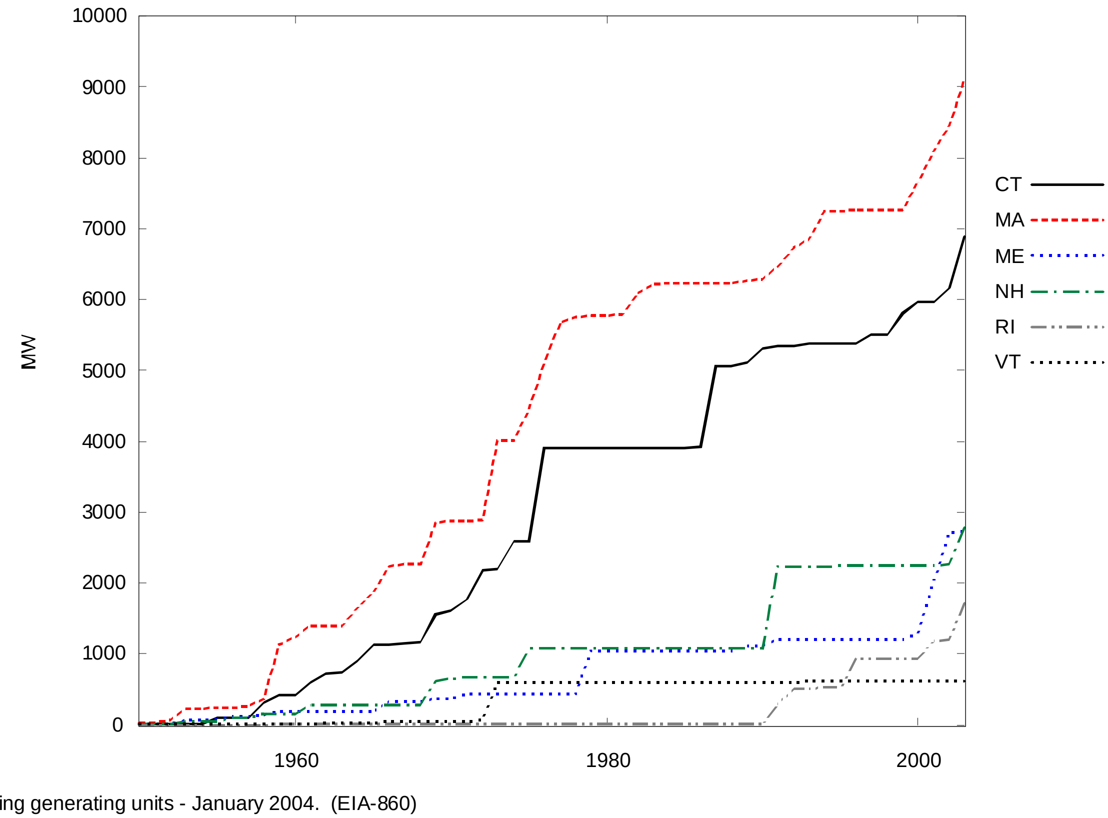
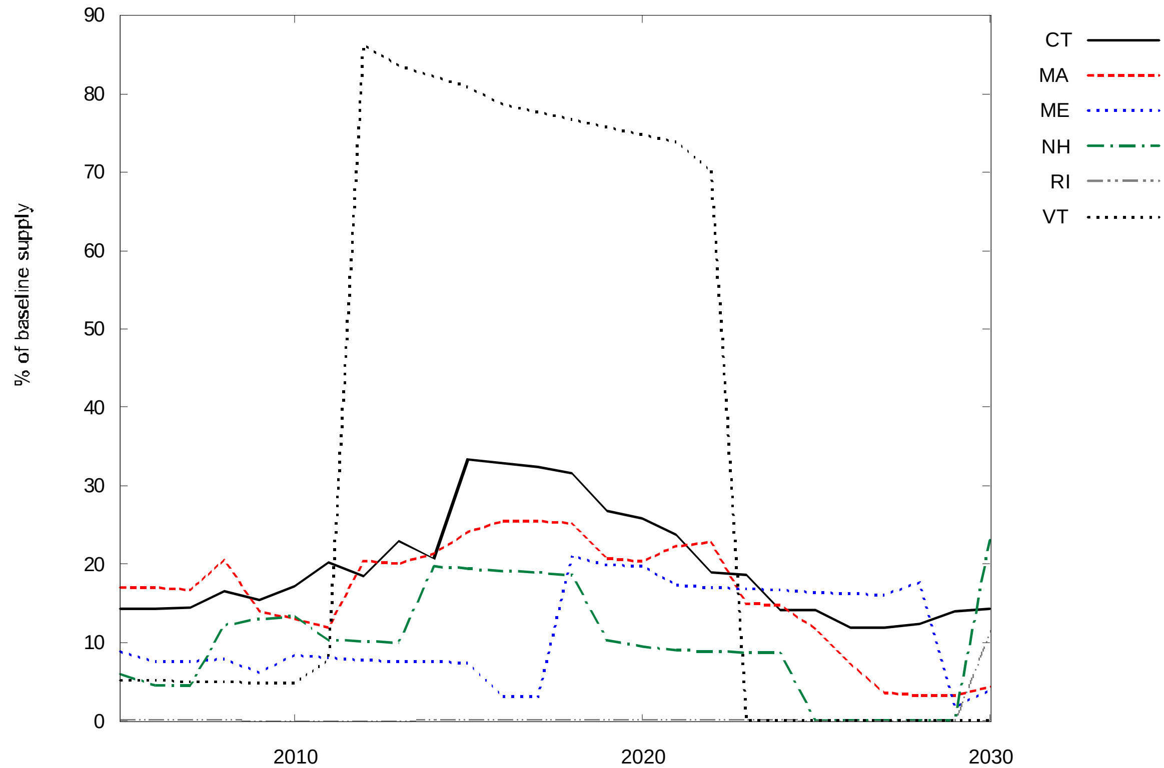


Figure 1. Age Distribution of Fossil Fuel Electricity Generating Capacity in New England



Authors calculations, based on EIA-860

Figure 2. Percentage of Fossil Fuel Plants over 40 Years in Age

5. FINDINGS

Our model-based analysis of LICAP begins with GE-MAPS. The key parameters coming from this model are electricity prices by zone. These impacts are presented in Table 6.

Table 6. Zonal Impacts of LICAP in ISO-NE – (GE-MAPS output for 2010)

		Electricity Prices		
	Energy (GWh)	Status Quo ($/MWh)	LICAP ($/MWh)	% Change
Maine	12341	36.0	35.8	-0.4
New Hampshire	9998	44.1	43.7	-0.9
Vermont	8018	44.1	43.7	-0.9
West/Central Massachusetts	17495	54.3	52.0	-4.2
Boston	32219	50.3	49.1	-2.3
Southeast Massachusetts	13925	50.5	49.2	-2.6
Rhode Island	11950	51.1	49.9	-2.4
Rest of Connecticut	18760	54.7	51.2	-6.3
Southwest Connecticut	12208	58.0	54.2	-6.6
Norwalk-Stamford	6193	60.5	56.9	-6.1
Average New England	143106	49.3	47.5	-3.7

The regions most affected by the LICAP policy measures are in Connecticut where electricity prices decline by over six percent. Impacts in Massachusetts range from between 2 and 4 percent, whereas prices decline by smaller margins in Maine, Vermont and New Hampshire. Price impacts reflect the pattern of new capacity installation which we associate with the LICAP measures.

Within the MRN framework, we begin with a calculation of the status quo growth path in which retirements of fossil-fuel electric generators occur 50 years following the data of installation. Starting from the status quo, the LICAP scenario introduces two “shocks” to the model. First, we assume changes in the state-level marginal cost of electricity based on load-weighted averages of the zonal price impacts values shown in the final column of Table 6. Second, we introduce a shock to the extant electricity sector capital stock, removing a fraction of the capacity corresponding to output from units of age 40 to 50 in each period (as indicated in Figure 2).

LICAP transition costs in this model correspond to short-term premium on electricity sector capital stocks which follow the retirement of existing capital. Over time the improvement in system efficiency induces a net increase in installed capacity and aggregate electricity supply.

There are three dimensions in which we can summarize the impact of these policy measures. First, we can examine changes in electricity prices. The closely follow the LICAP scenario input assumptions which are obtained in the GE-MAPS model (Table 6.) Second, we can evaluate the net change in labor supply and employment by sector and in aggregate. Third, we can assess the net welfare impact, the most precise measure of economic effect. All three of these effects are summarized at the level of individual states in Table 7.

Following closely the GE-MAPS input assumption in 2010 and the assumed ongoing 0.5% per year improvement during the period 2010 to 2025, we find that electricity prices fall by 4.2% in 2015 and 6.1% in 2020. Most of these reductions are concentrated in load pockets in Connecticut and Massachusetts where LICAP incentives induce the construction of new capacity.

Employment effects follow the increased competitiveness of energy-intensive manufacturing. A reduction in electricity prices in these sectors corresponds to an increase in labor productivity which in turn induces higher levels of labor supply. While these mechanisms are easily interpretable, the changes in employment are quite small relative to the workforce as a whole. The only state in which measured employment impacts are negative is Rhode Island in which job losses of 300 are scarcely different from zero.

LICAP-induced changes in employment depend on a number of factors, including LICAP's impacts on both the average cost and reliability of the electricity network. Individual states are affected differently depending on the resulting changes in prices and the electricity-intensity of economic activity. Our analysis has focused conservatively on electricity rates and has explicitly ignored the potentially significant employment benefits associated with having a more reliable network. The model's employment impacts in Rhode Island which are virtually zero as a percentage of the employment base. This provides a lower bound assessment of employment impacts, as this estimate does not account for the beneficial impacts which would emerge from improved system reliability.

The most significant factor on which to judge the effectiveness of LICAP is regional economic welfare. Welfare measures in general equilibrium models provide a precise integration of direct and indirect effects of policy measures. The range of welfare impacts associated with LICAP in 2015 range from $87 per household in Maine to $188 per household in Connecticut. In 2020, the range of impacts increases to $100 and $230, respectively. The states in which LICAP offers the largest welfare gains are precisely those states and zones where system security is most likely improve. The average gains across New England are $130 per year in 2015 and $161 in 2020.

More detailed reports of state-level impacts are provided in Appendix C.

Table 7. Economic Impacts of LICAP in ISO-NE – (MRN output for 2015 and 2020)

State	Year	Change in Electricity Price (%)	Employment (number of jobs)	Financial benefit per household ($ per year)
New England	2015	-4.2	13490	130
	2020	-6.1	15522	161
Connecticut	2015	-6.6	3072	188
	2020	-8.4	4518	229
Massachusetts	2015	-3.7	2447	115
	2020	-5.4	2529	139
Maine	2015	-2.8	802	87
	2020	-4.9	2534	119
New Hampshire	2015	-3.3	1965	134
	2020	-5.7	919	156
Rhode Island	2015	-3.3	-323	89
	2020	-5.0	-323	104
Vermont	2015	-3.0	5526	126
	2020	-5.4	5343	205

5.1. SENSITIVITY OF THE RESULTS TO CHANGES IN INPUT PARAMETERS

Definition of our LIPAC scenario in MRN involved two exogenous parameters, the values of which are not known with certainty. These include:

1. Extant capital earnings rate, representing profitability of existing 40 year generating units. The default assumption is that these earn 20% of the return to new units.

2. Growth rate of electricity sector productivity induced through LICAP from 2010 to 2025. In the central case we assume a 0.5% per annum growth rate.

In order to provide an intuitive understanding of the range of uncertainty in our estimates, we have run the model one hundred times using randomly selected values for these two inputs. In these Monte-Carlo simulations, we assume that extant capital earnings are uniformly distributed between 0% and 40% of the earnings of comparable new units, and we assume that LICAP's induced productivity growth rates for the period 2010 to 2025 are uniformly distributed from 0% to 1%. In both cases, the central point in the distribution corresponds to the default value.

Figure 3 summarizes the resulting distribution of model results. In this graph, the vertical axis corresponds to the welfare impact in dollars per household per year, averaged across all of the New England states in the MRN model. The horizontal axes corresponds to years in the projection. The line in the center of the distribution corresponds to the median (50% percentile) welfare impact. At each point in time, out of 100 simulations, half of the simulations produced welfare impacts which are greater than the median, and 50 simulations produce results which are less than the median.

The shaded portions of this figure correspond to deciles in the same distribution of welfare impacts. None of the values are negative, and the range of welfare impacts in 2015 range from roughly $70 per household per year to $140 per household per year.

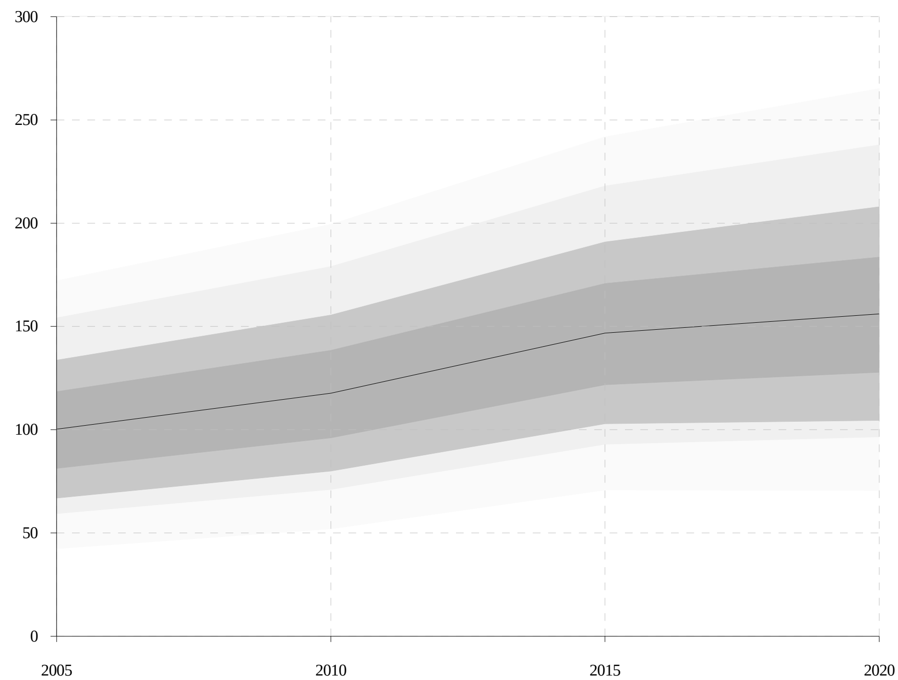
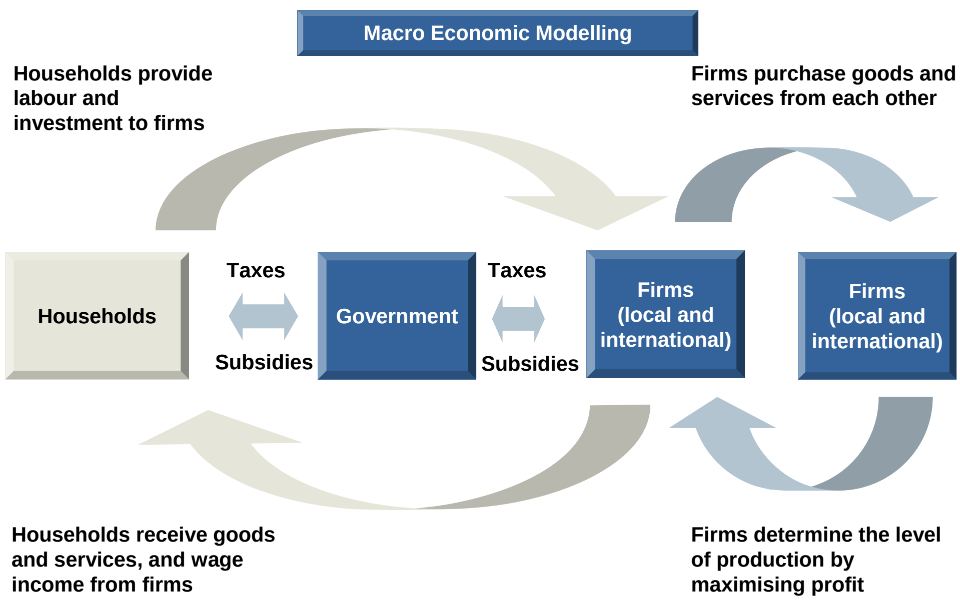


Figure 3. Projected Sample Deciles of Welfare Impacts ($ per household per year)

APPENDIX A: THE MRN DYNAMIC GENERAL EQUILIBRIUM MODEL

The theoretical concept underlying MRN is that of an Arrow–Debreu equilibrium, in which macro-level outcomes are driven by the self-interested decisions of consumers and producers. Consumers are represented by a single agent (the household sector) in each region that maximizes utility subject to endowments of primary factors and available production technologies that transform factors and intermediates into commodities. All production sectors are assumed to be competitive with underlying technology exhibiting constant returns to scale. An evolving capital stock is replaced and supplemented through investments which correspond to an optimal trade-off of current and future consumption. The resulting equilibrium is characterized by income and production levels, and a set of relative present-value prices. A basic structure of a Computable General Equilibrium model is shown below.



Household utility is defined by a discounted constant-elasticity-of-substitution (CES) utility function defined over the time path of period-by-period utility. Instantaneous utility within each time period is based on a CES aggregate of goods consumption and leisure demand. The budget constraint equates the present value of consumption to the present value of income earned in the labor market and the value of the initial capital stock minus the value of post-terminal capital. The representative agent optimally distributes wealth over the horizon by choosing how much output in a given period to consume and how much to forego for investment.

Two primary factors are supplied by the household sector for production: labor (an exogenous time endowment) and capital. The labor-leisure choice within each period determines labor supply. The capital stock depreciates geometrically but can be augmented in each period through an investment activity. We model adjustment costs in the capital stock through a partial putty-clay production structure. In addition to labor and capital, the model is extended to include primary resource factors specific to the extraction of crude oil and natural gas, and extraction of coal.

Production sectors are assumed to be competitive, exhibiting constant returns to scale (except the natural resource extracting sectors). A nested CES structure is employed for production in the non-resource extraction sectors that utilize new capital. The CES process combines material (intermediate) inputs of non-energy commodities with capital, labor, and energy to produce final goods for consumption and intermediate goods for other sectors.

A.1 Adjustment Dynamics

Under typical assumptions about intertemporal elasticities of substitution, the above formulation of a Ramsey optimal growth model results in a rapid convergence to the steady state. Traditionally, modelers have slowed adjustments through ad hoc absorptive capacity or liquidity constraints, or quadratic adjustment costs. As an alternative, we incorporate adjustment costs based on an explicit specification of available technologies. The model is thus based on a partial putty-clay production structure. Capital that is in-place at the start of the horizon is sector-specific and has fixed input coefficients. Any production that utilizes the original capital must use other factors in a set of fixed proportions. New capital that replaces depreciated capital or augments the stock to support growth is malleable; that is, it can be designed to use inputs in a combination that satisfies a general nested CES production function.

The distinction between new vintage and extant capital plays a crucial role in our representation of electricity generation in these calculations. The model portrays output from old and new generators as identical products, yet the quantity supply by old (extant) units is based on an exogenously specified time path of retirements. New plants might have any range of efficiencies that are dictated by the amount of capital embodied in design and equipment. In contrast, extant electricity plants that are in operation prior to the first endogenous year of the model have a fixed efficiency. Over time, the rate of introduction of new producers depends on both the speed with which old plants are decommissioned and the rate of increase in productivity of older plants.

In addition to labor and capital, there are primary resource factors specific to the extraction of crude oil and natural gas (CRU), coal (COL), gas (GAS). In these sectors there is no putty-clay formulation, but all other inputs are used in fixed proportion to one another and then substituted against the specific resource input. This operationalizes the decreasing returns associated with natural resource extraction. Given the inelastically supplied resource, an elasticity of substitution between it and the other inputs is used to calibrate responses to an exogenously specified time-varying elasticity of supply along the baseline.

A.2 TRADE STRUCTURE

The basic Ramsey model is further extended to an open economy with interstate and international trade. An intertemporal balance-of-payments constraint dictates no change in net indebtedness over the horizon and inter-regional and international capital markets are otherwise unrestricted. Trade is specified such that all goods (except for Crude Oil) are differentiated by their origin. An Armington aggregate good, which is either consumed or used as an intermediate in production, is the CES composite of imports of the good from outside the U.S., imports from five U.S. regional markets, and finally goods produced locally (within the state). Similarly, a constant elasticity of transformation was defined between output destined for home consumption and output destined for one of the other six possible markets.

A.3 TAX INSTRUMENTS

The model takes into account the wedges between prices received by factor owners and marginal products of those factors, and the marginal costs of production and market prices, caused by the inclusion of taxes. The taxes represented in the model include: FICA (or labor taxes), corporate income tax, property taxes, indirect business taxes (or output and sales taxes), and personal income taxes.

APPENDIX B: DESCRIPTION OF THE GE-MAPS MODEL

GE-MAPS is a detailed economic dispatch and production-costing model for electricity networks. It was originally developed by General Electric and is currently used by over twenty major utilities in the U.S. CRA has worked closely with General Electric to ensure that the model's data structures and functionality accurately reflect the competitive market.

GE-MAPS determines the least-cost secured dispatch of generating units to satisfy a given demand, on the assumption that the units are dispatched according to their variable costs. The major advantage of GE-MAPS is its ability to simulate the hourly operation of generating units and transmission systems (e.g. transformers, lines, phase shifters, busses) in significant detail. For example, it accurately represents capacity constraints, minimum up time limitations, and thermal constraints on the transfer capability of transmission lines, line and unit contingencies and scheduling limitations of hydro-plants. Thus, GE-MAPS provides a highly accurate, detailed simulation of the hourly operation of the individual generating units and transmission system that constitute the wholesale market.

Among the key outputs of the GE-MAPS model are a set of Locational Marginal Prices (LMPs), computed for each bus in each hour, and a set of capacity prices for each relevant geographical market. Such a detailed representation of the physical part of power markets makes GE-MAPS an ideal tool for conducting a precise analysis of power markets.

B.1 Outputs

The outputs from GE-MAPS include key technical and economic parameters such as hourly generation levels, costs, revenues, profit margins, spot and average prices and profitability indices. These characteristics are generated at the market-wide, firm and generating unit levels and on an hourly, daily, weekly, monthly and annual basis.

B.2 System Representation in GE-MAPS

One of the major advantages of GE-MAPS is its ability to represent and simulate the operation of, the transmission system and individual generating units. Following is a list of the major inputs used to represent the market structure and physical system being modeled. The list is followed by a discussion of these components.

- Market Assumptions
  - Structure and rules
  - Boundaries
  - Operating reserves
  - Bidding behavior

- Demand
  - Load Inputs
  - Dispatchable Demand (Interruptible Load)
- Supply
  - Nuclear Units
  - Conventional Hydro & Pumped Storage Units
  - Thermal Unit s
  - Planned Additions and Retirements
  - NUG Contracts
  - Imports and Exports
  - Environmental Regulations
  - Fuel Price Forecasts
  - Transmission System

B.3 MARKET ASSUMPTIONS

ISO Boundaries: The unit commitment, dispatch and reserve requirements are maintained on a geographic basis using the existing and/or assumed ISO boundaries. The imports/exports among ISOs and between ISOs and neighboring systems reflect economy energy purchase/sales and incur wheeling charges. Transactions within the ISO boundary do not incur any transmission charge (we assumed selling/buying from the pool, and the load pays the transmission charge irrespective where it buys its energy from within the pool).

Operating Reserves (spinning and standby): The operating reserves are based on the specific requirements instituted by each ISO in the region. These requirements involve the loss of the largest single generator or the largest single generator and half the second largest generator. The spinning reserves market affects the energy market prices since the units that spin cannot produce electricity under normal conditions. The energy prices are typically higher when reserves markets are modeled.

Bidding Behavior. GE MAPS has a relatively simple bidding logic. Bids can be based either on variable generation costs or user-defined inputs. Bids based on variable generation costs are used in this study.

5.2. DEMAND ASSUMPTIONS

Load Inputs. GE MAPS takes load inputs on an hourly basis (8760 per year) for every load serving entity. Loads for future years are scaled based on a forecast of annual peak demand and energy. The model adjusts the load profile in every year to account for the change in the day of the week at the start of every new year.

Dispatchable Demand (Interruptible Load). We include a representation of interruptible load to capture its impact on electricity prices. The presence of demand response is important to the energy and installed capacity prices. In the energy market the value of energy to interruptible load caps the prices and the capacity of interruptible load works as installed reserves and lowers the capacity value.

B.4 SUPPLY ASSUMPTIONS

Nuclear Unit Analysis. We use a combination of market knowledge, the Nuclear Regulatory Commission's (NRC) watch list and economic performance as reflected in model runs to determine whether any nuclear units should retire prior to their license expiration. We use a four-year average of O&M costs and revenue projections from model runs to assess units' economic performance. We also incorporate maintenance schedules and current outages posted on the NRC website.

Conventional Hydro and Pumped Storage Units. GE MAPS has special provisions for modeling hydro units based on seasonal patterns of water flow.

Thermal Unit Characteristics. GE MAPS model generation units in detail, in order to accurately simulate their operational characteristics and therefore project realistic hourly prices. These characteristics include:

- Unit type (steam, combined-cycle, combustion turbine, cogeneration, etc.)
- Heat rate values and curve
- Summer and winter capacity
- Variable operation and maintenance costs
- Fixed operation and maintenance costs
- Forced and planned outage rates
- Minimum up and down times
- Quick start and spinning reserves capabilities
- Startup costs

We develop heat rate curves for different units based on technology type and data points obtained from the data sources described below.

Imports and Exports. To the extent important neighboring market regions are not fully modeled, they can be represented as the "outside world." The outside world is modeled as a series of representative loads or generating units. The thermal capacities of these representational units determine either the maximum export capability across tie lines, or the maximum generation capacity available for export from the outside area. We use historic exports, combined with our expectation of future conditions in the areas of this outside world, to project export levels and prices for each of the forecast years.

Planned Additions and Retirements. Planned entry and retirements impact the fuel mix of installed capacity and composition of plants on the margin. We add new capacity to the model for the next two years based only on existing projects in development or in advanced stages of permitting, as indicated by environmental permit applications and internal knowledge. Beyond that two-year timeframe, we enter capacity, in addition to known projects, based on economic criteria. That is, we enter only as much capacity as is profitable. We track planned and announced retirements from power pool load and capacity reports as well as trade press announcements. In addition, we monitor the profitability of units for every model run and retire those units that are not profitable, based on their performance in the model and external judgment about the likelihood of those plants improving profitability in later years.

Environmental Regulations. We implement the impact of compliance with the NOx budget and cap-and-trade program. We also include SOx emission adders.

Fuel Price Forecasts. GE MAPS takes monthly fuel prices for all plants. We model fuel-switching capability and the seasonality of fuel prices in order to accurately model dispatch behavior. Our fundamental assumption of bidding behavior in competitive energy markets is that generators' variable cost are driven by the opportunity cost of fuel purchased (in addition to variable O&M and environmental adders), or the spot price of fuels at the closest location to the plant. We therefore use forecasts of spot prices at regional hubs, and further refine these based on historical differentials between price points around each hub. For oil we use estimates of the price delivered to generators on a regional basis. For coal we use generating unit specific forecasts acquired from Platt's.

Transmission System Representation. We are capable of modeling any transmission system in the US and Canada, including transformers, lines, phase shifters and buses. Most data are provided with GE MAPS in the form of a solved load flow case (PTI file). GE provided the initial set of lines based on their contingency analysis.[3] We verify, refine and add to this list of monitored transmission lines, interface and contingency definitions based on publicly available information on Transmission Loading Relief (TLR) historical data, lists of binding constraints published by ISOs and in-house transmission and contingency studies.

Transmission Losses and Regional Wheeling Charges: In our simulations we account for transmission losses. GE MAPS offers the user a choice between accounting for losses on average basis or on the marginal basis. The wheeling charges for inter-ISO transactions are based on the ISOs tariffs filed with FERC. We used the hourly point-to-point transmission service charge for imports and exports.

[3] GE contingency analysis: GE iteratively performed load flow simulations with every line in the system taken out individually, and extracted for monitoring the cumulative set of lines that had flows over 80 percent of their emergency rating in any of the iterations.

B.5 DATABASES

Our market simulations are based on up-to-date data from public and commercial sources. We maintain databases on:

Load. Historical electricity load data for all local service territories of the United States and Canada and load forecast scenarios developed by major forecasting institutions.

*Fuel***.** Forecasts of fuel prices for specific generating units based on energy price forecasts from major forecasting institutions.

*Generating Units***.** Physical, geographical, environmental, administrative, regulatory and economic data for all existing generating units in the U.S. and Canada as well as for all generating units under development and proposed for development.

*Transmission Systems***.** Physical, geographical, regulatory and economic data for all existing transmission lines in the U.S. and Canada; constraints, contingencies and significant interfaces within and across all regions of the Eastern Interconnection modeled in this study: New England, New York, PJM and Ontario.

APPENDIX C: STATE-LEVEL RESULTS

CONNECTICUT

Benefits to the State Economy through Implementation of Locational Installed Capacity for New England[1]

The Locational Installed Capacity (LICAP) proposal that is currently pending before the Federal Energy Regulatory Commission (FERC) purports to encourage new investment in power plants in grid-congested areas and improve system performances to ensure reliable supply of power during high demand periods through "market signal." The initiative intends to minimize ISO New England's reliance on RMR contracts by implementing a non-uniform capacity payment in load pockets and control rate fluctuation by using a demand curve.

In this analysis, we feed electricity market impacts from a bottom-up model into CRA's MRN model to assess the costs of accelerated replacement of outmoded capacity in the New England control area. In the *Status Quo scenario* no generation capacity is retired prior to 2010 and further assumes continuation of RMR payments for reliability reasons. Under the *LICAP scenario*, poorly performing assets are retired prior to 2010 to meet load growth in the New England control area.

Overall Economic Impacts

The extent of economic impacts depends on efficiently locational decisions are made as a result of the LICAP. The proposal would provide a financial benefit of $188 per year on an average household (Census data indicate a typical household has 2.5 members and an average income of $53,250.) in Connecticut in 2015, rising to $229 per year by 2020. Connecticut would add up to 3,100 jobs in 2015 and up to 4,500 jobs by 2020. Overall output from all industrial would increase.

Lower energy prices for consumers and industry

Lowering energy price of electricity is an explicit goal of LICAP, with decrease of 8.4% by 2020. Figure 1 shows the percentage decrease in electricity prices faced by a typical household and industry as result of LICAP encouraging competitive market.

Lower energy cost would increase jobs

Figure 3 shows that Connecticut would add up to 3,100 jobs under the proposal in 2015 and up to 4,500 jobs by 2020.

All industries experience increases in output[2]

As Figure 4 shows, all of Connecticut's economic sectors are positively impacted by the policy as a result of LICAP. Electricity sector is the largest beneficiary. Electricity generation increase by 6.7% by 2020, while iron and steel, energy-intensive, services and manufacturing increase production by 0.9%, 0.6%, 0.2%, and 0.1% respectively.

Fig 1
Change in Energy Price - Electricity

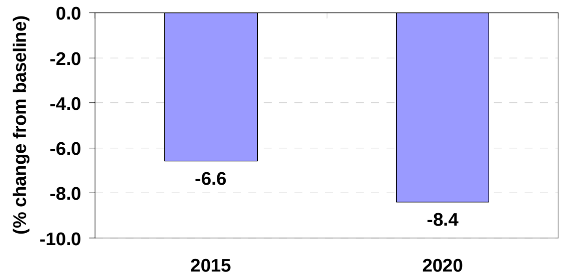


Fig 2
Per Household Impact (Welfare Benefit)

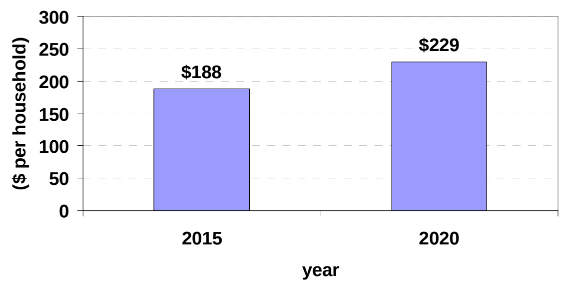


Fig 3
Change in Employment (jobs)

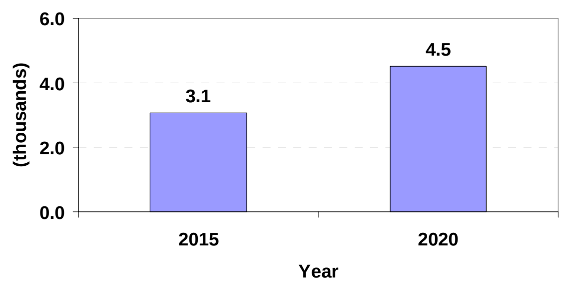
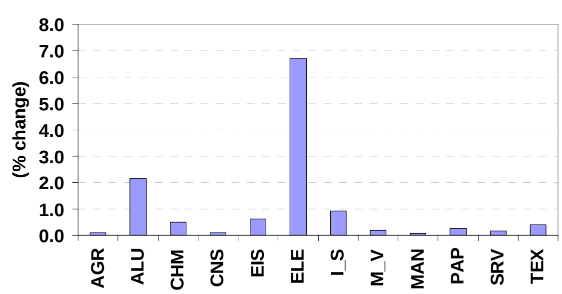


Fig 4
Change in Industrial Output (2020)



[1] This work was sponsored by the New England Coalition of Reliable Electricity (NECORE). The results are based on CRA's MRN model.

[2] COL: Coal, CRU: Crude Oil, ELE: Electricity, GAS: Natural Gas, OIL: Refined Petroleum Products, AGR: Agriculture, EIS: Energy Intensive Sectors, MAN: Manufacturing, M_V: Motor Vehicle Manufacturing, SRV: Services, ALU: Aluminum, CHM: Chemicals, I_S: Iron and Steel, CNS: Construction, PAP: Pulp-Paper-Print, and TEX: Textiles.

MAINE

Benefits to the State Economy through Implementation of Locational Installed Capacity for New England[1]

The Locational Installed Capacity (LICAP) proposal that is currently pending before the Federal Energy Regulatory Commission (FERC) purports to encourage new investment in power plants in grid-congested areas and improve system performances to ensure reliable supply of power during high demand periods through "market signal." The initiative intends to minimize ISO New England's reliance on RMR contracts by implementing a non-uniform capacity payment in load pockets and control rate fluctuation by using a demand curve.

In this analysis, we feed electricity market impacts from a bottom-up model into CRA's MRN model to assess the costs of accelerated replacement of outmoded capacity in the New England control area. In the *Status Quo scenario* no generation capacity is retired prior to 2010 and further assumes continuation of RMR payments for reliability reasons. Under the *LICAP scenario*, poorly performing assets are retired prior to 2010 to meet load growth in the New England control area.

Overall Economic Impacts

The extent of economic impacts depends on efficiently locational decisions are made as a result of the LICAP. The proposal would provide a financial benefit of $87 per year on an average household (Census data indicate a typical household has 2.5 members and an average income of $53,250.) in Maine in 2015, rising to $119 per year by 2020. Maine would add up to 1,000 jobs in 2015 and up to 2,500 jobs by 2020. Overall output from major industrial sectors in Maine increases (except for electricity generation).

Lower energy prices for consumers and industry

Lowering energy price of electricity is an explicit goal of LICAP, with decrease of 4.9% by 2020. Figure 1 shows the percentage decrease in electricity prices faced by a typical household and industry as result of LICAP encouraging competitive market.

Lower energy cost would increase jobs

Figure 3 shows that Maine would add up to 1,000 jobs under the proposal in 2015 and up to 2,500 jobs by 2020.

All industries experience increases in output[2]

As Figure 4 shows, all of Maine's major economic sectors (expect electricity sector) are positively impacted by the policy as a result of LICAP. Electricity sector is adversely impacted. Electricity generation decreases by 2.8% by 2020, while major industries - services and manufacturing benefit. Services, textiles, pulp-paper-print, and manufacturing increase production by more than 0.2%, 0.3%, 0.4%, and 0.1% respectively.

Fig 1
Change in Energy Price - Electricity

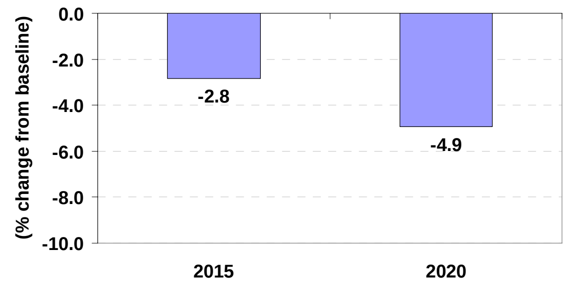


Fig 2
Per Household Impact (Welfare Benefit)

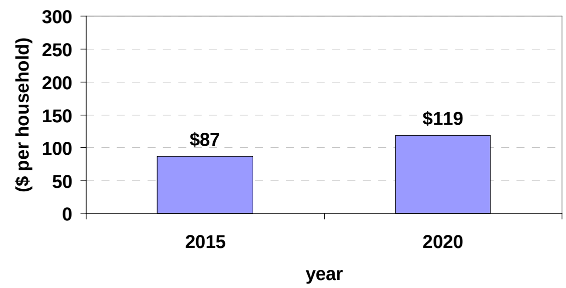


Fig 3
Change in Employment (jobs)

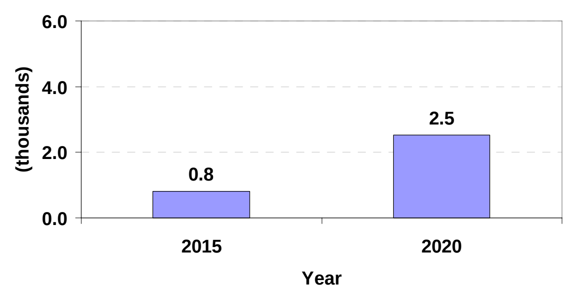
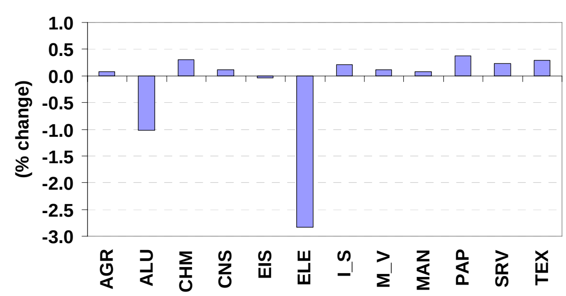


Fig 4
Change in Industrial Output (2020)



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[1] This work was sponsored by the New England Coalition of Reliable Electricity (NECORE). The results are based on CRA's MRN model.

[2] COL: Coal, CRU: Crude Oil, ELE: Electricity, GAS: Natural Gas, OIL: Refined Petroleum Products, AGR: Agriculture, EIS: Energy Intensive Sectors, MAN: Manufacturing, M_V: Motor Vehicle Manufacturing, SRV: Services, ALU: Aluminum, CHM: Chemicals, I_S: Iron and Steel, CNS: Construction, PAP: Pulp-Paper-Print, and TEX: Textiles.

MASSACHUSETTS

Benefits to the State Economy through Implementation of Locational Installed Capacity for New England[1]

The Locational Installed Capacity (LICAP) proposal that is currently pending before the Federal Energy Regulatory Commission (FERC) purports to encourage new investment in power plants in grid-congested areas and improve system performances to ensure reliable supply of power during high demand periods through "market signal." The initiative intends to minimize ISO New England's reliance on RMR contracts by implementing a non-uniform capacity payment in load pockets and control rate fluctuation by using a demand curve.

In this analysis, we feed electricity market impacts from a bottom-up model into CRA's MRN model to assess the costs of accelerated replacement of outmoded capacity in the New England control area. In the *Status Quo scenario* no generation capacity is retired prior to 2010 and further assumes continuation of RMR payments for reliability reasons. Under the *LICAP scenario*, poorly performing assets are retired prior to 2010 to meet load growth in the New England control area.

Overall Economic Impacts

The extent of economic impacts depends on efficiently locational decisions are made as a result of the LICAP. The proposal would provide a financial benefit of $115 per year on an average household (Census data indicate a typical household has 2.5 members and an average income of $53,250.) in Massachusetts in 2015, rising to $139 per year by 2020. Massachusetts would add up to 2,400 jobs in 2015 and up to 2,500 jobs by 2020. Overall output from all industrial would increase.

Lower energy prices for consumers and industry

Lowering energy price of electricity is an explicit goal of LICAP, with decrease of 5.4% by 2020. Figure 1 shows the percentage decrease in electricity prices faced by a typical household and industry as result of LICAP encouraging competitive market.

Lower energy cost would increase jobs

Figure 3 shows that Massachusetts would add up to 2,400 jobs under the proposal in 2015 and up to 2,500 jobs by 2020.

All industries experience increases in output[2]

As Figure 4 shows, all of Massachusetts's economic sectors are positively impacted by the policy as a result of LICAP. Electricity sector is the largest beneficiary. Electricity generation increases by 5.4% by 2020, while energy-intensive, services and manufacturing increase production by 0.1%, 0.1%, and 0.05% respectively.

Fig 1
Change in Energy Price - Electricity

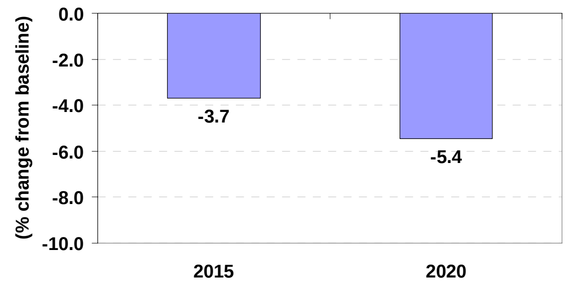


Fig 2
Per Household Impact (Welfare Benefit)

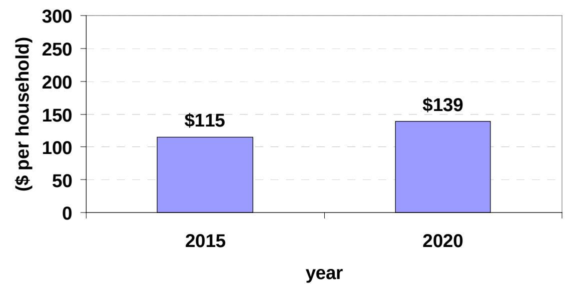


Fig 3
Change in Employment (jobs)

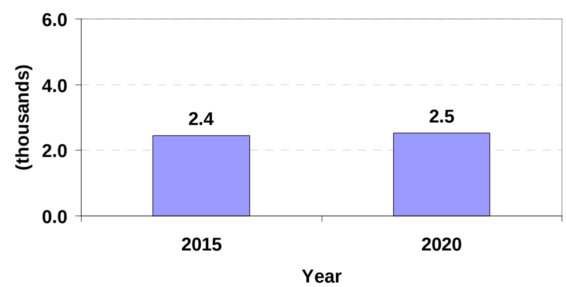
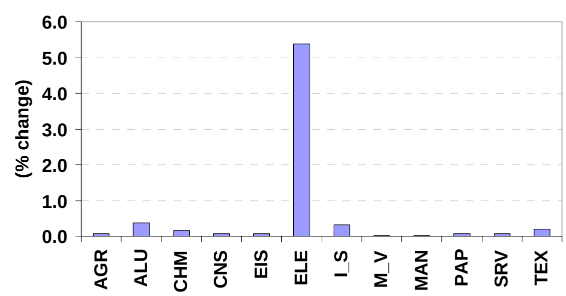


Fig 4
Change in Industrial Output (2020)



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[2] COL: Coal, CRU: Crude Oil, ELE: Electricity, GAS: Natural Gas, OIL: Refined Petroleum Products, AGR: Agriculture, EIS: Energy Intensive Sectors, MAN: Manufacturing, M_V: Motor Vehicle Manufacturing, SRV: Services, ALU: Aluminum, CHM: Chemicals, I_S: Iron and Steel, CNS: Construction, PAP: Pulp-Paper-Print, and TEX: Textiles.

NEW HAMPSHIRE
Benefits to the State Economy through Implementation of Locational Installed Capacity for New England[1]

The Locational Installed Capacity (LICAP) proposal that is currently pending before the Federal Energy Regulatory Commission (FERC) purports to encourage new investment in power plants in grid-congested areas and improve system performances to ensure reliable supply of power during high demand periods through "market signal." The initiative intends to minimize ISO New England's reliance on RMR contracts by implementing a non-uniform capacity payment in load pockets and control rate fluctuation by using a demand curve.

In this analysis, we feed electricity market impacts from a bottom-up model into CRA's MRN model to assess the costs of accelerated replacement of outmoded capacity in the New England control area. In the *Status Quo scenario* no generation capacity is retired prior to 2010 and further assumes continuation of RMR payments for reliability reasons. Under the *LICAP scenario*, poorly performing assets are retired prior to 2010 to meet load growth in the New England control area.

Overall Economic Impacts

The extent of economic impacts depends on efficiently locational decisions are made as a result of the LICAP. The proposal would provide a financial benefit of $134 per year on an average household (Census data indicate a typical household has 2.5 members and an average income of $53,250.) in New Hampshire in 2015, rising to $156 per year by 2020. New Hampshire would add up to 2,000 jobs in 2015 and decrease to 1,000 jobs by 2020. Overall output from major industrial sectors in New Hampshire increases (except for electricity generation).

Lower energy prices for consumers and industry

Lowering energy price of electricity is an explicit goal of LICAP, with decrease of 5.7% by 2020. Figure 1 shows the percentage decrease in electricity prices faced by a typical household and industry as result of LICAP encouraging competitive market.

Lower energy cost would increase jobs

Figure 3 shows that New Hampshire would add up to 2,000 jobs under the proposal in 2015 and decrease to 1,000 jobs by 2020.

All industries experience increases in output[2]

As Figure 4 shows, all of New Hampshire's major economic sectors (expect electricity sector) are positively impacted by the policy as a result of LICAP. Electricity generation decreases by 3.1% by 2020, while major industries – agriculture, services and manufacturing increase production by 0.4%, 0.2%, and 0.03%, respectively.

Fig 1
Change in Energy Price - Electricity

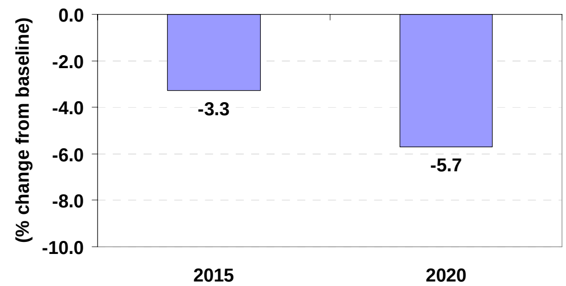


Fig 2
Per Household Impact (Welfare Benefit)

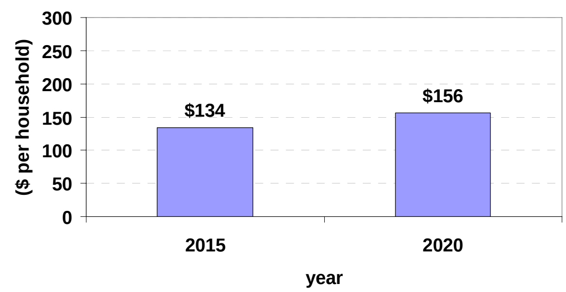


Fig 3
Change in Employment (jobs)

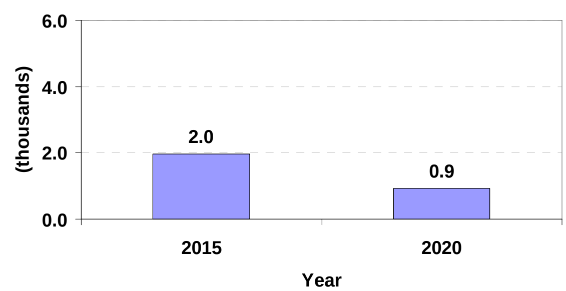
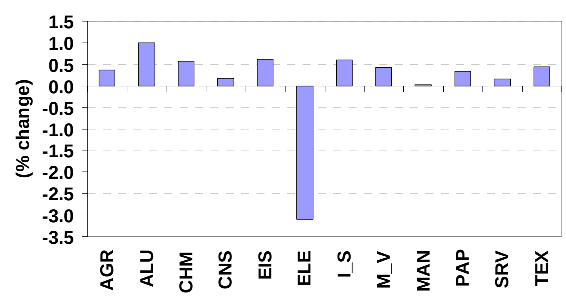


Fig 4
Change in Industrial Output (2020)



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[2] COL: Coal, CRU: Crude Oil, ELE: Electricity, GAS: Natural Gas, OIL: Refined Petroleum Products, AGR: Agriculture, EIS: Energy Intensive Sectors, MAN: Manufacturing, M_V: Motor Vehicle Manufacturing, SRV: Services, ALU: Aluminum, CHM: Chemicals, I_S: Iron and Steel, CNS: Construction, PAP: Pulp-Paper-Print, and TEX: Textiles.

RHODE ISLAND

Benefits to the State Economy through Implementation of Locational Installed Capacity for New England[1]

The Locational Installed Capacity (LICAP) proposal that is currently pending before the Federal Energy Regulatory Commission (FERC) purports to encourage new investment in power plants in grid-congested areas and improve system performances to ensure reliable supply of power during high demand periods through "market signal." The initiative intends to minimize ISO New England's reliance on RMR contracts by implementing a non-uniform capacity payment in load pockets and control rate fluctuation by using a demand curve.

In this analysis, we feed electricity market impacts from a bottom-up model into CRA's MRN model to assess the costs of accelerated replacement of outmoded capacity in the New England control area. In the *Status Quo scenario* no generation capacity is retired prior to 2010 and further assumes continuation of RMR payments for reliability reasons. Under the *LICAP scenario*, poorly performing assets are retired prior to 2010 to meet load growth in the New England control area.

Overall Economic Impacts

The extent of economic impacts depends on efficiently locational decisions are made as a result of the LICAP. The proposal would provide a financial benefit of $89 per year on an average household (Census data indicate a typical household has 2.5 members and an average income of $53,250.) in Rhode Island in 2015, rising to $104 per year by 2020. Rhode Island would loose about 300 jobs in 2015 and by 2020. Overall output from major industrial sectors in Rhode Island change by about 0.1%.

Lower energy prices for consumers and industry

Lowering energy price of electricity is an explicit goal of LICAP, with decrease of 5.0% by 2020. Figure 1 shows the percentage decrease in electricity prices faced by a typical household and industry as result of LICAP encouraging competitive market.

Lower energy cost would increase jobs

Figure 3 shows that Rhode Island would loose up to 300 jobs per year over the periods 2015 and 2020.

Electricity sector experience increases in output[2]

As Figure 4 shows, Rhode Island's electricity sectors benefits due to the LICAP proposal. Electricity generation increases by 3.7%, while other sectors of the economy show small variation in production. Services, textiles, and energy-intensive increase production by 0.02%, 0.06%, and 0.13% respectively.

Fig 1
Change in Energy Price - Electricity

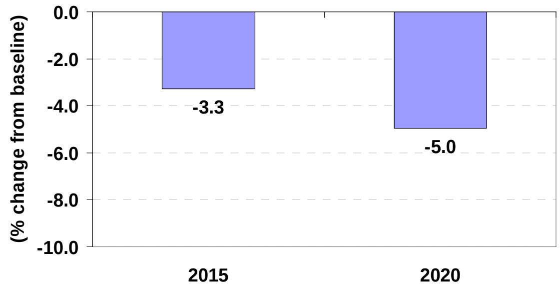


Fig 2
Per Household Impact (Welfare Benefit)

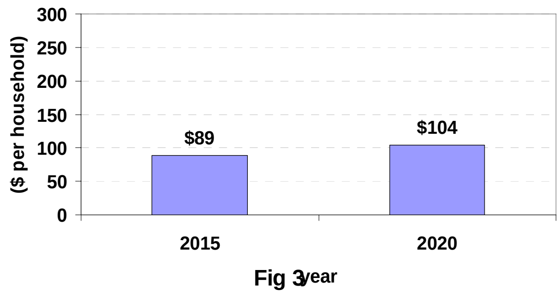


Fig 3
Change in Employment (jobs)

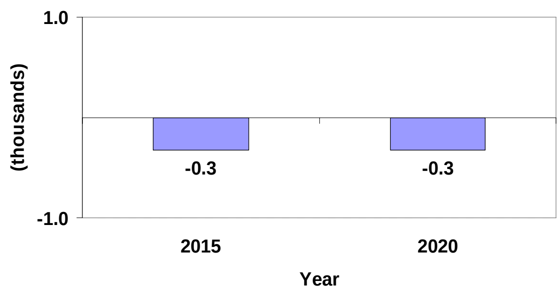
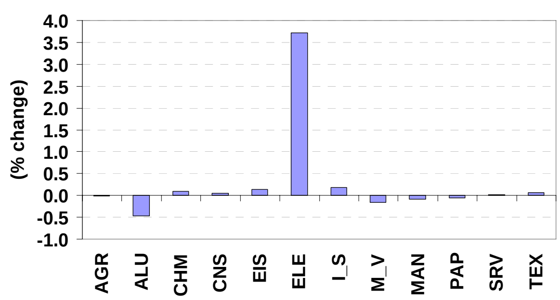


Fig 4
Change in Industrial Output (2020)



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[2] COL: Coal, CRU: Crude Oil, ELE: Electricity, GAS: Natural Gas, OIL: Refined Petroleum Products, AGR: Agriculture, EIS: Energy Intensive Sectors, MAN: Manufacturing, M_V: Motor Vehicle Manufacturing, SRV: Services, ALU: Aluminum, CHM: Chemicals, I_S: Iron and Steel, CNS: Construction, PAP: Pulp-Paper-Print, and TEX: Textiles.

VERMONT

Benefits to the State Economy through Implementation of Locational Installed Capacity for New England[1]

The Locational Installed Capacity (LICAP) proposal that is currently pending before the Federal Energy Regulatory Commission (FERC) purports to encourage new investment in power plants in grid-congested areas and improve system performances to ensure reliable supply of power during high demand periods through "market signal." The initiative intends to minimize ISO New England's reliance on RMR contracts by implementing a non-uniform capacity payment in load pockets and control rate fluctuation by using a demand curve.

In this analysis, we feed electricity market impacts from a bottom-up model into CRA's MRN model to assess the costs of accelerated replacement of outmoded capacity in the New England control area. In the *Status Quo scenario* no generation capacity is retired prior to 2010 and further assumes continuation of RMR payments for reliability reasons. Under the *LICAP scenario*, poorly performing assets are retired prior to 2010 to meet load growth in the New England control area.

Overall Economic Impacts

The extent of economic impacts depends on efficiently locational decisions are made as a result of the LICAP. The proposal would provide a financial benefit of $126 per year on an average household (Census data indicate a typical household has 2.5 members and an average income of $53,250.) in Vermont in 2015, rising to $205 per year by 2020. Vermont would add up to 5,500 jobs in 2015 and up to 5,300 jobs by 2020. Overall output from major industrial sectors in Vermont increases (except for electricity generation).

Lower energy prices for consumers and industry

Lowering energy price of electricity is an explicit goal of LICAP, with decrease of 5.4% by 2020. Figure 1 shows the percentage decrease in electricity prices faced by a typical household and industry as result of LICAP encouraging competitive market.

Lower energy cost would increase jobs

Figure 3 shows that Vermont would add up to 5,500 jobs under the proposal in 2015 and up to 5,300 jobs by 2020.

All industries experience increases in output[2]

As Figure 4 shows, all of Vermont's major economic sectors (expect electricity sector) are positively impacted by the policy as a result of LICAP. Electricity sector is adversely impacted. Electricity generation decreases by 3.5% by 2020, while major industries - services and manufacturing benefit. Services, textiles, pulp-paper-print, manufacturing, and agriculture increase production by 0.6%, 1.3%, 1.5%, 0.9%, and 1.1% respectively.

Fig 1
Change in Energy Price - Electricity

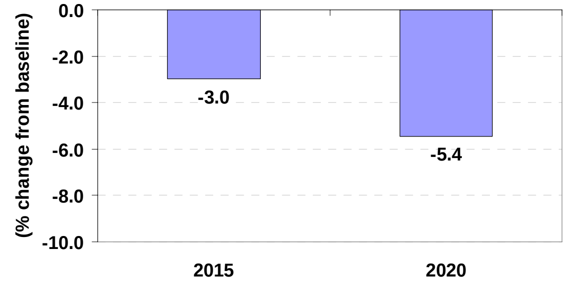


Fig 2
Per Household Impact (Welfare Benefit)

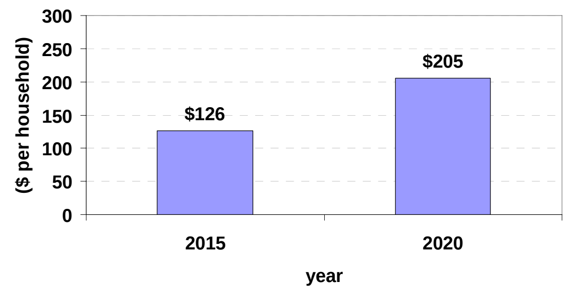


Fig 3
Change in Employment (jobs)

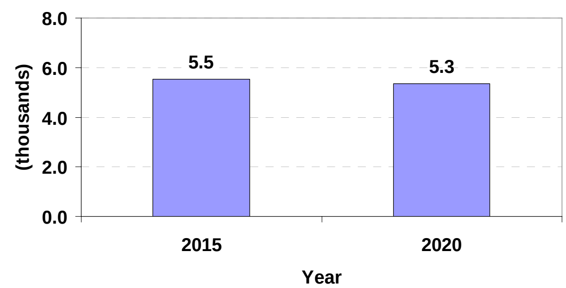
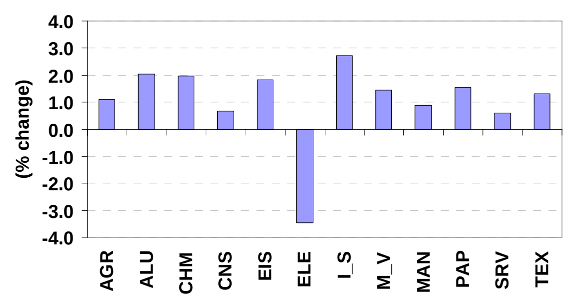


Fig 4
Change in Industrial Output (2020)



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[1] This work was sponsored by the New England Coalition of Reliable Electricity (NECORE). The results are based on CRA's MRN model.
[2] COL: Coal, CRU: Crude Oil, ELE: Electricity, GAS: Natural Gas, OIL: Refined Petroleum Products, AGR: Agriculture, EIS: Energy Intensive Sectors, MAN: Manufacturing, M_V: Motor Vehicle Manufacturing, SRV: Services, ALU: Aluminum, CHM: Chemicals, I_S: Iron and Steel, CNS: Construction, PAP: Pulp-Paper-Print, and TEX: Textiles.