3. The Supply of Electricity

GMP meets virtually its entire electricity load obligation through a combination of energy from purchased power agreements ("PPAs") and the output of units in which it has complete or partial ownership interests. This decade, two PPAs that have supplied the bulk of the Company's energy will be replaced by smaller supply resources. First, GMP's contract to purchase a large share of the Vermont Yankee nuclear power plant's output ended in March 2012. Second, about 90% of the Hydro-Quebec Vermont Joint Owners contract expires in October 2015, with the remainder expiring a year later. Taking their place are a new, much smaller nuclear PPA, owned and purchased wind projects, a smaller Hydro-Quebec contract, short-term purchases, and other arrangements.

3.1 Current GMP Supply Resources

GMP's power supply resources include facilities spread across New England and Québec, and system purchases that are generally short term (5 years or less). From an ownership perspective, GMP's electricity comes from two types of resources: owned generation and PPAs. Table 3.1.1 summarizes our resource mix.

Table 3.1.1: GMP's Generation Supply

Ownership	Subtype	Generator Description
Owned Generation	Joint Owned	McNeil, Millstone 3, Stony Brook and Wyman
	Wholly Owned	GMP's hydroelectric, oil-fired, solar and wind generators
Purchased Power Agreements	Long-Term Units	NextEra Seabrook, Granite Reliable Wind, Moretown Landfill, Ryegate biomass, Stony Brook combined cycle
	Long-Term System	HQ Vermont Joint Owners, HQUS PPA
	Short-Term Unit	Ampersand Gilman, North Hartland, other small independent producers
	Short-Term System	J.P. Morgan, Shell, Citigroup, exGen, and NextEra energy contracts
	Standard Offer (SPEED)	Biomass, farm or landfill methane, hydro, solar PV
	VEPPI	Vermont's Qualified Facilities (Hydro) under PURPA

Major owned generation resources include 32 hydroelectric, 12 solar, six oil-fired, and two wind projects. Major PPAs currently include six long-term contracts, six short-term contracts, and several that are credited to GMP's supply portfolio by statute.

Owned Hydroelectric Generation

GMP's 32 hydroelectric generators are capable of generating almost 100 MW of electricity and produce an average of about 373,000 MWh of energy each year[1]. These resources provide approximately 43 MW of FCA-based capacity credit and additional seasonal capacity payments.

Table 3.1.2: Hydro Resources

Generator Name	Commercial Operation	Nameplate MW	2013 Net MWh
ARNOLD FALLS	1928	0.35	1,476
BELDENS	1913/1988	5.9	18,579
BOLTON FALLS	1986	7.5	26,924
CARVER FALLS	1894	2.3	7,621
CAVENDISH	1908	1.4	3,832
CENTER RUTLAND	1898	0.3	-31
CLARK FALLS (L. LAMOILLE COMPOSITE)	1937	3.0	18,081
EAST BARNET	1983	2.2	3,750
ESSEX #19	1917	7.2	46,311
FAIRFAX FALLS	1920	4.2	25,528
GAGE	1919	0.7	2,906
GLEN (N. RUTLAND COMPOSITE)	1920	2.0	7,152
GORGE #18	1928	3.0	9,374
HUNTINGTON FALLS	1911/1989	5.5	21,750
MARSHFIELD #6	1927	5.0	10,789
MIDDLEBURY LOWER	1920	2.3	7,958
MIDDLESEX #2	1928	3.2	11,865
MILTON (LOWER LAMOILLE COMPOSITE)	1929	7.5	42,304
PASSUMPSIC	1928	0.7	2,189
PATCH	1921	0.4	-13
PETERSON (L. LAMOILLE COMPOSITE)	1948	6.4	28,632
PIERCE MILLS	1928	0.3	1,293
E. PITTSFORD (N. RUTLAND COMPOSITE)	1914	3.6	9,848
PROCTOR	1905/1984	6.9	1,033
SALISBURY (MIDDLEBURY COMPOSITE)	1917	1.3	3,183
SILVER LAKE (MIDDLEBURY COMPOSITE)	1916	2.2	1,373
SMITH	1984	1.5	5,865
TAFTSVILLE	1942	0.5	-88
VERGENNES	1912	2.4	13,587

[1] The 20–year average output through FY2013 for legacy GMP and CVPS units is about 323,000 MWh per year. An estimate for legacy VT Marble units is 50,000 MWh per year.

WATERBURY LITTLE RIVER #22	1953	5.5	22,513
WEST DANVILLE #1	1917	1.0	-56
WEYBRIDGE (MIDDLEBURY COMP.)	1951	3.0	16,815
Total		**99.25**	**372,343**

Collectively, GMP's fleet of owned hydroelectric plants provides an average of roughly 8 percent of the company's annual energy requirements. The output of the hydroelectric plants can vary significantly on a daily, monthly and annual basis depending on the actual flow of several Vermont rivers. Although these plants require substantial operation and maintenance expenses, along with periodic capital expenditures in major improvements, on average, the hydroelectric fleet is one of GMP's lowest-cost power resources. The hydroelectric plants incur no fuel expenses so the output helps to stabilize GMP's power supply costs and retail rates, and they produce no air emissions.

The following is a summary of GMP's hydroelectric plants, including license status and major improvements that have been completed or are in progress.

- *Arnold Falls*: Run-of river facility located in St. Johnsbury on the Passumpsic River. FERC license No. 2396. A 40-year license was issued June 16th, 1994. Significant recent improvements include station electrical modernization of switchgear, relay protection and controls in 2008, and construction of new concrete gravity dams to replace deteriorated timber crib dams in 2009.

- *Beldens Falls:* Run-of-river facility located in New Haven on Otter Creek. FERC license No. 2558 with relicensing pending. Former VMPD station acquired by CVPS in 2011. Significant recent improvements include station electrical modernization of switchgear, relay protection and controls and refurbishment of T/G Unit 2 in 2008.

- *Bolton Falls:* Run-of-river facility located in Duxbury, originally built in 1899. It was rebuilt in 1985 and 2005, and operates under a 40-year FERC license that expires January 31, 2022.

- *Carver Falls*: Run-of-river facility located in East Hampton, N.Y., and West Haven, on the Poultney River. FERC license No. 11475. A 30-year license was issued in 2009. Significant recent improvements include replacement/uprate of T/G Unit 1 in 2011.

- *Cavendish*: Run-of-river facility located in Cavendish, FERC license No. 2489. Since the unit was commissioned, significant improvements include the installation of automated spillway crest control at the dam.

- *Center Rutland*: Run-of-river facility located in Rutland on Otter Creek. FERC license No. 2445. A 30-year license was issued in 1994. This is a former VMPD station acquired by CVPS in 2011. Significant recent improvements include the addition of relay protection and SCADA controls for improved remote operation, and refurbishment of major mechanical components to allow the unit to be brought back online. Center Rutland has the potential for an increase in turbine/generator size, which GMP plans to explore following the completion of work at Proctor and Huntington Falls.

- *Clark Falls*: Dispatchable facility located in Milton, on the Lamoille River. FERC license No. 2205. A 30-year license was issued in 2005. One of three stations that make up the Lower Lamoille Composite[2], which combined generates about 90,000 MWh of energy per year, about 25% of GMP's total hydro generation. Significant recent improvements include a new turbine runner replacement in 2004, and a new generator step-up transformer in 2001.

- *East Barnet*: Run-of river facility Located in Barnet, on the Passumpsic River. FERC Exempt No. 3051.

- *East Pittsford*: Dispatchable facility located in Pittsford, on East Creek. This project is non-FERC jurisdictional and falls under PSB dam safety regulation given the size and hazard classification of the Chittenden Dam, which forms the impoundment for this facility. It is one of two stations that make up the North Rutland Composite. Significant recent improvements include station electrical modernization of switchgear, relay protection and controls, and new penstock replacement in the powerhouse in 2010.

- *Essex Hydro #19*: Run-of-river facility located in Williston and Essex Junction, the dam was constructed in 1917 and had significant repairs done in 1990, and operates under a 30-year FERC license that expires on March 30, 2025.

- *Fairfax Falls*: Run-of-river facility located in Fairfax, on the Lamoille River. FERC license No. 2205. A 30-year license was issued in 2005. Significant recent improvements include station electrical modernization of switchgear, relay protection and controls, and refurbishment and uprate of T/G Unit 1 in 2004.

[2] Composites are groups of hydro facilities recognized by ISO-NE as a single resource in determining capacity value.

- *Gage*: Run-of-river facility located in St. Johnsbury, on the Passumpsic River. FERC license No. 2397. A 40-year license was issued in 1994.

- *Glen*: Dispatchable facility located in Rutland, on East Creek. This project is non-FERC jurisdictional. One of two stations that make up the North Rutland Composite. Significant recent improvements include station electrical modernization of switchgear, relay protection and controls, a new generator step-up transformer, and new penstock replacement sections.

- *Gorge Hydro #18*: Run-of-river facility located in Colchester and South Burlington, and is non-FERC jurisdictional. The facility's two dams were built in 1914 and 1928. With recent improvements including a new runner to capture lower flows and an automated crest control rubber dam system, generation is expected to increase from approximately 9,500 MWh to approximately 18,000 MWh per year.

- *Huntington Falls*: Former Vermont Marble Power Division (VMPD) run-of-river facility located in Weybridge, on Otter Creek. FERC license No. 2558 was reissued in October 2014. T/G Unit 3 is presently operating and in good repair. T/G Units 1 and 2 are presently out of service with planned refurbishment/uprate pending re-license authorization.

- *Marshfield Hydro #6*: Dispatchable facility located in Cabot, the dam is a rolled earth-fill construct that was built in 1927, with an additional spillway added in 1991. This project is non-FERC jurisdictional and falls under PSB dam safety regulation given the size and hazard classification of the Marshfield Dam.

- *Middlebury Lower:* Run-of-river facility located in Middlebury, on Otter Creek. FERC license No. 2737. A 30-year license was issued in 2001. Significant recent improvements include station electrical modernization of relay protection and controls in 2004, and a new generator step-up transformer in 2010.

- *Middlesex Hydro #2*: Run-of-river with minimal ponding facility located in Middlesex, this facility was originally built in 1928. It is non-FERC jurisdictional.

- *Milton*: Dispatchable facility located in Milton, on the Lamoille River. FERC license No. 2205. A 30-year license was issued in 2005. One of three stations that make up the

Lower Lamoille Composite. Significant recent improvements include station electrical modernization in 2002, installation of automated spillway crest control in 2005, and reconstruction of the project intake/headworks in 2007.

- *Passumpsic*: Run-of-river facility located in St. Johnsbury, on the Passumpsic River. FERC license No. 2400. A 40-year license was issued in 1994.

- *Patch*: Located in Rutland, on East Creek, is a non-FERC jurisdictional run-of-river project. Tropical Storm Irene did significant damage to the Patch station, including flooding the plant. The plant underwent an intense cleaning and replacement of many electrical components, including a full rewind of the generator, and was brought back online in 2013.

- *Pierce Mills*: Run-of-river facility located in St. Johnsbury, on the Passumpsic River. FERC license No. 2396. A 40-year license was issued in 1994.

- *Peterson*: Dispatchable facility located in Milton, on the Lamoille River. FERC license No. 2205. A 30-year license was issued in 2005. One of three stations that make up the Lower Lamoille Composite.

- *Proctor*: Dispatchable facility located in Proctor, on Otter Creek. A former VMPD station acquired by CVPS in 2011, this hydro facility has been undergoing major renovations. Recent significant improvements include the installation of a bridge in 2012 that spans the Otter Creek at the station for vehicular access, expansion modifications of the project intake headworks in 2013, and the start of mechanical/electrical modernization improvements with new turbine/generator capacity additions following FERC authorization in 2014. FERC issued the new license in October, 2014, allowing for the final stages of the overhaul with the complete replacement of three turbine/generator sets and a full rebuild of one unit. GMP anticipates this plant to be fully restored and producing in the second quarter of 2015.

- *Salisbury*: Dispatchable facility located in Salisbury, on the Leicester River, this is a non-FERC jurisdictional project, and is one of three stations that make up the Middlebury Composite. Recent significant improvements include station electrical modernization of switchgear, relay protection and controls, a new generator step-up transformer, and recoating of penstock pipeline sections in 2011.

- *Silver Lake*: Dispatchable facility located in Leicester, on the Sucker Brook, is one of three stations that make up the Middlebury Composite. A 30-year FERC license (No. 11478) was issued in 2009. Recent significant improvements include automation of station components in 2011 and dam stability improvements at Goshen and Silver Lake dams in 2008 to meet FERC dam safety guidelines.

- *Smith*: Run-of-river facility located in Bradford, on the Waits River. FERC Exempt No. 3051. Recent significant improvements include the replacement of the Unit 1 turbine runner in 2006.

- *Taftsville*: Run-of-river facility located in Woodstock, on the Ottaquechee River. FERC license No. 2490. A 30-year license was issued in 1994. Significant improvements have been made since suffering significant flood damage from tropical storm Irene in 2011. Improvements include powerhouse modifications and site work, electrical modernization, and replacement of switchgear, relay protection and control, and generator rewind.

- *Vergennes*: Run-of-river facility with limited storage capacity located on Otter Creek in Vergennes, the dam was constructed in 1910 and underwent significant repair in 1992 and again in 2010. This included a complete rebuild of the intake system and associated penstocks to Units 1 and 2. The plant operates under a 30-year FERC license that expires on June 1, 2029.

- *Waterbury Hydro #22*: Currently a dispatchable facility, located in Waterbury. The dam was constructed in 1938 and received significant repairs in 2006. Although GMP operates the facility, the dam itself is owned by the State of Vermont, and operated under a 50-year FERC license that expired on September 1, 2001. GMP and ANR have been working since that time to agree to a Section 401 Water Quality Certification, which is a prerequisite to FERC issuing the license. Under the new 401 as proposed, GMP will eventually lose the ability to use Waterbury as a dispatchable or "peaking" facility as the 401 requires an eventual transition to run-of-river. In addition to transitioning to run-of-river operation, the proposed 401 is also requiring a much lower maximum flow downstream along with a minimum flow requirement. To best meet these requirements while maximizing generation, the turbine runner will need to be replaced with a runner that produces more efficiently at lower flows. This work will likely occur in the next two to three years. Lastly, in order for the facility to move to

true run-of-river, the State must repair gates on the dam. This is likely to occur in the next five to 10 years.

- *West Danville #1 (Joes Pond)*: Run-of-river facility with limited storage capacity located in West Danville. This is a non-FERC jurisdictional facility, and the dam was constructed in 1917 and was resurfaced in 1996. The dam suffered significant damage in 2012 during Hurricane Irene, and was repaired this past year in 2014.

- *Weybridge*: Dispatchable facility located in Weybridge, on Otter Creek. FERC license No. 2731. A 30-year license was issued in 2001. One of three stations that make up the Middlebury Composite.

Owned Peaking Generation

GMP owns a fleet of six oil-fired generators that provide generation capacity primarily for use on peak load days and ancillary products required for operation of the NEPOOL system. In 2013, GMP successfully conducted performance emissions testing on its fleet of peaking plants. All units received air permits that expire in 2018. Although these plants do not typically operate often (in 2013, the average capacity factor for these units was less than 1 percent), they provide significant value for GMP customers - primarily through their revenues in the Forward Capacity Market and Forward Reserve Market. These revenues depend on the ability of the plants to start quickly and reliably during the occasional periods when they are called upon to operate. This reliable operation will become even more important in the coming years, as the ISO-NE Performance Incentive Program will penalize capacity sources that fail to produce during regional shortage events, and reward those that do. GMP plans to review its operation and maintenance regimes or these units with the goal of maximizing availability. We expect that this will include performing monthly test starts, targeting worst-case periods, such as extreme temperatures when possible, and continuing internal inspections of the turbines each spring.

Table 3.1.3: Owned peaking generation

Resource Name	Commercial Operation	Nameplate MW	2013 MWh
Ascutney GT	1961	12.5	363
Berlin 1 GT	1972	46.5	3,877
Essex Diesels	2006	8.0	693

Gorge GT	1965	17.0	150
Rutland 5 GT	1963	12.5	467
Vergennes 5 & 6 Diesels	1963	4.0	304
Total		**100.5**	**5,854**

- *Ascutney GT:* The Ascutney Gas Turbine is a two-stage turbine, internal combustion unit located in Ascutney. The unit operates under an air pollution control permit issued by the VANR's Air Quality and Climate Division. The unit provides value as a stand-by unit through participation in various ISO markets: the Reserve, Black Start, VAR support, and Forward Capacity Markets. Significant recent improvements include the replacement of the fuel control system in 2004; replacement of the voltage regulator and autosynchronizer in 2008; and replacement of the engine section as part of a hot gas path/overhaul project in 2011.

- *Berlin GT:* The Berlin Gas Turbine facility is the largest peaking plant in Vermont, and consists of a Pratt & Whitney Twin Pack gas turbine generator and two Pratt & Whitney Simple Cycle FT4 engines. The unit has an approximate capacity of 50 MW at full output. Low-sulfur kerosene fuels the engines from two on-site fuel tanks.

  In 2008, the Berlin Gas Turbine facility was upgraded; both engines were overhauled and rebuilt, together with a complete rewind of the generator. An additional air-assisted start pack was installed, enabling both engines to start simultaneously. Additional improvements/upgrades/replacements were made in 2012 and 2013. As a result of the upgrades, the plant can more fully participate in the ISO Reserve market, the life expectancy of the plant was extended, and reliability improved.

- *Essex Diesels*: This diesel generation facility consists of four 2 MW Caterpillar diesel reciprocating engines that operate on ultra-low sulfur diesel. In 2007, GMP upgraded the facility, replacing the 60-year-old, 1.0-MW Electro-Motive Division (EMD) diesel engines with four new Caterpillar, 2-MW diesel engine/generator sets, totaling 8 MW of capacity. In addition, all associated switchgear and controls were upgraded.

- *Gorge GT:* The Gorge Gas Turbine is a two-stage turbine, internal combustion unit located in Colchester. The unit operates under an air pollution control permit issued by the VANR's Air Quality and Climate Division. The Gorge GT is out of service, and had a major inspection during 2014. GMP is evaluating the feasibility of repairing or replacing this unit.

- *Rutland GT:* The Rutland Gas Turbine is a two-stage turbine, internal combustion unit located in Rutland. The unit operates under an air pollution control permit issued by the ANR's Air Quality and Climate Division. The Rutland GT provides value as a stand-by unit and participations in various ISO markets: the Reserve, Black Start, VAR support, and Forward Capacity Markets. Significant recent improvements include the replacement of the fuel control system in 2006; replacement of the autosynchronizer in 2008, and refurbishment of the unit's engine components as part of a hot gas path inspection/overhaul project in 2009.

- *Vergennes Diesels*: The Vergennes peaking facility consists of two 16-cylinder reciprocating engines, originally installed in 1964. They have a total nameplate capacity of 4 MW. The engines are fueled using ultra-low sulfur, blended #2 diesel oil. Both engines have been overhauled in the last decade. In 2013, we installed a DOC catalyst to the emissions control system, and in 2014, we upgraded the unit's control systems.

Owned Wind Generation

Green Mountain Power owns two utility-scale wind projects. The first project is known as Searsburg Wind, a 6-MW facility located near the Massachusetts border. The second project is known as Kingdom Community Wind (KCW). With a nameplate rating of 64.5 MW, KCW entered commercial operation in 2012, and is located in the town of Lowell in northeastern Vermont.

Table 3.1.4: GMP-owned Wind Projects

Generator Name	Commercial Operation	Nameplate MW	2013 Net MWh
Kingdom Community Wind	2012	64.5	114,860
Searsburg Wind	1997	6	12,197
Total		**70.5**	**127,057**

- *Kingdom Community Wind:* Kingdom Community Wind is a 21-turbine, wind generation facility. Green Mountain Power partnered with Vermont Electric Cooperative to build the project, which began generating electricity at the end of 2012. The wind turbines at Kingdom Community Wind were manufactured by VESTAS, and are rated at just over 3 MW each. The plant is expected to operate at an approximate 33 percent annual

capacity factor[3], which yields approximately 186,000 MWh of energy annually. GMP owns 100% of the project, and retains 87% (55 MW) of the output for its customers. The remaining output serves Vermont Electric Cooperative customers, via a long-term power sale agreement.

- *Searsburg Wind:* Searsburg is an 11 turbine facility completed in July 1997, and produces energy at an average annual capacity factor between 20 and 25 percent.

Owned Solar Generation

GMP has embraced solar PV technology, particularly as its cost-competitiveness has improved in recent years. With the commercial operation of its 2.5 MW (DC) Stafford Hill project, GMP will soon have a total of about 5 MW of owned solar PV facilities. We have installed solar generation at a number of our sites as well as other sites at which we partner with the site's owner. GMP wants to help accelerate adoption of small renewable technologies such as solar and continues to build solar projects, especially in Rutland, which is fast becoming the Solar Capital of New England.

GMP believes that solar power can play a key role in its power portfolio based on its declining construction costs, low operating costs, and environmental and operating attributes. We expect to continue adding solar projects based on distributed generation benefits, renewable energy goals, and our Rutland area Solar Capital initiative.

- *Stafford Hill:* The Stafford Hill project is an innovative, first-of-its-kind project using solar, two types of battery storage and a common inverter to tie it all together on top of a previously capped landfill. The project is currently being constructed and will be able to electrically island the nearby Rutland High School emergency shelter during times of grid emergency. Under normal operating conditions, this project will supply energy to the grid while the battery system continues to smooth, regulate and support the grid throughout the day. The battery system is expected to generate significant revenue as a supplier of Regulation Service in the ISO-NE market, and will provide for peak shaving and capacity benefit during times when the solar facility is producing energy at less than full capacity. This plant also has the potential (in combination with other local solar projects and other reliability resources) to defer transmission investments to serve the Rutland area.

[3] Since the Jay synchronous condenser facility was installed and fully operational in spring of 2014, the project has produced at approximately this level.

- *Other Owned Solar:* GMP has installed solar PV equipment at a number of its sites as well at sites owned by others. We have installed projects at the site of the Berlin GT, on a former CV site on Cleveland Ave ("Creek Path Solar") in Rutland, and at a number of the Company's office buildings. We've also installed projects at Rutland Region Medical Center and the College of Saint Joseph's in Rutland.

- *Streetlights:* In partnership with the City of Rutland, GMP has deployed an innovative project that installs solar panels on utility poles in conjunction with street lighting. The project utilizes small, utility-pole-mounted solar panels that are directly connected into the secondary network of the local distribution system, which in turn feeds the streetlights. This system includes a lighting control system and the installation of LED lights that can allow the City to better control its streetlight usage. It also provides more real-time information on failed lights. Due to the success of this partnership, we expect that this type of solar installation will be replicated in other towns and cities across the state.

Net-Metered Solar Generation

As explained in Section 2.3 of the Demand for Electricity Chapter, GMP expects net-metered solar capacity to grow quickly over the remainder of this decade. While the actual pace and volume of net metering (and the mix of project sizes) could vary significantly based on a number of factors, we project that the 15 percent cap will be reached in 2021, primarily due to the addition of about 180 group-net-metered (500 kW) systems. After 2021, one or two group-net-metered systems are added each year as demand growth creates available capacity below the 15% cap. Note that rooftop-net-metering development is assumed to remain constant after 2017. The rationale is that group-net-metering will offer economies of scale that could leave little incentive for individual customers to own their own rooftop systems[4]. The following table summarizes the projected net-metered generation over the forecast period.

Although all net-metered solar customers are compensated in the same manner, the production from these systems is credited to GMP's power supply portfolio in two different ways.

[4] The mix of net-metering projects shown above illustrates one of many potential future combinations of project sizes; it does not reflect a policy recommendation by GMP. The actual mix of net-metered projects in the future will, of course, differ from the illustrative mix and will almost certainly feature meaningful numbers of rooftop systems along with some group-net-metering projects sized smaller than 500 kW.

- *Small Scale Rooftop Solar:* These customers receive a price similar to their retail rate, and also receive a solar payment (presently 6 cents/kWh) for all of the energy they produce. From a power supply perspective, GMP purchases solar energy from these homeowners and businesses when the amount of solar energy they produce is greater than their (net-metered) needs.[5]

- *Large-Scale Group Solar:* These customers represent homeowners and businesses that have chosen to become net-metered customers by participating in a share of a larger, off-site solar project. Like rooftop net-metered customers, they receive a price similar to their retail rate, plus a solar payment for all of the energy they produce. However, from a power supply perspective, the output from group-net-metering projects is represented as a purchase by GMP, as opposed to a reduction in GMP retail sales.

[5] In actual practice, such excess volumes tend to be very small relative to the scale of the net-metering program.

Table 3.1.5: GMP Net Metering Output Forecast (MWh/Year)

	RoofTop	Group	Total
2014	1,120	-	1,120
2015	7,977	5,453	13,430
2016	13,317	22,989	36,306
2017	13,574	42,652	56,225
2018	13,580	62,349	75,929
2019	13,583	82,059	95,642
2020	13,584	102,008	115,592
2021	**13,584**	**119,347**	**132,931**
2022	13,584	122,202	135,786
2023	13,584	122,747	136,331
2024	13,584	123,685	137,269
2025	13,584	124,119	137,703
2026	13,584	124,718	138,303
2027	13,584	125,921	139,505
2028	13,584	126,978	140,562
2029	13,584	127,951	141,535
2030	13,584	129,206	142,790
2031	13,584	131,065	144,649
2032	13,584	133,339	146,923
2033	13,584	135,614	149,199
2034	13,584	138,180	151,764

Joint-Owned Generation

GMP has joint ownerships in four generation facilities and one transmission facility. The generation facilities include one nuclear, one wood, and two fossil-fuel projects, representing baseload and peaking capacity. The Highgate Converter facilitates the import of up to 225 MW (185 MW GMP share) of energy from Canada.

Table 3.1.5: Joint-Owned Facilities

Resource Name	Commercial Operation Date	GMP Share Nameplate MW	2013 MWh
Highgate Converter	1985	185	N/A
McNeil Station	1984	15.5	90,120
Millstone #3	1986	21.3	164,731
Stony Brook	1981	31	15,913
Wyman #4	1978	17.7	4,579
Total		**270.5**	**275,343**

- *Highgate Converter*: The Highgate Converter is a back-to-back HVDC facility located near Highgate Springs, with transmission capability as high as 225 MW connecting with Hydro-Quebec to the North and the VELCO system to the South. It began commercial operations in 1985, and its annual capacity factor for energy deliveries has typically been about 75%. The facility has primarily been used to import Hydro-Quebec Vermont Joint Owner (HQ VJO) power, but exports are also possible. GMP owns an 82.29% (185 MW) share of the facility, and the remainder is owned by the other Vermont Distribution Utilities. VELCO operates the facility on behalf of the Joint Owners.

- *McNeil*: McNeil Station is a 50-MW wood-fired generation facility located in Burlington. The plant can also operate using natural gas, either alone or in combination with woodchips. It began operation in June 1984. GMP's ownership share is 31% (15.5 MW), and in recent years the plant has operated at well over a 50% capacity factor. The other owners are the Burlington Electric Department (BED) (50%) and the Vermont Public Power Supply Authority (19%). BED operates the facility on behalf of the Joint Owners.

  In 2008, a selective catalytic reduction (SCR) system was installed on the plant to reduce its NOx (nitrous oxide) emissions, which qualifies the plant's output as new renewable energy under the renewable portfolio standards (RPS) of some New England states. As a result of this investment, McNeil also supplies renewable energy credits (RECs), which

in recent years have typically been sold to load-serving entities in Connecticut for RPS compliance, with our associated revenues used to reduce GMP's power supply costs and retail electric rates.

- *Millstone 3*: Millstone Unit #3 is a 1,235-MW pressurized-water base-load nuclear reactor situated in Waterford, C.T., on Long Island Sound, and is part of the three-unit Millstone Station. Millstone #1 is being decommissioned, and Millstone #2 is actively generating. Millstone #3 began commercial operations in 1986, and GMP owns a 1.7303% (21.5-MW) share of the unit. The other owners are Dominion Nuclear Connecticut and the Massachusetts Municipal Wholesale Electric Company (MMWEC) with ownerships shares of 93.470% and 4.799% respectively. Dominion Nuclear Connecticut operates the facility on behalf of its Joint Owners.

  The Millstone #3 Operating License from the NRC runs through November of 2045. The future decommissioning of Millstone #3 is supported by dedicated Decommissioning Trust Funds for each Joint Owner.

- *Stony Brook, 1A, 1B, 1C*: The Stony Brook Station, located near Springfield, M.A., hosts a combined-cycle gas/oil-fired generation facility with both peaking and intermediate units. The intermediate units (1A, 1B and 1C) have a combined capacity of 353 MW and typically operate as peaking generation with an annual capacity factor of under 5 percent. The primary fuel is natural gas, although the plant has operated on oil (and provided value to GMP customers) for significant periods during cold snaps in recent winters, when regional scarcity of natural gas supply made operation on gas uneconomic. This dual-fuel capability provides important protection against the physical unavailability and financial costs associated with potential interruptions of natural gas supply. Stony Brook began commercial operations in 1981, and GMP owns an 8.8029% (31 MW) share of the combined intermediate units. MMWEC operates the facility on behalf of its Joint Owners, which are mostly Massachusetts municipal utilities.

- *Wyman #4:* The Wyman Station facilities, located on Cousins Island near Yarmouth M.E., comprise four generating units. The oil-fired Wyman #4 unit is the largest at 606 MW, and functions as a peaking generator in the ISO-NE dispatch. It began commercial operations in 1978 and was originally intended to function as an intermediate dispatch unit. Wyman #4 earns Forward Capacity Market and other ancillary product revenue from ISO-NE. GMP owns a 2.9207% (17.7 MW) share of Wyman #4. Florida Power & Light/NextEra owns 84.346% of the plant and operates the facility on behalf of GMP and its other Joint Owners. The plant has been economically dispatched at low annual

capacity factors in recent years, but it tends to be dispatched more heavily (and provide savings to GMP customers) during winter cold snaps, when regional natural gas prices and energy market prices are high.

Long-Term Purchased Power Agreements (PPAs)

The majority of GMP's energy supply comes from long-term PPAs. Until the expiration of the Vermont Yankee (VY) contract, the VY and HQ VJO PPAs supplied nearly 90% of the energy requirements of the legacy companies. GMP is now transitioning away from a few large PPAs towards smaller and more diverse resources, including new nuclear and hydro-based PPAs, an 82 MW wind PPA, and other purchased and owned resources. Through the forecast period in this IRP, GMP does receive a significant portion of its energy from a few large, long-term PPAs (HQ US and NextEra), but significantly less than before the merger. Current contracts and 2013 volumes are shown in the following table.

Table 3.1.6: Long-Term Purchased Power Agreements

Generator Name	Contract Period	Contract MW (1)	2013 MWh
HQ VJO	1989-2016	230	1,574,390
HQUS (2)	2012-3038	8	41,615
Moretown	2009 - 2023	3	26,126
Granite Reliable	2012-2032	82	191,305
Small Renewable PPAs	Various		~5,000
NextEra Seabrook (2)	2012-2034	15	131,400
Stony Brook 1a, b, and c	1981-Life of Unit	15	4,526
Total			**~1,975,000**

(1) HQUS and the current portion of GMP's NextEra Seabrook contract are energy-only; the contract MW therefore refers to the 2014 maximum hourly MWh delivery. Also, renewable resources normally have significantly lower FCM capacity than the units' nameplate ratings.

(2) The amounts of energy delivered under these contracts increase substantially during calendar year 2015, HQUS to about 148 MW starting November and Seabrook to 60 MW (unit contingent) in January.

- *Hydro-Québec / Vermont Joint Owners*: GMP currently has a 230 MW share of the stably priced Hydro-Québec Vermont Joint Owners (HQ VJO) contract. This PPA is structured with a target energy delivery volume equivalent to a 75% annual capacity, factor, which represents approximately 1.5 million MWh per year — about 33% of GMP's current

energy requirements. Roughly two-thirds of the energy from this source is delivered during peak hours, with the remainder normally delivered during off-peak hours. About 90% of GMP's contract share expires in October 2015, with the remainder expiring one year later.

- *Hydro-Québec – United States*: In April 2011, GMP and a group of other Vermont distribution utilities received approval from the PSB for a 26-year PPA with Hydro-Québec–United States (HQUS) starting in November 2012. GMP's current share of the purchase will increase to about 170 MW by the end of 2016 as the HQ VJO contract expires. The HQUS PPA will provide annual energy volumes of approximately 1,000,000 MWh per year (representing about 22 percent of GMP's current annual energy requirements) during much of the delivery term, in a flat schedule during the peak 16 hours of every day (i.e., 7x16). These deliveries are financially firm, and not contingent on the operation of particular generating units or transmission facilities. In addition to the energy delivered, the PPA includes all environmental attributes of the power, at least 90 percent of which will be based on hydroelectric resources, helping GMP to maintain our low-emission energy profile at a relatively stable price that reflects a blend of general inflation and regional energy market prices. No capacity is included in this purchase.

- *Granite Reliable Wind*: GMP purchases about 80 percent of the output from a 99 MW wind plant located in northern New Hampshire, under a 20-year contract. This will supply about 5% of our energy requirements at a fixed schedule of contract prices. The output of the project includes unit-contingent energy, capacity (starting April 2016), and RECs.

- *Moretown Landfill Gas*: In December 2008, GMP began receiving energy from Moretown Landfill Gas through a 15-year PPA. GMP receives 100 percent of the 3.2 MW plant output, which includes energy, capacity and RECs. This plant operates in a baseload mode to provide GMP around 25,000 MWh of renewable energy annually at a stable price.

- *Small Renewable PPAs*: In order to help facilitate development of local small renewable projects across a range of technologies, GMP has entered into PPAs for the output from a number of these facilities. These purchases currently represent a small number of annual megawatt hours (about 5,000 MWh per year), but may grow in future years to the extent that economics of smaller-scale resources improve.

- *Seabrook NextEra*: This PPA with NextEra for energy from its Seabrook nuclear facility will provide an estimated annual average of up to about 500,000 MWh of unit-contingent energy starting in 2015. Deliveries under the contract are scheduled to decline by 10 MW (about 80,000 MWh per year) starting June 2021 and by another 10 MW starting in June 2029.

  Beginning in June 2015, the PPA will also include deliveries of unit-contingent capacity to offset GMP's obligations in the ISO-New England Forward Capacity Market. Similar to the long-term energy schedule, the capacity quantity exhibits a declining volume profile, with deliveries of 85 MW per month to start, dropping to 75 MW in June 2021, and 65 MW in June 2029.

  Overall, the purchase provides low-emission baseload energy and capacity at relatively stable prices (with increases driven primarily by an index of general inflation), with the volumes ramping down gradually over time.

Long-Term Statutory PPAs

- *NYPA:* GMP receives approximately 0.5 MW of NYPA power, most of which comes from the Niagara Power Plant on the US-Canada border. Although the current NYPA contracts expire in 2017 and 2025, they are projected to remain available through the planning period. Delivery of NYPA energy can be shaped to correspond with the higher load periods of the day, and is expected to amount to about 5,000 MWh per year.

- *Ryegate*: Ryegate is a 21-MW woodchip-fired generator located in Ryegate, VT. A new 10-year contract between Ryegate Associates and VEPP Inc. began in November 2012. The PPA has an estimated levelized price of roughly 10 cents per kWh over the life of the contract, with a portion of fuel price risk passed through the PPA price. The expected annual plant output is 172,000 MWh, of which GMP's portion is approximately 82%, or 141,000 MWh per year.

- *SPEED Standard Offer:* Under the SPEED standard offer program, GMP purchases its load ratio share (presently about 78%) of up to 127.5 MW of eligible new renewable resources. The PSB appointed the Vermont Electric Power Producers Inc. (VEPPI) as the

SPEED Facilitator to administer these resources, which include more than 40 solar, hydro, biomass, and methane generators that are less than 2.2 MW in size.[6]

SPEED resources generally carry a fixed, levelized price for a term of 20 or 25 years. GMP estimates these resources will supply about 78,000 MWh per year to our portfolio in FY2015 and projects that this amount will grow to about 180,000 MWh per year when the program is fully subscribed. The actual volumes and cost will depend on the specific mix of renewable technologies that supply the program, and the actual capacity factors of those plants. The SPEED program is implemented by the Public Service Board as described in Rule 4.300, and its goal is to "achieve the goals of 30 V.S.A. § 8001 related to the promotion of renewable energy and long-term stably priced contracts for such energy that are anticipated to be below the market price."[7]

- *VEPPI:* GMP purchases approximately 78% of the output from Vermont's Qualified Facilities. The PSB appointed Vermont Energy Power Producers Incorporated (VEPPI) as the agent to administer these resources, which currently include 15 hydroelectric generating stations. These are fixed-price, plant-specific contracts, the last of which will expire by 2020.

  A share of the output of these Qualified Facilities (QFs) is assigned to GMP's power supply portfolio by Public Service Board Rule 4.100, which states that "The purpose of this rule is to encourage development of electricity through use of biomass, other renewable resources, waste and cogeneration, while giving due consideration to the duties and responsibilities of utilities. The rule implements the provisions of 30 V.S.A. Section 209(a)(8) and 16 U.S.C. Section 824a-3."[8]

Short-Term PPAs

GMP sources a portion of its energy requirements each year through fixed-price energy purchases from the New England wholesale energy market. These purchases reduce our customers' exposure to spot market energy prices, and to year-over-year volatility in power supply costs and retail rates. GMP typically implements these market purchases on a layered basis with terms up to five years, so that over a five-year period the company's power supply

[6] For more information, please refer to www.vermontspeed.com
[7] Vermont Public Service Board, 4.300 Sustainably Priced Energy Enterprise Development Program, 4.301 Purpose
[8] Vermont Public Service Board, 4.100 Small Power Production and Cogeneration, 4.101 Purpose

costs maintain some linkage to the New England wholesale energy market. This prevents GMP's retail rates from becoming disconnected from those of utilities in neighboring states – particularly during periods in which wholesale market prices are falling (as they did in the 2010 to 2012 period). GMP purchases only from credit-worthy counterparties. All contracts are for firm energy (not unit contingent) settled at the ISO Internal Hub, and they do not convey generation attributes from particular sources. As a result, for purposes of describing the fuel mix and air emission profile of GMP's power supply, these market purchases are represented based on a slice of the "system residual" mix in the NEPOOL Generation Information System.

Currently contracted-for purchases total over 1 million MWh for each of FY2015, FY2016 and FY2017, about 300,000 MWh for FY2018, and about 100,000 MWh (Oct-Dec) for FY2019. Table 3.1.7 shows total purchases by counterparty, and Table 3.1.8 shows monthly and total fiscal year purchases including volumes and total costs. The total costs reflect a number of factors, including the forward energy market outlook at the time that each purchase was contracted, and the period(s) and monthly volumes for which each purchase. The average price paid by GMP for these forward-market purchases in any given year is typically not an indication of the value of energy in that single period, but a weighted average value of multiple contracts that cover multiple delivery periods having widely varying market values.

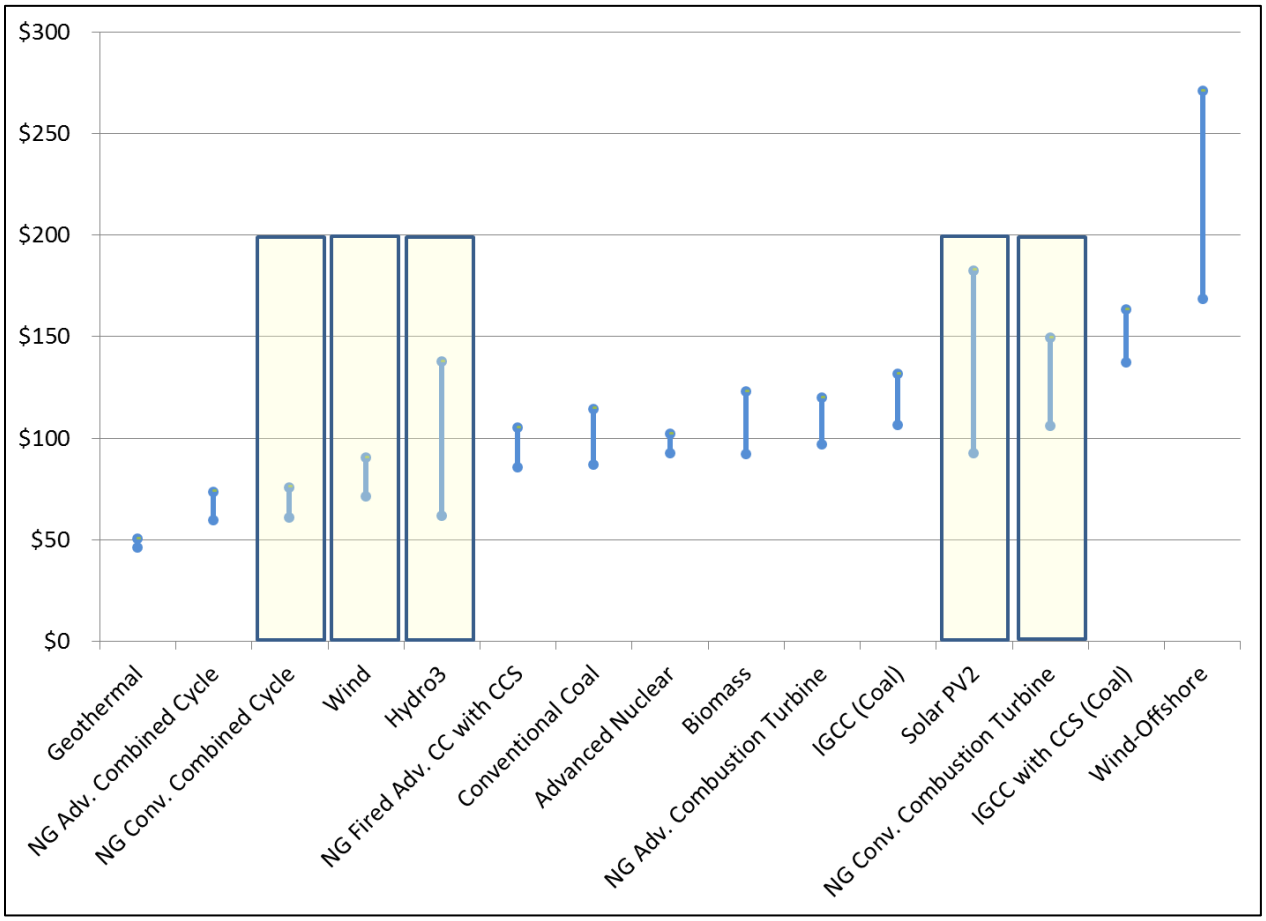
Table 3.1.7: Short-term Purchased Energy Summary by Counterparty

Counterparty	Remaining Contract Period	Description	MWh	Cost
J.P. Morgan	FY2015-FY2018	7X24; volume varies by month and year	1,227,720	$73,133,609
Shell	FY2015-FY2017	Some flat by on- and off-peak; some shaped	883,745	$39,503,307
ExGen	FY2016	Oct and Apr-Sept mostly off-peak shaped	189,520	$6,311,016
Citigroup	FY2015 & FY2017	FY2015 shaped; FY2017 7x24	578,775	$27,988,331
NextEra	FY2015-FY2016	Shaped	726,625	$35,652,058
Total			**3,606,385**	**$182,588,320**

3.2 Potential New Supply Resources

Broadly speaking there are only three categories of generation: fossil fueled, nuclear, and renewable. However, there are over a dozen specific generation technologies that make use of these resource types. Figure 3.2.1 shows an illustrative range of levelized costs of power[9] for a variety of different technologies, and highlights the ones explicitly modeled in the resource plan. The following sections describe in more detail how GMP approaches these resources, and the rationale for the role they could play in maintaining a low-cost, low-carbon portfolio that is also diverse, flexible, and reliable.

Figure 3.2.1 New Generation Supply Curve, Levelized Cost of Energy in 2012 $/MWh[10]



[9] These levelized price ranges reflect national cost parameters and assumed capacity factors, and are not focused on the northeast region; they are presented for illustrative purposes only.

[10] "Levelized Cost and Levelized Avoided Cost of New Generation Resources", Energy Information Administration, Annual Energy Outlook 2014, Table 2. Regional Variation in LCOE for New Generation Resources, 4/17/14

Renewable Generation

GMP's portfolio includes a variety of renewable resources including wind, solar, biomass, biodigesters, landfill gas, and both small and large hydroelectric resources. The following bullets describe how we think about each source of renewable generation.

- **Wind Power:** In terms of volume, GMP's power portfolio already includes over 140 MW of wind, which is projected to meet between 8 and 9 percent of GMP's current annual energy requirements. On-shore wind projects in New England are often sited on mountains where a combination of difficult terrain and relatively distant transmission access results in higher-than-average costs. GMP expects wind power costs to be at the high end of the range in Figure 3.2.1 (e.g., in the $85 to $100/MWh range). In this price range, wind represents one of the most cost-competitive sources of new utility-scale renewable power in New England.

  The federal Production Tax Credit (PTC) expired at the end of 2013, but projects that were already in development as of that date may be able to qualify for a safe-harbor exemption. As a result, the resource plan uses an illustrative nominal levelized cost of $94/MWh for projects that have safe-harbor and are projected to be operational before 2017. After 2017, the cost of wind projects is modeled at $98/MWh plus inflation.

  As Figure 3.2.1 shows, off-shore wind is the most expensive source of new renewable generation. For this reason, it is not included in the resource plan. In the long-term, offshore wind could be considered as a potential resource for GMP if the costs come down into a competitive range with other new renewable resources – for example, if large-scale offshore projects can be networked to achieve scale economies.

- **Solar Power:** Solar photovoltaic power production in Vermont is growing rapidly as a result of strong policy support and improving economics. Both the SPEED standard offer program and the recent changes to the state's net-metering statute have resulted in a substantial increase in the amount of solar power already developed and planned in the state. We expect development to continue at a significant pace through the end of 2016, when the federal Investment Tax Credit (ITC) is slated to drop from 30 percent to 10 percent of project capital cost. In 2017, we assume that the levelized price of new utility scale solar power will rise from about $120/MWh to $140/MWh. Because of solar power's long-term trend of falling costs, we *do not* apply inflation to this number, and instead assume that technological improvements will hold the cost of solar power constant in nominal terms over time, offsetting the effects of inflation.

The total volume of solar power on GMP's system (and in its resource portfolio) will reflect a combination of net-metering, SPEED standard offer projects, other PPAs, and GMP-owned projects. This total is expected to grow substantially. As noted above, net-metering installations have increased significantly in recent years and this trend is expected to continue. The SPEED standard offer program has supported the deployment of tens of MW of solar projects in Vermont, and it appears likely that a clear majority of that program's 127.5 MW of cumulative capacity will be filled by solar projects. Declining costs of distributed utility-scale solar projects have made the most attractive projects cost-competitive with large-scale renewable resource options like wind, so GMP expects to explore additional volumes through direct PPAs and/or project ownership.

While actual solar volumes will depend on a number of uncertainties (e.g., costs of panels and installation, state net-metering policy, interest rates, availability of suitable sites, etc.), it is reasonable to expect that the collective volume of solar PV sources for GMP will approach or exceed 200 MW by the end of this decade. This scale of solar capacity will represent over 25 percent of GMP's current system peak, and at an illustrative 15 percent annual capacity factor would produce roughly 6 percent of GMP's current annual energy requirements.

- **Hydroelectricity:** Hydroelectric resources continue to represent the largest portion of renewable power in GMP's resource mix, and are projected to meet about one-third of GMP's total energy requirements over the next 20 years. As discussed above, the largest single source is the HQUS contract, which provides firm deliveries in accordance with a fixed schedule. Looking forward, because hydroelectricity is a resource that can play multiple roles within the portfolio (renewable, zero-air emissions, stable price), GMP will continue to explore adding cost-effective hydroelectric resources to the portfolio as those opportunities arise. In particular, GMP will continue to seek additional opportunities to increase output from its existing hydro plants and to develop new projects, although we expect that the scale of new projects that are feasible and cost-competitive will be limited. GMP also expects to explore acquisitions of existing hydroelectric power, through PPAs and/or purchases of specific plants.

- **Biomass Power:** As a joint-owner of McNeil and the majority off-taker of Ryegate, GMP receives about 5 percent of its energy requirements from woody biomass. As with all renewable resources, we will continue to investigate adding more biomass to the portfolio as those opportunities arise. However, newly constructed biomass plants appear less cost-competitive than both wind and solar, in spite of their dispatchable (non-intermittent) output profile and ability to produce power in a baseload duty cycle (high capacity factor).

This is because new biomass plants tend to feature both a substantial capital cost ($/kW) and a significant fuel expense ($/MWh) to operate. In contrast to wind and (particularly) solar, we are not aware of any technological changes that are expected to lower the cost of biomass energy in a major way over the next 20 years. As a result, while GMP would consider many types of new renewable power including biomass, we have not modeled biomass as a new resource in the Resource Plan chapter.

- **Bio-Digesters:** Methane-producing farm digester systems have been a part of the GMP mix for a number of years, and continue to be added under the Cow Power program. As previously mentioned, these facilities are owned by the farmers, with the revenue from the electricity and renewable credits flowing back to them. As GMP explores the next generation of these facilities, we believe that a GMP-owned model that incorporates both farm manure as well as pre- and post-consumer food waste could provide substantial benefit for Vermonters.

  The Vermont Legislature has recently taken a step forward with the passing of Act 148, which requires a phased-in approach to ultimately keep all food waste out of landfills. This creates an opportunity to capture this abundant wastestream and turn it into energy, as well as heat and other products, such as compost. This can further be combined with wastewater treatment facilities to produce additional methane, which can also be used to generate clean electricity.

- **Geothermal Power**: GMP is not aware of any commercial-quality sources of geothermal energy for electricity production at present, so geothermal resources are not specifically considered in the resource plan.

Most of the new renewable technologies discussed above are relatively capital-intensive, and are typically developed through long-term and stable-priced purchased power agreements or utility ownership. In addition, several of the renewable technologies (most notably wind, solar, and hydroelectric) feature intermittent output profiles, which fluctuate significantly based on actual wind speed, incoming solar radiation, and stream flow. These considerations and their applicability to GMP's resource portfolio are discussed further in Section 7.

Fossil-Fueled Generation

Although GMP's portfolio includes a relatively small amount of energy directly from oil- and gas-fired generators, our short-term purchases are sourced from generation that includes fossil fueled generation from around New England, primarily from natural gas. Because natural-gas generation plays such a prominent role in New England's power market, with new natural-gas-fired plants appearing to be among the region's most cost-competitive sources of new capacity in the Forward Capacity Market, this type of capacity is included in the resource planning chapter. Both a combined cycle and a combustion turbine (CT) are included to determine how the characteristics of an otherwise highly renewable portfolio would change in the presence of new natural-gas generation.

Natural Gas Generation

According to ISO-NE, natural-gas-fired generators set the energy clearing price in New England during most hours of the year. This means that natural gas is typically the marginal fuel resource in New England, and is among the lower-cost sources of electricity during most of the year. This is true not only for energy, but also for capacity. The most recent changes to the capacity market included revised values for the cost of new entry (CONE), which are based on a natural gas fired combined cycle (CC) unit. As the marginal-cost source of conventional generation capacity, the cost of a natural-gas CC unit is linked directly to the cost of capacity in the FCM.

Peaking Resources

Conventional fossil-fuel-fired peaking facilities will continue to play a significant role in providing both capacity and peaking energy for the foreseeable future. Because these resources are fast starting, they can also provide reserves to the ISO markets, and can enable greater levels of intermittent generation. In the context of the recent changes in the Forward Capacity Market (FCM) and the Pay-for-Performance program (PFP), new peaking resources are also likely to be a cost-competitive hedge against both capacity and energy prices. As a result, the Resource Plan evaluates the role of conventional peaking resources in GMP's future portfolio.

Oil & Coal Generation

Oil- and coal-fired generation has been declining in New England for years, and are neither as cost competitive or as clean burning as natural gas. As a result, new coal-fired generation is not considered in the resource plan. New oil-fired generation is only considered as a potential

peaking resource, which would likely generate only occasionally and not provide a meaningful portion of GMP's energy supply.

Nuclear Generation

With a long-term PPA from NextERA increasing in size starting January 2015, GMP will receive about 10 percent of its energy requirements from nuclear power, which helps keep our emissions profile well below the New England average. This fraction of nuclear energy is far below GMP's historical level of nuclear reliance, which exceeded 40 percent during the past decade, when GMP's largest single power source was the Vermont Yankee plant. Adding more nuclear power purchases to the portfolio could support GMP's vision of low-cost, low-carbon, and reliable power, so GMP does not rule out purchasing energy from nuclear plants in the future. However, no new nuclear development is taking place in New England, and hydroelectricity can provide the same low emissions and price stability that nuclear sources are well-suited to provide, while also increasing GMP's reliance on renewable energy. For these reasons, nuclear is not modeled as a potential resource in the Resource Plan chapter.

Short-Term Contracts

GMP utilizes shorter-term contracts to meet its needs that are not met through GMP's owned resources and long-term commitments. Due to their flexibility, shorter-term purchase contracts offer GMP the ability to closely match its resources to its load requirements. Because short-term purchases are negotiated a short time before delivery, they reflect then-current market conditions and therefore do not provide any meaningful protection against long-term market price trends.

At the time of our last IRP, opportunities for contracting in the energy market, both the contractual options and potential counterparties, were somewhat limited due to the poor credit standing and weak balance sheets of many of the sellers in the market. We had assumed, however, that over the planning period, the wholesale energy market would improve in liquidity and product customization and that a significant market in bilateral contracts would return. This has indeed occurred. The market for short-term contracts is now quite liquid. There are plenty of offers for standard block contracts, with terms of a few days to a few years available on two exchanges, Intercontinental Exchange and NYMEX, as well as over the counter.

Our analysis did not explicitly model any short-term hedging for GMP's open energy or capacity position. In developing and scoring the portfolios, the load that is met through "market purchases and sales" is assumed to occur hourly at the spot price. Similarly, GMP's open capacity position is priced at the forecasted FCM price. In actual practice, GMP typically

balances its loads and resources with short-term bilateral purchases so that its spot market exposure is limited to just a few percent on average. In the context of the IRP's long-term trend analysis (which lacks the daily and monthly volatility of the actual spot market), the pricing of short-term purchases/sales using simulated spot market price is a reasonable approximation.

Other pricing structures – such as options or collars – could also be available to hedge shorter-term open positions. However, such alternative pricing structures are not traded on a standard basis today despite the liquid market for standard products. It is not clear whether the market for them will become liquid and competitive similar to the market for energy. As a result, we have not explicitly analyzed them in this portfolio analysis. We note, however, that at some point in the future, they could potentially be effective tools to help GMP manage price uncertainty.

Non-Generating Resources: Demand Response & Energy Efficiency

In recent years GMP has directly, and in partnership with firms like EnerNOC, helped some of its customers manage their consumption during peak-demand events. In addition, a number of GMP's large customers participate in curtailable and interruptible retail rate programs. Together, these activities can reduce GMP's capacity obligations, transmission costs, and the need for peaking power.

Regional demand-response programs designed to allow large customers to reduce consumption in response to market prices complement GMP's efforts. The regional programs should temper the volatility of market prices, reducing fixed-price contract premiums. To the extent this occurs, GMP will benefit from lower contract prices. Please refer to Chapter 6 for a description of the regional market context for demand response resources and energy efficiency.

GMP will continue to support the acquisition of cost-effective demand response and energy efficiency through both regional and state mechanisms. For in-state energy efficiency, we will continue to work with Efficiency Vermont and make use of the CEED Fund. Please refer to Chapter 2 for a description of how energy efficiency savings were incorporated in GMP's 2014 IRP load forecast and subsequent resource analysis.

Distributed Resources

Distributed resources can come in many shapes and forms, from kW-scale biodigesters, PV and wind projects to MW-scale PV and aggregated demand-response resources. As GMP continues to develop as an integrated energy service company, we can see a world where distributed resources comprise everything from load control to battery energy storage to controllable

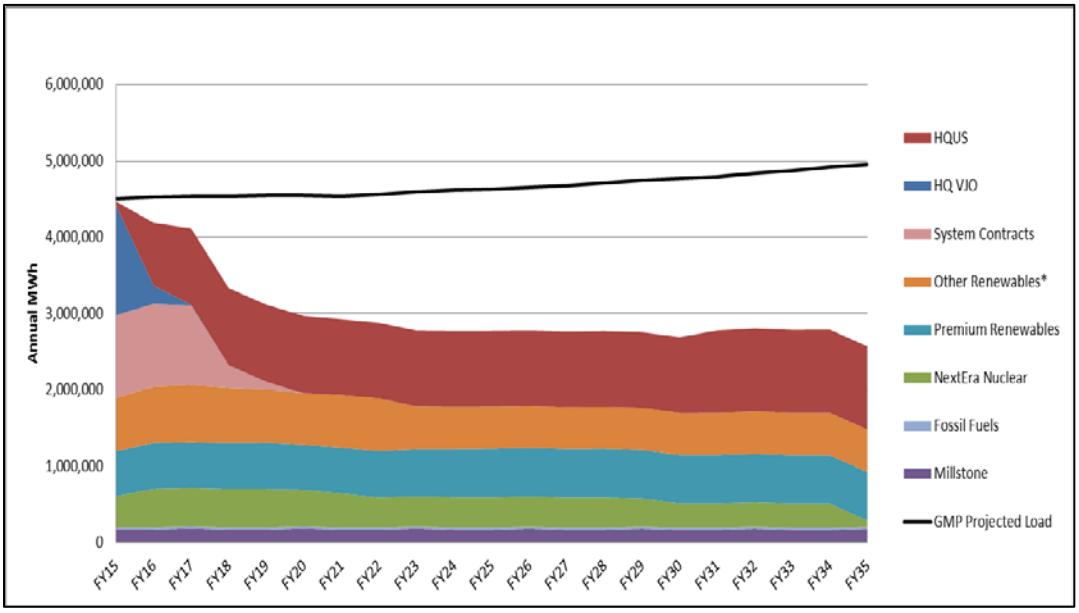
thermal storage technologies. Although conventional fossil-fuel-fired peaking facilities are likely to continue playing a significant role in our future capacity needs, GMP will continue to advocate for decreasing dependence on these resources and increasing our reliance on end-use, distributed technologies.

It will be critical that both markets and energy policy evolve to enable the value of distributed energy resources to be aggregated and monetized. This could come from a wholesale market (ISO-NE), or it could be developed at the distribution level, where a distribution marginal pricing (DMP) scheme could place a value on individual and highly localized resources in near-real time. However, the technologies that would enable this to happen are just now beginning to enter the market, and energy policies that would enable the technologies to participate in the market have not yet been adopted. In any event, GMP will be actively seeking cost-effective, commercially ready opportunities to deploy distributed resources as these trends emerge and mature.

3.3 Conclusions for Resource Planning

Figure 3.3 illustrates how GMP's committed supply-side resources compare to the load forecast from Chapter 2. The projected annual energy output of GMP's committed energy resources is sufficient to meet about 57 percent of GMP's projected load over the 20-year planning period. This level of long-term, mostly fixed-price resource commitments strikes a balance between three important portfolio attributes: diversity, flexibility and stability.

Figure 3.3 GMP's Projected Energy Supply Compared to the Forecasted Load (Before REC Sales)



It is important to note that this chart depicts GMP's portfolio of committed supply sources – that is, the mix of sources that will offset purchases in the ISO-NE energy market. The chart does not necessarily depict the mix of sources that can be claimed to serve GMP customers in particular years. That mix – which reflects ownership of renewable attributes or RECs - can be noticeably different if GMP sells RECs from some of these committed sources, or purchases RECs from other sources. As discussed in Chapter 7, the renewable energy policy choices that Vermont makes in the coming years will have important effects on the fuel mix and emission profile of electricity supply that ultimately serves GMP customers.

In terms of portfolio *diversity*, these resources are both geographically dispersed and apportioned amongst different fuels and technologies. The figure also makes clear that no single resource represents either a disproportionate percentage of GMP's portfolio or a disproportionate percentage of its overall energy requirements.

The largest resource in terms of MWh will come from short-term PPA's, which preserve GMP's *flexibility* to adapt to changes in load and/or market prices over time. Importantly, these same short-term PPAs also provide a measure of price *stability* because GMP's hedge program covers 100% of the forecast load with fixed-price resources before the operating year occurs.

The major conclusion of this chapter for resource planning purposes is that the current balance between long-term and short-term supply commitments is congruent with the second conclusion from Chapter 2: "…load growth/decline rates are not a constraint on the acquisition of, or a driver of the need for, new resources."