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Rhode Island Greenhouse Gas (GHG) Emissions Reduction Study

Developing the Reference Case in the Long-range Energy Alternatives Planning (LEAP) Framework

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This memorandum describes how the reference case scenario is developed in the LEAP model for the Rhode Island GHG Emissions Reduction Study. The reference case incorporates historical and projected energy supply and demand data as well as data on non-energy GHG emissions to create a baseline against which GHG mitigation scenarios can be evaluated.

Energy Demand

Historical energy consumption for all fuels consumed in Rhode Island's residential, commercial, industrial, and transportation sectors is taken from the U.S. Energy Information Administration's (EIA's) State Energy Data System (SEDS) (U.S. Energy Information Administration 2015c). Covering the period 2000 – 2013, these data present a top-down view of energy consumption with no technological detail. They are used for calibration purposes and to establish historical energy intensities for comparison with projected intensities, as necessary.

Projections of energy consumption for all fuels in the residential, commercial, and industrial sectors are based on EIA's Annual Energy Outlook (AEO) 2015 and incorporate the technological and subsectoral detail[1] provided in the National Energy System Model (or NEMS, which underlies the AEO) (U.S. Energy Information Administration 2015g). Since NEMS generates regional results but not results for Rhode Island specifically, data and outputs from AEO are downscaled in LEAP to produce projections for Rhode Island. This approach is briefly described for each demand sector in Table 1. Projected final energy demand is calculated by multiplying the number of units of activity by fuel consumption per unit of activity.

Useful service demands for household and commercial building heating are then reduced to account for the shorter heating season in Rhode Island when compared with the AEO New England average. An analysis of the average number of heating degree days in Rhode Island implies an 11% reduction in useful heat requirements per square foot, relative to the service demand described by AEO 2015. Further, the mix of residential heating fuels and technologies currently in use is adjusted using the state's heating market segmentation analysis (Meister Consultants Group, n.d.), relative to the average regional mix seen in AEO 2015 projections. Having made these adjustments, the average efficiency of all technologies consuming the same fuel within each sector is calibrated to recover the sector's total consumption of that fuel observed in 2013 from SEDS.

[1] There are many technologies satisfying many end-uses in a variety of subsectors. Examples of (heating, for example) technologies include natural gas furnaces, oil boilers, etc. Examples of (industrial, for example) subsectors include cement and lime, metal fabrication, etc.

AEO generates projections through 2040. These are extended in the reference case to 2050 by applying an average annual growth rate to the energy intensity of each demand technology or fuel consumption activity. The average growth rate in NEMS during 2025-2040 is used in each case. Full details on the assumptions implicit in the AEO projections can be found in the NEMS Residential (U.S. Energy Information Administration 2014c), Commercial (U.S. Energy Information Administration 2014a), and Industrial (U.S. Energy Information Administration 2014b) Demand Module documentation.[2]

The modeling of the transportation sector in the LEAP reference case is based on emissions estimated using the Motor Vehicle Emissions Simulator (MOVES) model. MOVES is the U.S. Environmental Protection Agency (EPA) accepted mobile source emission model for state air quality planning and emissions inventory development under the Clean Air Act. The MOVES runs for the LEAP reference case use input data specific to Rhode Island for projecting state vehicle miles traveled (VMT), energy consumption, and emissions out to 2050 by vehicle type. All key vehicle classes are represented—e.g., passenger cars, passenger trucks, long-haul trucks, refuse trucks, etc. The emissions estimates from MOVES include vehicles meeting the latest federal fuel efficiency standards and low-sulfur gasoline requirements ("Tier 3").[3]

Table 1: Major Inputs and Summary of Reference Case Methodology for Demand Sectors

Sector	Primary Data Sources	Unit of Activity	Activity Downscaling Methodology	Characterization of End-Uses and Technologies/Fuel Consumption for each Unit of Activity
Residential	AEO 2015 outputs (U.S. Energy Information Administration 2015f) and (U.S. Census Bureau 2015)	# of households by housing type (single family, multi-family, mobile) and Square footage per household for heating and cooling end-uses	Number of households by housing type provided for RI from US Census Bureau Heating service demands and technology/fuel mix adjusted for RI as described above	(U.S. Energy Information Administration 2014c)
Commercial	AEO 2015 outputs (U.S. Energy Information Administration 2015d)	Commercial square footage by business type	Total RI square footage = (Total New England square footage) * (Commercial GDP in RI / Commercial GDP in New England)	(U.S. Energy Information Administration 2014a)
Industrial	AEO 2015 outputs (U.S. Energy	Dollars of output by industrial sector	RI output = (New England output) * (Sector GDP in	(U.S. Energy Information

[2] These documents are for the 2014 AEO as the U.S. Energy Information Administration has not yet provided updated, full NEMS documentation for the 2015 AEO. However, little of the methodology has changed since 2014, having also reviewed the updated (but less comprehensive) AEO 2015 assumptions.
[3] For additional details on standards and policies covered in the MOVES modeling, see Table 3.

	Information Administration 2015e)	or Physical commodity production (paper and allied products, glass and glass products, cement, iron and steel, aluminum only)	RI / Sector GDP in New England)	Administration 2014b)
Transportation	RI-specific MOVES run	Vehicle miles traveled	MOVES outputs are RI specific	MOVES

Energy Supply

The reference case modeling of energy supply for Rhode Island covers the electric power sector, indigenous production of primary renewable energy, and imports of other primary and secondary fuels. The LEAP representation of the power sector is a downscaled model of the ISO New England (ISO-NE) power system from which Rhode Island draws electricity. Consumption-based emissions associated with electricity use in Rhode Island are calculated assuming that Rhode Island load is served by the average mix of resources projected for ISO-NE as a whole. Several types of resources are represented in the electric power model, including:

a) Currently existing generating capacity in Rhode Island. Plants with a total capacity of at least 1 MW are represented individually, while other capacity is aggregated by technology. Behind-the-meter solar and wind capacities (comprised of all net-metered capacity as well as capacity which is both less than 25 kW and installed under the state's Renewable Energy Growth program) are distinguished from front-of-the-meter capacities.
b) Existing generating capacity within the ISO-NE control area but outside Rhode Island (represented by 24 distinct generation technologies, each an aggregation of corresponding plants).
c) Potential future generating capacity in ISO-NE (represented by 16 generation technologies).
d) ISO-NE demand resources inside and outside Rhode Island, including on peak and seasonal peak passive demand resources, real-time demand response, and real-time emergency generation.
e) Imports from adjoining control areas (New Brunswick, New York, and Québec).

Existing generating capacity is derived from EIA Form 860 (U.S. Energy Information Administration 2015a), State of Rhode Island Office of Energy Resources (2016), and ISO-NE (2015b). Generators labeled industrial or commercial according to EIA-860 are excluded from the power model because they are assumed to be implicitly contained in the AEO 2015 demand

projections.[4] The same argument is applied to a fraction of behind-the-meter capacity, which is assumed to be embedded in the AEO-based demand projections and load curves taken from ISO-NE (ISO New England 2015b). Finally, any capacity which was decommissioned before 2014 is also excluded because it is not required to recreate historical electricity generation. The effective capacity from demand resources and imports is taken from ISO-NE documentation (ISO New England 2016b; ISO New England 2016a; ISO New England 2015b; ISO New England 2015a). Historical generation of electricity and associated consumption of various feedstock fuels for 2001-2014 is calculated using EIA's 900-series forms (U.S. Energy Information Administration 2015b). Historical imports are from ISO-NE (2016e). Historical electricity supply and installed capacity values for ISO-NE as a whole are downscaled to Rhode Island following the methodology laid out in Table 2. This ensures that the appropriate mix of historical production and future capacities and supply from across ISO-NE is available to meet Rhode Island demand.

Various other technical characteristics of power resources, or the power system more broadly, such as heat rates, capacity factors, seasonal load curves, and reserve margin, are derived from the previously cited and other sources, including ISO-NE Seasonal Claimed Capability (SCC) data (ISO New England 2016d) and AEO documentation.

Reference case projections in the electric power sector are driven by Rhode Island's requirements for electricity (see discussion on Energy Demand). Capacity expansion plans that are explicitly described in ISO-NE's current Interconnection Request Queue (ISO New England 2016c) are included in the reference case using the downscaling method described in Table 2 and assuming an attrition rate for wind (82% of planned capacity[5]) and other projects (85% of planned capacity) calculated from historical data in the Queue. Any additional capacity that is needed to maintain the planned system reserve margin, but which may not explicitly appear in ISO-NE documents, is constructed as necessary from the list of available technologies in the same ratio observed in the Interconnection Queue since 2008, factoring in historical attrition rates. The electricity generation mix is projected by dispatching available capacity both inside and outside Rhode Island. Each dispatchable resource is assigned a priority (merit) order that determines when it is used to meet load. Must-run resources are dispatched at their full available capacity at all times; these include wind, solar photovoltaic, tidal/ocean, run-of-river hydro, and demand-side energy efficiency.

The supply of primary renewable energy produced in Rhode Island (e.g., wind, solar, hydro, biomass) is represented in the reference case by modeling the annual sustainable yield of each resource. These amounts serve as a constraint on total production in each year. Other primary fuels (such as natural gas) and secondary fuels besides electricity (such as refined petroleum products) are assumed to be imported into Rhode Island as necessary.

[4] Industrial and commercial distributed generation capacity that qualifies as an ISO-NE demand resource is excepted from this exclusion for the sake of consistency with how other demand resources are modeled. The amount of capacity in question is small (approximately 61 MW in 2015).

[5] A lower attrition rate for wind of 41% is used initially, reaching 82% by 2025. This was found to be necessary to ensure that the required renewable portfolio standard was being met during the first ten years of the scenario.

Table 2: Major Inputs and Summary of Reference Case Methodology for Supply Sectors

Sector	Primary Data Sources	Unit of Activity	Activity Downscaling Methodology	Characterization of Technologies and Fuel Production for each Unit of Activity
Electricity Generation	(U.S. Energy Information Administration 2015a; U.S. Energy Information Administration 2015b), (State of Rhode Island Office of Energy Resources 2016), (ISO New England 2015b; ISO New England 2016b; ISO New England 2015a; ISO New England 2016a; ISO New England 2016e; ISO New England 2016d; ISO New England 2016c)	MW of available capacity, dispatch merit order	Capacity or historical production available to meet RI requirements = (Total capacity or historical production) * (RI electricity energy demand / ISO-NE system-wide energy supply)	(U.S. Energy Information Administration 2015a)
Transmission and Distribution	(ISO New England 2014) (electricity) Study team assumption (natural gas)	Average percent loss[6], system-wide	(not applicable)	(not applicable)
Primary Renewable Energy Production	(Brown et al. 2015), (Lopez et al. 2012), (Applied Technology & Management et al. 2007), (National Grid 2010), (U.S. Energy Information Administration 2015c)	Energy yielded per year[7]	(not applicable)	(not applicable)
Supply of Other Primary and Secondary Fuels	(not applicable)	(not applicable)	(not applicable)	(not applicable)

Current Policies

The reference case projection accounts for existing federal, regional, and state policies expected to shape future energy use and GHG emissions in Rhode Island. It does not include proposed

[6] Electrical losses of (8% of generation) are determined consistently with the consumption-based approach used to model the electricity system. Conversely, natural gas losses are determined territorially, meaning that these leaks are assumed to occur within Rhode Island. On average, 1.5% of gas is assumed to be lost during distribution to end-users, while loss incurred during transmission to power plants is ignored.

[7] It is not expected that business-as-usual development of renewable energy will encroach upon these resource constraints. The annual yield is included mainly to ensure that alternative high-penetration scenarios for renewables remain within physical limits.

policies or rules that are not yet adopted as requirements. Table 3 summarizes how major existing policies are addressed in the reference case.

Table 3: Handling of Major Existing Policies in Reference Case

Policy	Description	How Addressed in Reference Case Model
Transportation		
Corporate Average Fuel Economy (CAFE) Standards	Fuel economy standards for existing light-duty vehicles, through 2011 model year.	Included in MOVES Rhode Island assumptions (MOVES outputs imported into LEAP model).
EPA/NHTSA Emissions and Fuel Efficiency Standards	Standards for cars and light trucks, model years 2012-2016 and 2017-2025. Also includes Phase 1 Standards for medium- and heavy-duty engines and vehicles with 2014-2016 model years.	Included in MOVES Rhode Island assumptions (MOVES outputs imported into LEAP model).
EPA Emissions Standards	Tier 1 and 2 light-duty vehicle standards for nitrogen oxides (NOx) and non-methane volatile organic compounds (NMVOC) through 2016 model year. Tier 3 light-duty vehicle NOx and NMVOC standards and low-sulfur gasoline for model year 2017.	Included in MOVES Rhode Island assumptions (MOVES outputs imported into LEAP model).
California's LEV Regulations	Low emission vehicle standards for NOx and NMVOC in light-duty vehicles.	Included in MOVES Rhode Island assumptions (MOVES outputs imported into LEAP model).
EPA On-Road Emission Standards	On-road standards are also applied to construction equipment, small gasoline engines, off-road recreational vehicles, etc.	Included in MOVES Rhode Island assumptions (MOVES outputs imported into LEAP model).
Driving Rhode Island to Vehicle Electrification (DRIVE)	Consumer rebate for electric vehicles.	Not included in modeling assumptions. Reference scenario is compliant with CAFE standards for automakers, which is a fleet-average requirement. Therefore DRIVE does not impact GHG projections.
Other Energy		
Regional Greenhouse Gas Initiative (RGGI)	Cap and trade market for 25+ MW power stations in the following states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont (RGGI Inc. 2016a). Adjusted[8] regional carbon dioxide allowances in each year are the following:	Baseline capacity expansion plans through 2020 (ISO New England 2016c) are assumed to be in alignment with declining RGGI targets given market signals. As noted previously, the reference case model uses a consumption-based approach to determine GHG emissions from electricity supply, so reference case emissions are not

[8] From the "First and Second Control Period Interim Adjustment for Banked Allowances" (RGGI Inc. 2014). Simply, these adjustments account for historical emissions which have been less than the historical emissions cap –

Policy	Description	How Addressed in Reference Case Model
	• 2014: 82,792,336 tonnes CO_2 • 2015: 66,833,592 tonnes CO_2 • 2016: 64,615,467 tonnes CO_2 • 2017: 62,452,795 tonnes CO_2 • 2018: 60,344,190 tonnes CO_2 • 2019: 58,288,301 tonnes CO_2 • 2020: 56,283,807 tonnes CO_2 In 2015, Rhode Island was allocated 2.8% of regional allowance (RGGI Inc. 2016b).	directly comparable to the RGGI allocation. By adjusting emission factors, the model could be used to estimate generation-based emissions that would be comparable to the allowances, but this is outside the scope of this study.[9]
Renewable Energy Standard (RES)	Renewable energy share of retail electricity sales in Rhode Island must be the following, interpolating linearly between each (State of Rhode Island 2016, sec. R.I.G.L § 39-26-4): • 3% in 2007 • 5.5% in 2011 • 8.5% in 2014 and 2015[10] • 38.5% in 2035 Permitted under the standard: renewable electricity produced anywhere in the ISO-NE control area, electricity produced by consumer-owned distributed generators located in Rhode Island. Eligible renewable resources include solar, wind, geothermal, tidal/ocean, small hydro (plant size not exceeding 30 MW), wood/wood waste, and landfill gas. Exclusions under the standard: renewable electricity purchased voluntarily by consumers; renewable capacity that entered into service before December 31, 1997, may provide only 2% of retail sales used to meet the standard.	Renewable portfolio standards from all ISO-NE states—including Rhode Island's RES—are combined to determine the expected renewable electricity requirements for the entire ISO-NE system through 2035 (the final year under Rhode Island's current policy). Priorities for dispatching supply resources and constructing new resources are adjusted as necessary to align the reference case power mix with the combined requirements. Voluntary purchases of renewable power are not considered.
Various Renewable Capacity Targets	Long-Term Contracting Standard for Renewable Energy (90 MW 2009-2014) (Rhode Island Division of Planning 2015)	Capacity for the Long-Term Contracting Standard and Distributed Generation Program is represented as existing generation capacity in the model, as is capacity installed

i.e. if the cap is larger than is shown to be necessary to induce change, it will have little impact and should therefore be reduced.

[9] Such a comparison would not include purchased offsets outside the power sector, which may meet up to 10% of compliance obligations under RGGI but are not represented in the LEAP model.

[10] Table 1 of Rhode Island Public Utilities Commission (2016) describes a delayed increase in the RES mandate in the year 2015. The RES in 2015 is thus 8.5% instead of 10%, as it would be following the schedule of increases since 2007.

Policy	Description	How Addressed in Reference Case Model
	Distributed Generation Standard Contracts Program (40 MW 2011-2014) (ibid) 160 MW Renewable Energy Growth Program (160 MW 2014-2019) (ibid)	to date under the Renewable Energy Growth Program. New capacity is assumed to be developed to meet the Renewable Energy Growth (REG) Program's 160 MW target in 2019. New capacity under the REG program is expected to be 85% solar PV, 13% onshore wind and the remainder for hydropower and anaerobic digestion of waste.
Least-Cost Energy Efficiency Procurement Law	"Least-cost procurement, which shall include procurement of energy efficiency and energy conservation measures that are prudent and reliable and when such measures are lower cost than acquisition of additional supply, including supply for periods of high demand." (State of Rhode Island 2006, sec. R.I.G.L § 39-1-27.7). *Newly-added*[11] electric energy savings from the least-cost procurement (LCP) program are projected to be, in each year (National Grid 2016): • 268,468 MWh in 2014 • 222,822 MWh in 2015 • 199,760 MWh in 2016 (estimated) • 201,347 MWh in 2017 (estimated) Similarly, newly-added natural gas savings are (ibid): • 409,029 MMBTU in 2014 • 419,778 MMBTU in 2015 • 395,760 MMBTU in 2016 (estimated) • 414,606 MMBTU in 2017 (estimated)	Projected energy demand from AEO 2015 accounts for efficiency mandates in the following federal laws: • American Recovery and Reinvestment Act of 2009 • Energy Independence and Security Act of 2007 • Energy Policy Acts of 1992 and 2005 • Energy Improvement and Extension Act of 2008 • National Appliance Energy Conservation Act of 1987 • Clean Air Act Amendments of 1990 Additional details are provided in Appendix A of the AEO 2015 assumptions (U.S. Energy Information Administration 2015h). Notwithstanding, the LEAP reference case projection assumes that the least-cost procurement law enables *additional* efficiency beyond what is already contained in AEO 2015. Electricity and natural gas savings from the law will be represented by substituting more efficient technologies for their less efficient counterparts within each demand-side end-use, as applicable, and also by reducing useful HVAC requirements for homes or buildings undergoing shell retrofits. This implementation requires a number of additional data items, for completed LCP program years but which fall after the model's last historical year of 2013. A request to National Grid is pending, which includes: a) Number of improved technologies or energy-saving projects,

[11] Newly-added efficiency refers to any efficiency measure which did not exist the previous year. However, the total energy savings expected in any one year is the result of surviving efficient devices introduced in all previous years. Only post-2014 savings from the LCP program are included, since the model relies upon real historical consumption data from SEDS through 2013.

Policy	Description	How Addressed in Reference Case Model
		b) Energy savings per technology or project, c) Expected lifetime of the efficient technology or project. Projections for the deployment of additional technologies or energy-saving projects from 2016 – 2024 (the end year for the LCP statute) will then be estimated based on these data from National Grid. After the expiry of the LCP statue in 2024, no additional efficient technologies or projects are introduced, and those already implemented will gradually retire. In addition to the *electricity*-saving impact of the LCP, ISO-NE recognizes energy efficiency as a passive demand resource and assigns an appropriate capacity credit. The contribution of efficiency resources to ISO-NE system reserve capacity is included on the supply-side of the model. Peak MW of capacity and capacity factors are derived from ISO-NE (2016b), ISO-NE (2016a), and ISO-NE (2015b). To be consistent with the consumption-based approach, all efficiency resources in the ISO-NE control area are counted, however, only those energy savings from efficiency in Rhode Island are explicitly included in the model.
Net Metering	Net metering may be offered to consumers generating electricity in an amount that does not exceed their average annual consumption over the previous three years (State of Rhode Island 2011, sec. R.I.G.L § 39-26.4-2). Excepting biomass (but including biogas from anaerobic digestion), all generation resources that qualify for the RES are eligible.	A fraction of behind-the-meter generation capacity (determined from ISO-NE (2015b)) does not need to be represented explicitly in the model because it is embedded in the load curves used in the model and is assumed to be embedded in the AEO-derived demand projections. Other behind-the-meter capacity is included in the electricity supply model, where its production contributes to meeting demand and load. Projected growth in behind-the-meter capacity is taken from ISO-NE's Distributed Generation Forecast, which accounts for the incentives provided by net metering in Rhode Island and other New England states (ISO New England 2015b).
Biodiesel Heating Oil Act of 2013	Distillate heating oil supplied to residential, commercial, and industrial consumers must contain the following volumetric share of biodiesel (State of	Appropriate fraction of distillate consumption for heating is shifted to biodiesel. Target in 2017 is assumed to persist in all following years.

Policy	Description	How Addressed in Reference Case Model
	Rhode Island 2013, sec. R.I.G.L § 23-23.7-4): • 2% in 2014 • 3% in 2015 • 4% in 2016 • 5% in 2017	
Clean Power Plan	Pollution reduction for existing power plants. Stayed by Supreme Court in 2016.	Not represented explicitly in the reference case.
Solarize Rhode Island	Education and financial incentives for homeowner and business adoption of solar photovoltaics.	Not represented explicitly in the reference case—not expected to be additional to other policies.
Renewable Energy Fund	Grants for residential, commercial, and public renewable energy installations.	Not expected to have an additional effect on the reference case.
Low Income Home Energy Assistance Program (LIHEAP) Enhancement	Small subsidies for residential electricity and natural gas consumers on their bill.	Not expected to have an additional effect on the reference case.
Rhode Island Residential Property Assessed Clean Energy (PACE) Program	Small loans to homeowners for energy efficiency and renewable energy improvements.	Not expected to have an additional effect on the reference case.
Non-Energy		
Rhode Island State Guide Plan (various elements)	Various elements of State Guide Plan (State of Rhode Island Division of Planning 2015): • Element 121: All items under Land Use 2025 (State of Rhode Island Division of Planning 2006, 20). • Element 155: Restoration of 100 acres of degraded wetland each year, 1/3 of state area to be greenspace by 2020. • Element 156: Tree management in built environments, overall forest cover stabilized near present level. • Element 161: Private and public stewardship of state forests.	Included in the reference case non-energy emission modeling.

Emission Factors for GHGs and Other Air Pollutants

To calculate emissions of GHGs and other air pollutants from the energy system, emission factors—defined as the mass of pollutant per unit of energy consumed or produced—are assigned to each activity or process that uses or produces energy in the reference case model. The factors are then multiplied by projected energy consumption or production to determine emissions. Factors are specified for all GHGs emitted from the energy system (including carbon

dioxide, nitrous oxide, and methane) as well as NOx, NMVOC, sulfur dioxide, carbon monoxide, and particulate matter less than 10 and 2.5 microns in diameter. For consistency with Rhode Island's most recent GHG inventory, state-specific factors are taken from EPA's State Inventory Tool (SIT) where possible (U.S. Environmental Protection Agency 2015b). Gaps for fuel, sector, and pollutant combinations that are not represented in SIT are filled from a variety of publicly available sources, particularly EPA's WebFIRE system and eGRID database and the Intergovernmental Panel on Climate Change's Database on Greenhouse Gas Emission Factors (U.S. Environmental Protection Agency 2016; U.S. Environmental Protection Agency 2015a; Intergovernmental Panel on Climate Change 2016).

GHG emissions from non-energy activities in Rhode Island, such as waste decomposition and industrial processes, are also represented in the reference case model. Total historical and projected emissions by source category and gas are specified in LEAP based on non-energy analyses conducted for this study. In some cases (e.g., the semiconductor manufacturing subcategory within industrial processes), emissions for multiple gases are combined using global warming potentials and represented as total carbon dioxide equivalent in LEAP. Emission factors used in the non-energy analyses are derived from EPA (2015b).

Reference Case Validation

The LEAP reference case will be validated by comparing key results to other recent analyses of Rhode Island's energy system and GHG emissions. Historical GHG emissions in 2010 by sector and source will be compared to the state's 2010 emissions inventory (Northeast States for Coordinated Air Use Management 2013). The consumption-based emissions from electricity supply that are reported in the inventory will be used for this comparison. Any significant differences versus the LEAP results will be investigated, and the reference case will be adjusted if appropriate. Projected energy demand, energy supply, and GHG emissions from LEAP will also be compared to the business-as-usual forecast in the 2015 Rhode Island State Energy Plan (Rhode Island Division of Planning 2015). Again, significant differences will be explored and the LEAP reference case updated as needed.

References

Applied Technology & Management, Loria Emerging Energy Consulting, Maguire Group, TRC Companies, and Birch Tree Capital. 2007. "Final Report, RIWINDS Phase 1: Wind Energy Siting Study." RIWINDS Siting Study. http://rkozlo51-25.umesci.maine.edu/SBE/avian/Assets/Monitoring%20Network%20PDFs/ReportsPDFs/RIWINDSReport_2007.pdf.

Brown, Austin, Philipp Beiter, Donna Heimiller, Carolyn Davidson, Paul Denholm, Jennifer Melius, Anthony Lopez, Dylan Hettinger, David Mulcahy, and Gian Porro. 2015. "Estimating Renewable Energy Economic Potential in the United States: Methodology and Initial Results." National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy15osti/64503.pdf.

ENE. 2013. “Rhode Island State Energy Plan Business-As-Usual Forecast.” http://www.energy.ri.gov/documents/energyplan/ENE_RISEP_Business_As_Usual_Forecast.pdf.

Intergovernmental Panel on Climate Change. 2016. “Intergovernmental Panel on Climate Change Database on Greenhouse Gas Emission Factors (IPCC-EFDB).” http://www.ipcc-nggip.iges.or.jp/EFDB/main.php.

ISO New England. 2014. “Transmission Planning Technical Guide Appendix C: Guidelines for Treatment of Demand Resources in System Planning Analysis.” http://www.iso-ne.com/static-assets/documents/committees/comm_wkgrps/prtcpnts_comm/pac/plan_guides/plan_tech_guide/technical_planning_guide_appendix_c_guidelines_for_treatment_of_demand_resources_in_system_planning_analysis.pdf.

———. 2015a. “2015 Regional System Plan.” http://www.iso-ne.com/static-assets/documents/2015/11/rsp15_final_110515.docx.

———. 2015b. “CELT Report: 2015-2024 Forecast Report of Capacity, Energy, Loads, and Transmission.” http://iso-ne.com/static-assets/documents/2015/05/2015_celt_report.pdf.

———. 2016a. “2016 Energy-Efficiency Forecast 2020-2025.” http://iso-ne.com/static-assets/documents/2016/04/ISO_NE_2016_EE_Forecast_2020_2025_Final.pdf.

———. 2016b. “CELT Report: 2016-2025 Forecast Report of Capacity, Energy, Loads, and Transmission.” http://iso-ne.com/static-assets/documents/2016/05/2016_celt_report.xls.

———. 2016c. “Interconnection Request Queue 05-01-16.” http://iso-ne.com/static-assets/documents/2014/09/interconnection_request_queue.xls.

———. 2016d. “ISO New England Seasonal Claimed Capability (SCC) Report as of 2/1/2016.” http://www.iso-ne.com/static-assets/documents/2016/02/scc_february_2016.xls.

———. 2016e. “Net Energy and Peak Load by Source.” http://iso-ne.com/static-assets/documents/markets/hstdata/rpts/net_eng_peak_load_sorc/energy_peak_source.xls.

Lopez, Anthony, Billy Roberts, Donna Heimiller, Nate Blair, and Gian Porro. 2012. “U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis.” National Renewable Energy Laboratory. http://www.nrel.gov/docs/fy12osti/51946.pdf.

Meister Consultants Group. n.d. “Rhode Island Thermal Market Segmentation Summary.”

National Grid. 2010. “Renewable Gas — Vision for a Sustainable Gas Network.” https://www9.nationalgridus.com/non_html/ng_renewable_wp.pdf.

———. 2016. “Energy Efficiency Program Basic Data,” June 27.

Northeast States for Coordinated Air Use Management. 2013. “Greenhouse Gas (GHG) Emission Inventories for Rhode Island for 1990, 2010, and 2020.”

RGGI Inc. 2014. “Second Control Period Interim Adjustment for Banked Allowances Announcement.” http://www.rggi.org/docs/SCPIABA.pdf.

———. 2016a. “Regional Greenhouse Gas Initiative Program Design.” https://www.rggi.org/design/overview.

———. 2016b. “2015 Allowance Allocation.” http://www.rggi.org/design/overview/allowance-allocation/2015-allowance-allocation.

Rhode Island Division of Planning. 2015. “Energy 2035: Rhode Island State Energy Plan.” http://www.planning.ri.gov/documents/LU/energy/energy15.pdf.

Rhode Island Public Utilities Commission. 2016. “Annual RES Compliance Report For Compliance Year 2014.” http://www.ripuc.org/utilityinfo/RES-2014-AnnualReport.pdf.
State of Rhode Island. 2006. *The Comprehensive Energy Conservation, Efficiency and Affordability Act of 2006*. http://webserver.rilin.state.ri.us/BillText06/SenateText06/S2903Baa.htm.
———. 2011. *Net Metering*. http://webserver.rilin.state.ri.us/Statutes/TITLE39/39-26.4/39-26.4-2.HTM.
———. 2013. *Biodiesel Heating Oil Act of 2013*. http://webserver.rilin.state.ri.us/Statutes/title23/23-23.7/23-23.7-4.HTM.
———. 2016. *Relating to Public Utilities and Carrier - Renewable Energy*. http://webserver.rilin.state.ri.us/BillText/BillText16/SenateText16/S2185A.pdf.
State of Rhode Island Division of Planning. 2006. “Rhode Island State Land Use Policies and Plan.” http://www.planning.ri.gov/documents/121/landuse2025.pdf.
———. 2015. “Rhode Island State Guide Plan.” http://www.planning.ri.gov/planning/.
State of Rhode Island Office of Energy Resources. 2016. “2015 Rhode Island Renewable Energy Data Report.”
The Rhode Island Energy Efficiency and Resource Management Council. 2010. *Filing 9-1-10*. http://www.ripuc.org/eventsactions/docket/4202-EERMC-EST-Filing(9-1-10).pdf.
U.S. Census Bureau. 2015. “2014 American Community Survey 1-Year Estimates.” DP04: Selected Housing Characteristics. http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk.
U.S. Energy Information Administration. 2014a. “Commercial Demand Module of the National Energy Modeling System: Model Documentation 2014.” http://www.eia.gov/forecasts/aeo/nems/documentation/commercial/pdf/m066(2014).pdf.
———. 2014b. “Model Documentation Report: Industrial Demand Module of the National Energy Modeling System.” http://www.eia.gov/forecasts/aeo/nems/documentation/industrial/pdf/m064(2014).pdf.
———. 2014c. “Residential Demand Module of the National Energy Modeling System: Model Documentation 2014.” https://www.eia.gov/forecasts/aeo/nems/documentation/residential/pdf/m067(2014).pdf.
———. 2015a. “Form EIA-860 Detailed Data, 2014.” https://www.eia.gov/electricity/data/eia860/xls/eia8602014.zip.
———. 2015b. “Form EIA-923 Detailed Data with Previous Form Data (EIA-906/920), 2014.” www.eia.gov/electricity/data/eia923/.
———. 2015c. “State Energy Data System.” https://www.eia.gov/state/seds/.
———. 2015d. “NEMS Commercial Module Output.”
———. 2015e. “NEMS Industrial Module Output.”
———. 2015f. “NEMS Residential Module Output.”
———. 2015g. “Annual Energy Outlook 2015 with Projections to 2040.” DOE/EIA-0383(2015). Washington, DC. http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf.
———. 2015h. “Appendix A: Handling of Federal and Selected State Legislation and Regulations in the AEO.” http://www.eia.gov/forecasts/aeo/assumptions/pdf/appendix_a.pdf.

U.S. Environmental Protection Agency. 2015a. “Emissions & Generation Resource Integrated Database (eGRID), Year 2012 Data.” https://www.epa.gov/energy/egrid.
———. 2015b. *State Inventory and Projection Tool* (version August 2015 Energy Update). http://www3.epa.gov/statelocalclimate/resources/tool.html.
———. 2016. “Web Factor Information Retrieval System (WebFIRE).” https://cfpub.epa.gov/webfire/.