Cold Weather Impact

late 2017 – early 2018

vermont electric power company

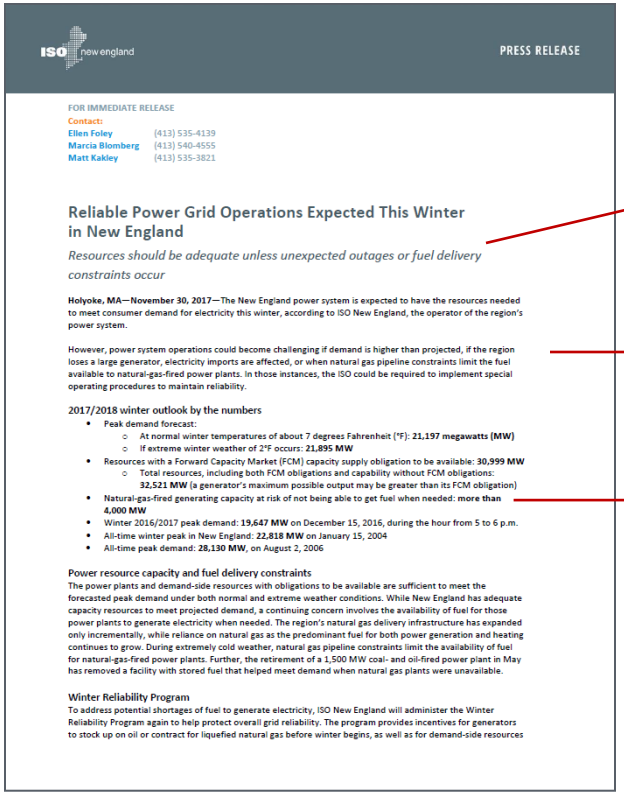
VELCO

VELCO Operating Committee

January 18, 2018

Jason Pew

Expected 2017-18 Winter Operations



ISO new england PRESS RELEASE

FOR IMMEDIATE RELEASE

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Reliable Power Grid Operations Expected This Winter in New England

Resources should be adequate unless unexpected outages or fuel delivery constraints occur

Holyoke, MA—November 30, 2017—The New England power system is expected to have the resources needed to meet consumer demand for electricity this winter, according to ISO New England, the operator of the region's power system.

However, power system operations could become challenging if demand is higher than projected, if the region loses a large generator, electricity imports are affected, or when natural gas pipeline constraints limit the fuel available to natural-gas-fired power plants. In those instances, the ISO could be required to implement special operating procedures to maintain reliability.

2017/2018 winter outlook by the numbers

- Peak demand forecast:
  - At normal winter temperatures of about 7 degrees Fahrenheit (°F): **21,197 megawatts (MW)**
  - If extreme winter weather of 2°F occurs: **21,895 MW**
- Resources with a Forward Capacity Market (FCM) capacity supply obligation to be available: **30,999 MW**
  - Total resources, including both FCM obligations and capability without FCM obligations: **32,521 MW** (a generator's maximum possible output may be greater than its FCM obligation)
- Natural-gas-fired generating capacity at risk of not being able to get fuel when needed: **more than 4,000 MW**
- Winter 2016/2017 peak demand: **19,647 MW** on December 15, 2016, during the hour from 5 to 6 p.m.
- All-time winter peak in New England: **22,818 MW** on January 15, 2004
- All-time peak demand: **28,130 MW**, on August 2, 2006

Power resource capacity and fuel delivery constraints

The power plants and demand-side resources with obligations to be available are sufficient to meet the forecasted peak demand under both normal and extreme weather conditions. While New England has adequate capacity resources to meet projected demand, a continuing concern involves the availability of fuel for those power plants to generate electricity when needed. The region's natural gas delivery infrastructure has expanded only incrementally, while reliance on natural gas as the predominant fuel for both power generation and heating continues to grow. During extremely cold weather, natural gas pipeline constraints limit the availability of fuel for natural-gas-fired power plants. Further, the retirement of a 1,500 MW coal- and oil-fired power plant in May has removed a facility with stored fuel that helped meet demand when natural gas plants were unavailable.

Winter Reliability Program

To address potential shortages of fuel to generate electricity, ISO New England will administer the Winter Reliability Program again to help protect overall grid reliability. The program provides incentives for generators to stock up on oil or contract for liquefied natural gas before winter begins, as well as for demand-side resources

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- Natural-gas-fired generating capacity at risk of not being able to get fuel when needed: **more than 4,000 MW**

https://www.iso-ne.com/static-assets/documents/2017/11/20171130_pr_winter_outlook_final.pdf

Cold Weather Impact

Fuel Security for Natural-Gas-Fired Generators

The dependable performance of New England's fleet of power resources is the cornerstone of a reliable supply of electricity, but that performance hinges on adequate arrangements for and access to fuel. This fuel-security issue has been a growing concern over recent winters, particularly for generators that run on natural gas, but also for those that run on oil either primarily or as an alternate fuel source.

The performance of the largest and most flexible sector of generators is being weakened by insufficient pipeline and storage

- **Reliability risks:** Because such a large and still growing amount of the region's generating capacity uses this fuel, its unavailability can pose a serious risk to the reliable supply of electricity, particularly when non-gas-fired resources are also unavailable. Learn more at Key Stats—Resource Mix.
- **Price volatility:** Similarly, the price of this fuel also has an immediate effect on wholesale electricity prices. See Key Stats—Markets for more on the link between prices for natural gas and wholesale electricity.
- **Air emissions:** Pipeline constraints are also affecting regional air emissions during winter because the ISO has increasingly had to run higher-emitting generators when gas-fired units can't access fuel or when the price of natural gas spikes.

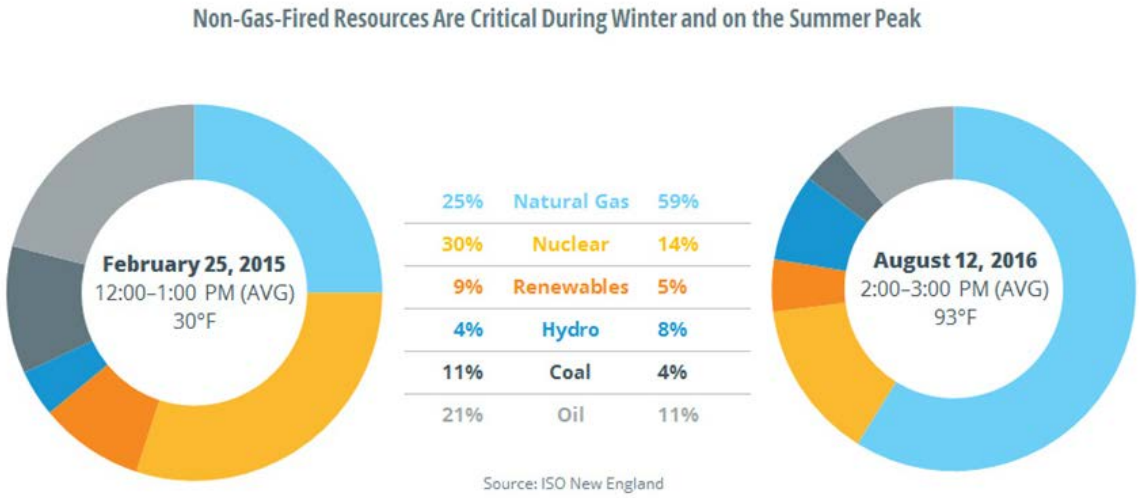
Generators Running on Oil also Raise Fuel-Security Concerns

Fuel security isn't just about natural gas. Adequate arrangements for oil are also a concern for both generators that run exclusively on this fuel source and those natural-gas-fired generators that have the ability to switch to oil when necessary. That's why the ISO has been working to ensure these generators are properly incentivized to fill up their oil tanks before winter sets in.

"Dual-fuel technology" that allows switching to oil may be the most cost-effective investment natural-gas-fired generators might take to ensure operation when pipelines are constrained. However, state restrictions on air emissions may limit this option. Consequently, more natural gas plants may need to turn to LNG in winter when pipeline gas is unavailable or its price spikes.

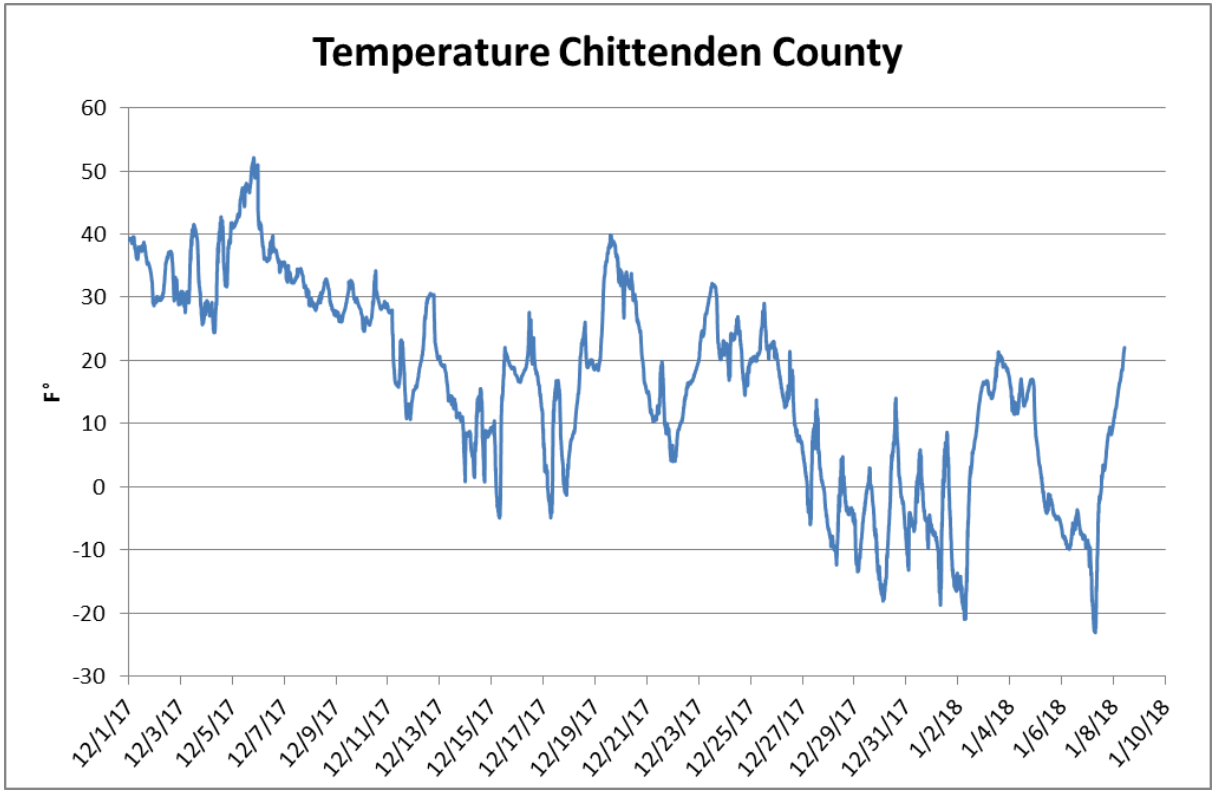
https://www.iso-ne.com/about/regional-electricity-outlook/grid-in-transition-opportunities-and-challenges/natural-gas-infrastructure-constraints

“Peak” New England Fuel Mix



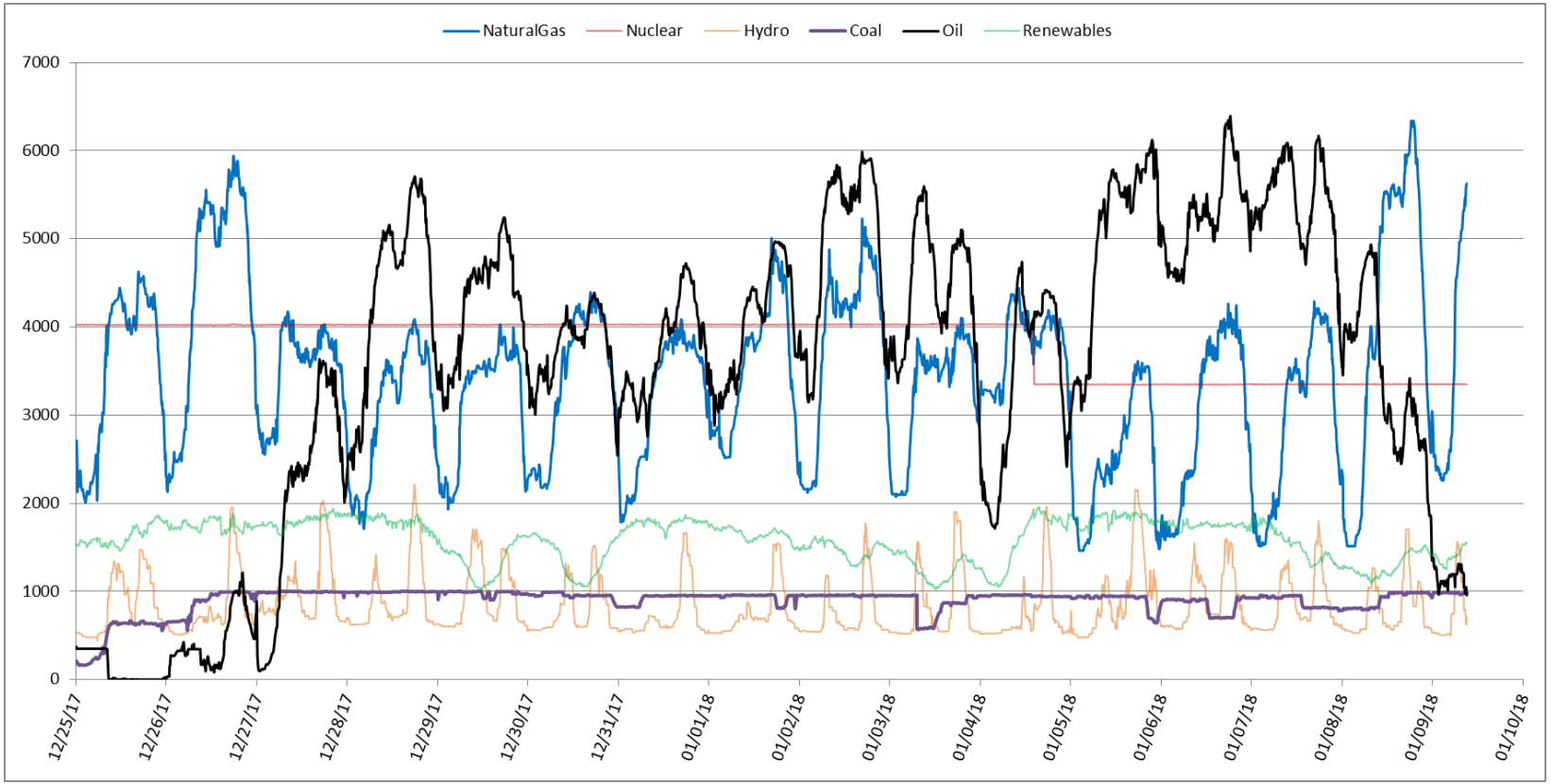
https://www.iso-ne.com/about/key-stats/resource-mix

Cold Weather Impact



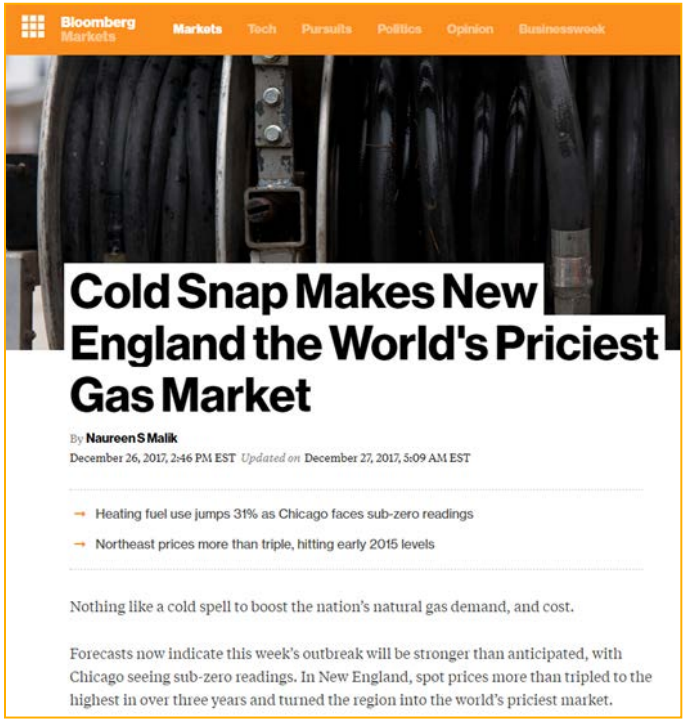
12/28/17
Cold Weather Watch
12/31/17
Cold Weather Watch
1/1/18
Cold Weather Watch
1/2/18
Cold Weather Watch
1/3/18 1600
M/LCC2 Abnormal Conditions
1/5/18
Cold Weather Watch
1/6/18
Cold Weather Watch
1/7/18
Cold Weather Watch
1/9/18
M/LCC2 Cancelled

New England Fuel Mix



Source: *https://www.iso-ne.com/isoexpress/*

Cold Weather Impact

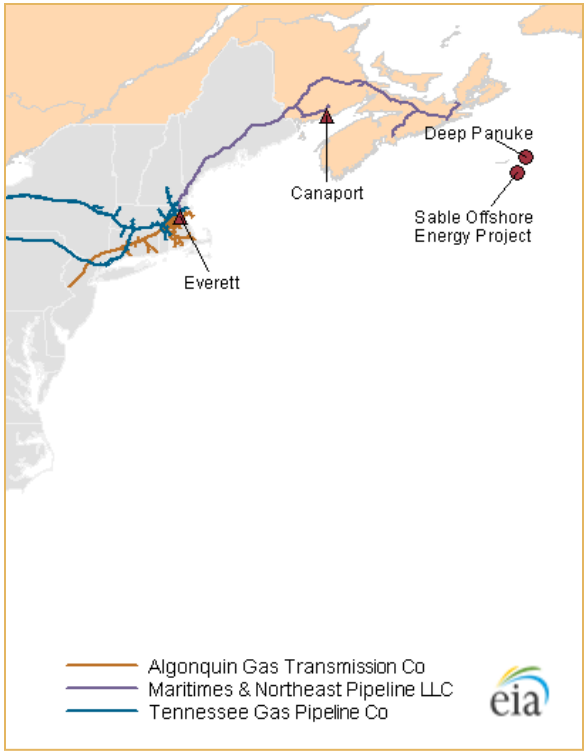


https://www.bloomberg.com/news/articles/2017-12-26/cold-snap-makes-new-england-the-world-s-priciest-market-for-gas

Jan. 4, 2018

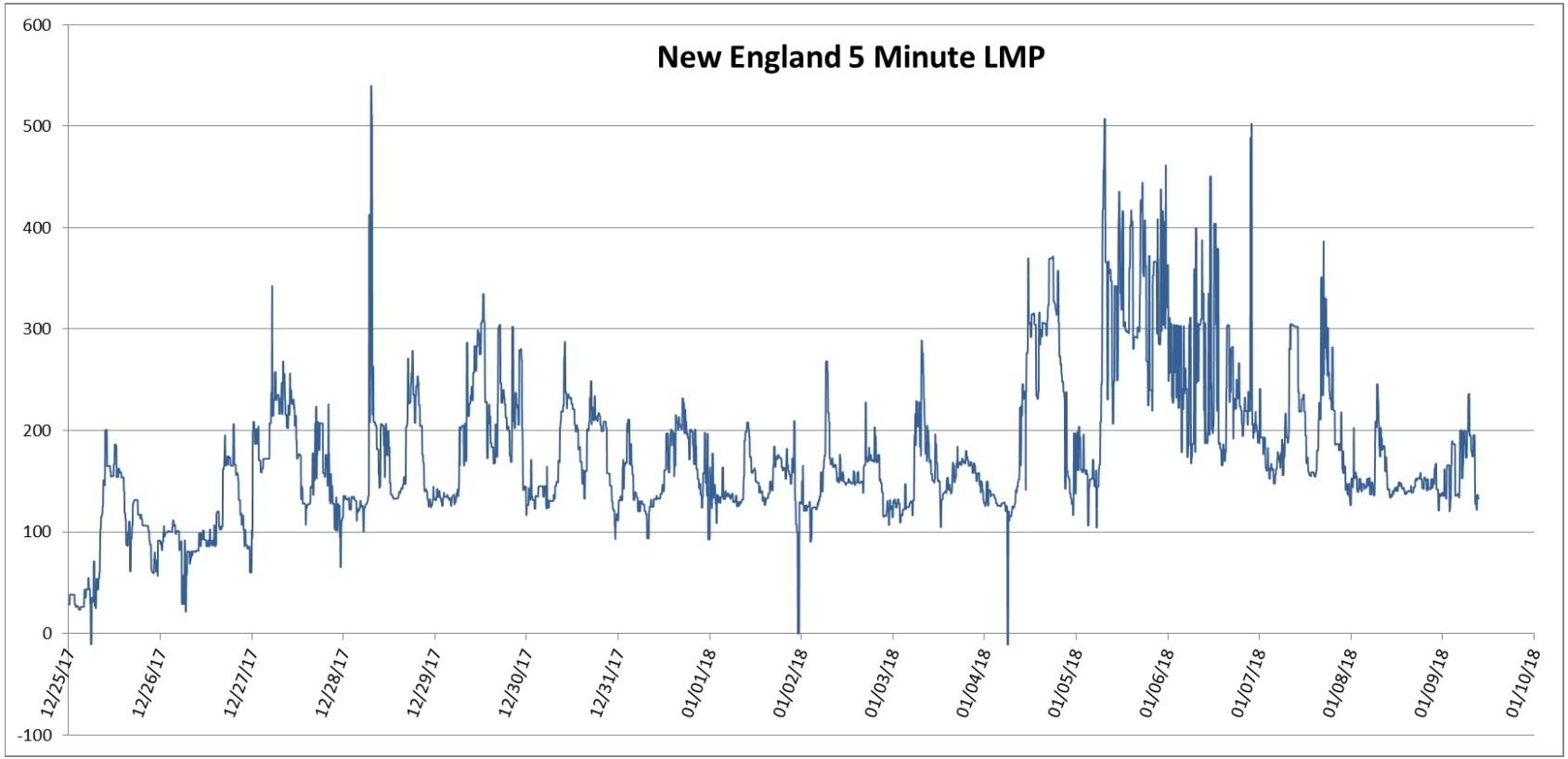
Geocolor Image From NOAA's GOES-16 Satellite of Powerful East Coast Storm

https://www.nasa.gov/image-feature/geocolor-image-from-noaas-goes-16-satellite-of-powerful-east-coast-storm



https://www.eia.gov/naturalgas/review/deliverysystem/2013/

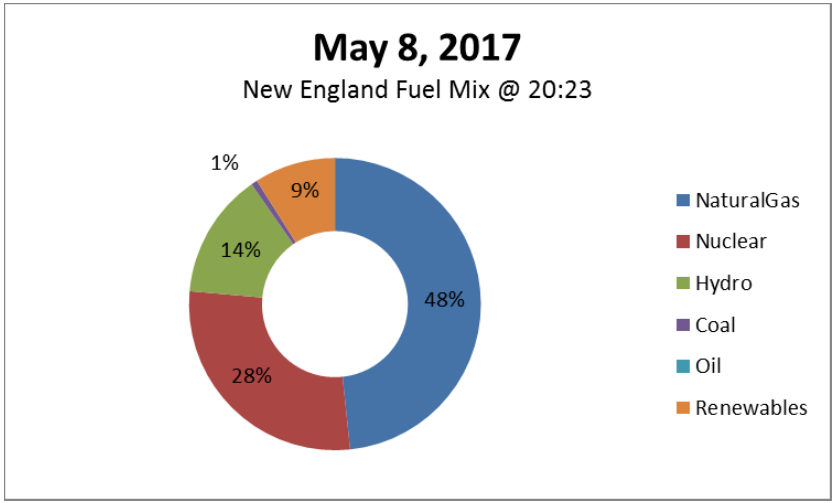
New England LMP



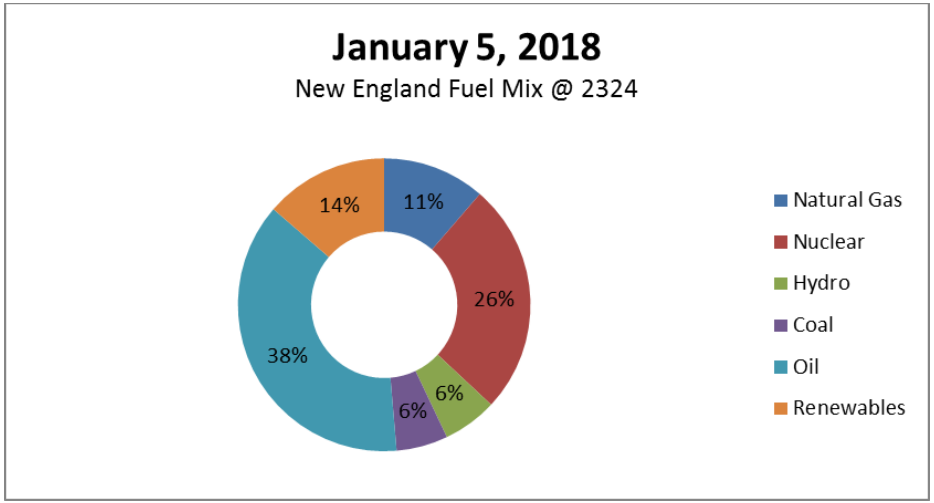
Source: *https://www.iso-ne.com/isoexpress/*

New England Fuel Mix

“Typical” NE Generation
(5 min LNP: **$22.93**)



“Cold” NE Generation
(5 min LNP: **$462.49**)



Data from*: https://www.iso-ne.com/isoexpress/*

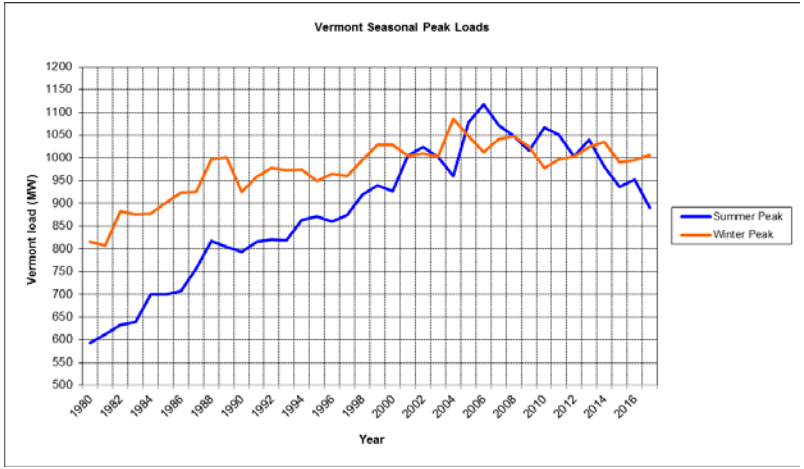
VELCO Load History

Vermont Monthly Peak (One Hour) Loads

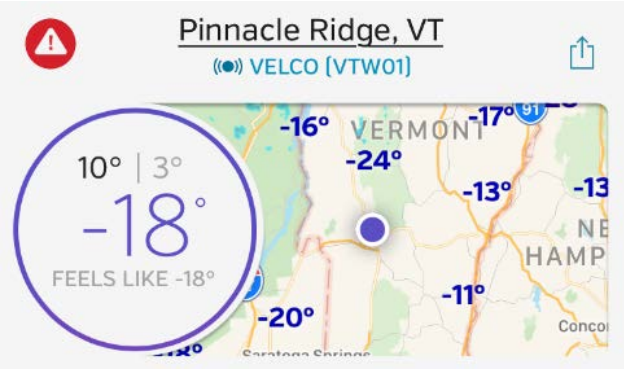
Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Year	Summer Peak	Winter Peak	Spring Peak	Fall Peak
1980	770	769	737	615	562	562	581	594	586	640	708	815	1980	594	815	615	640
1981	807	808	739	650	605	612	607	613	630	673	716	800	1981	613	808	650	673
1982	882	795	794	756	600	590	633	623	593	650	685	819	1982	633	882	756	650
1983	847	838	725	676	641	630	616	640	641	679	721	876	1983	640	876	676	679
1984	877	863	841	699	653	672	658	699	640	665	768	875	1984	699	877	699	665
1985	897	883	830	716	657	658	677	699	660	705	784	901	1985	699	901	716	705
1986	924	866	824	705	677	680	703	708	681	732	835	882	1986	708	924	705	732
1987	919	906	866	756	694	709	749	757	696	763	824	926	1987	757	926	756	763
1988	996	901	921	725	723	757	767	817	721	781	851	984	1988	817	996	725	781
1989	982	932	936	802	729	777	805	779	739	775	913	1001	1989	805	1001	802	775
1990	925	926	907	782	742	779	782	794	749	794	867	925	1990	794	926	782	794
1991	942	910	856	764	746	781	816	814	783	768	847	959	1991	816	959	764	783
1992	977	942	874	802	732	766	772	820	779	786	865	940	1992	820	977	802	786
1993	928	939	902	796	732	770	817	819	787	799	875	973	1993	819	973	796	799
1994	975	941	873	794	739	839	864	824	750	755	867	959	1994	864	975	794	755
1995	935	868	809	832	735	856	859	871	771	804	912	949	1995	871	949	832	804
1996	965	938	871	783	764	832	849	860	829	807	905	962	1996	860	965	783	829
1997	956	925	896	813	781	843	874	874	817	850	912	960	1997	874.2	960	813	850
1998	956	919	919	794	807	886	918	905	854	822	905	995	1998	918.2	995	807	854
1999	979	920	871	800	838	921	939	880	904	834	971	1029	1999	939	1029	838	904
2000	1028	967	894	839	829	917	883	927	932	868	932	1013	2000	927	1028	839	932
2001	987	959	903	822	829	937	981	1004	876	853	929	1004	2001	1004	1004	829	876
2002	964	944	922	838	832	924	993	1023	959	882	930	1010	2002	1023	1010	838	959
2003	1004	992	934	856	796	1001	987	994	890	868	916	1004	2003	1001	1004	856	890
2004	1042	976	898	826	818	924	960	953	881	860	942	1086	2004	960	1086	826	881
2005	1041	977	951	833	806	1059	1077	1045	957	890	962	1047	2005	1077	1047	833	957
2006	1011	1001	926	840	903	999	1074	1118	872	873	939	1013	2006	1118	1013	903	873
2007	1030	1013	999	874	879	1049	1028	1072	966	871	976	1042	2007	1072	1042	879	966
2008	1047	980	905	845	808	1048	1022	923	960	878	978	1024	2008	1048	1047	845	960
2009	1006	961	923	794	798	903	941	1016	828	824	876	1023	2009	1016	1023	798	828
2010	970	931	851	770	921	907	1067	991	993	803	868	978	2010	1067	978	921	993
2011	949	939	904	819	859	928	1050	951	841	841	873	996	2011	1050	996	859	841
2012	1003	921	882	775	858	1003	984	956	846	801	933	955	2012	1003	1003	858	846
2013	994	955	862	821	842	929	1040	914	933	837	947	1023	2013	1040	1023	842	933
2014	1035	938	907	781	754	900	981	873	929	828	921	975	2014	981	1035	781	929
2015	990	970	911	810	844	824	936	935	946	792	888	962	2015	936	990	844	946
2016	995	969	865	791	800	856	874	952	897	791	894	979	2016	952	995	800	897
2017	937	909	885	768	757	836	846	890	905	781	874	1006	2017	890	1006	768	905

Vermont All-Time Peak Load - Winter = 1086.37MW, 12/20/2004 at 1800 hours

Vermont All-Time Peak Load - Summer = 1118.45MW, 8/2/2006 at 1300 hours



Data Source: VELCO Power Accounting



1/7/2018 @ 0650

You Can't get too much winter in the winter

- Robert Frost