The nrg logo consists of the lowercase letters 'nrg' in a bold, black, sans-serif font. To the right of the letters is a colorful graphic composed of several small squares and crosses in shades of yellow, magenta, and cyan, arranged in a pattern that suggests energy or a digital grid.

nrg

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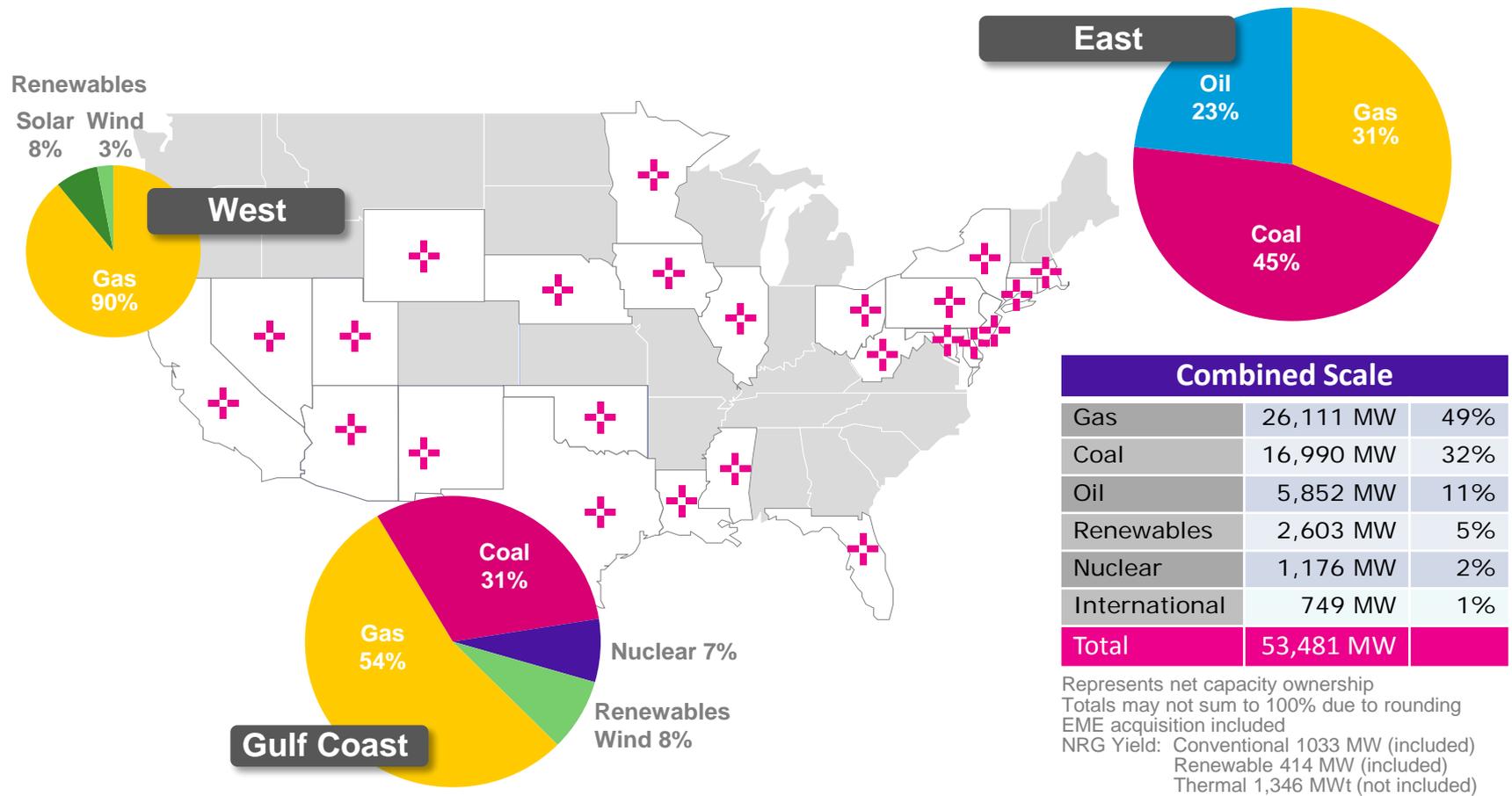
April 1, 2014

# 2013/14 Cold Weather Operations

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FERC Technical Conference

# One of the Nation's Largest and Most Diverse Generation Portfolios



National Footprint with Diverse Fuel & Merit Order Units



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# Cold Weather Operations

- Overall, the system worked very well.
  - Spikes in gas prices have revealed a few cracks in our energy markets, but the foundation remains strong.
  - Fuel diversity was critical to keeping the lights on.
    - Oil units had record runs and were critical to system reliability.
    - Natural gas curtailments were a significant issue in isolated areas – including units with firm natural gas transportation contracts.
  - Recommend three commonsense changes:
    1. Electric: Intra-day bidding should be the rule.
    2. Electric: Align electric day with gas day.
    3. Natural Gas: Break up weekend gas packages.



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# NRG's Winter Preparations Worked

- Pre-winter: NRG built up on-site liquid fuel and coal supplies.
  - Participated in New England's fuel supply program. Out-of-market intervention, but it worked!
- Plant Operations were stressed as cold weather operations persisted into multiple weeks:
  - Employees from less affected areas were sent East.
  - Senior Plant Operations were deployed on-site during cold snap.
  - Plants implemented "Conservative Operation & Maintenance Alerts."
- Liquid fuel deliveries were usually limited by availability of trucking:
  - Sought emergency waivers of trucking regulations to allow additional liquid fuel deliveries.
  - Out-of-town truck drivers were positioned close to delivery points.
- Worked with IMMs and ISOs to implement opportunity cost bidding to preserve scarce liquid fuel supplies.
- Grant of emergency waivers of price caps in PJM and NYISO:
  - May never be used, but preserved confidence in the market.

***Fleet-Wide Comprehensive Response Contributed to Reliable Operations***



# Cold Weather Observations: Natural Gas

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- NRG successfully delivered 17 BCF of gas in January 2014.
- In constrained areas, NRG typically transports on firm contracts or buys firm delivered gas from third parties.
- Outages occurred at several facilities when gas was unavailable:
  - Chicago area experienced intermittent curtailments.
  - Some firm transportation curtailments.
  - Limited derates occurred in NYC as well.
- In California, poor coordination between ISO and Pipelines resulted in units with supply being shuttered during critical periods.

Agents	History	Formulas	Live Only							
	Strip	+ -	Sell	Qty	Bid	Offer	Qty	Buy	Hig	
Cal 15		+	Hit	2500	4.130	4.140	2500	Lift	4.1	
Cal 16		+	Hit	2500	4.120	4.137	2500	Lift	4.1	
Cal 17		+	Hit	2500	4.150	4.170	2500	Lift		
Cal 18		+	Hit	2500	4.175	4.210	2500	Lift		
Cal 19		+	Hit	2500	4.230	4.300	2500	Lift		
Cal 20			Hit	2500	4.390					
Next Day Gas		+	Hit	10000	4.5800	4.6075	8000	Lift	4.65	
Next Day Gas		+	Hit	9600	4.4400	4.4900	5000	Lift	4.50	
Next Day Gas		+	Hit	9300	6.8100	6.9000	10000	Lift	7.00	
Next Day Gas		+	Hit	5000	77.0000	89.0000	2500	Lift	88.00	
Next Day Gas		+	Hit	200	118.0000	123.5000	1900		125.00	
Same Day		+	Hit	2000	25.0000	30.0000	2000			
Next Day Gas		+	Hit	2500	107.0000	124.7500	4000		125.00	
Next Day Gas		+	Hit	5000	4.3200	4.3750	5000	Lift	4.40	
Next Day Gas		+	Hit	10000	4.4700	4.5300	10000	Lift		
Next Day Gas		+	Hit			4.6600	20000	Lift	4.55	
Next Day Gas		+	Hit	1000	5.0100	5.0600	18000		5.20	
Next Day Gas		+	Hit	10000	4.5000	5.1200	5000		5.15	
Next Day Gas		+	Hit	100	85.2500	88.0000	5000		88.00	
02 14		+	Hit	2500	4.156	4.162	2500	Lift	4.16	
03 14		+	Hit	2500	4.190	4.199	2500	Lift	4.20	
04 14		+	Hit	2500	4.256	4.265	2500	Lift		
01 15		+	Hit	2500	4.366	4.381	2500	Lift		
02 15		+	Hit	2500	3.994	4.024	2500	Lift		
03 15		+	Hit	2500	4.012	4.055	2500	Lift		
04 15		+	Hit	2500	4.098	4.144	2500	Lift		
01 16		+	Hit	2500	4.257	4.314	2500	Lift		
Feb14/Mar14		+	Hit	2500	0.069	0.071	52500	Lift	0.07	
Mar14/Apr14		+	Hit	2500	0.184	0.185	2500	Lift	0.19	
Apr14/May14		+	Hit	2500	0.015	0.017	10000	Lift	0.016	
May14/Jun14		+	Hit	2500	-0.021	-0.020	2500	Lift	-0.02	
Jun14/Jul14		+	Hit	2500	-0.055	-0.052	10000	Lift	-0.05	
Jul14/Aug14		+	Hit	2500	-0.027	-0.025	2500	Lift	-0.02	
Aug14/Sep14		+	Hit	2500	-0.019	-0.017	2500	Lift	-0.01	

\* ICE screenshot - January 21, 2014 at 10:11 am, showing Transco Zone 6 (non-NY) trading with a \$118 - \$125 bid-ask spread.



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# Cold Weather Observations: Oil & Other Liquid Fuels

## ***Critical to Keeping the Lights on in Winter 2014:***

- Burned over 1.1 million barrels of liquid fuel in January 2014.
  - Compared to ~800,000 barrels in all of 2013.
  - From February 26<sup>th</sup> through March 6<sup>th</sup> NRG delivered 31 trucks of ULS Kerosene to the Connecticut facilities.
- Collectively referring to ULSD, No. 2, No. 6 and kerosene.
- Infrastructure for delivery of liquid fuel is limited.
  - Barges diverted to other uses;
  - Limited trucking capacity and availability of drivers;
    - Also affected delivery of other critical supplies, such as ammonia.
  - Frozen rivers and lack of dredging hampers barge deliveries; and
  - Less power plant spec liquids in refining of U.S. domestic crude oil.

***Oil was priced out of the market as a power plant fuel in the 2000s, and the infrastructure is gradually fading away.***



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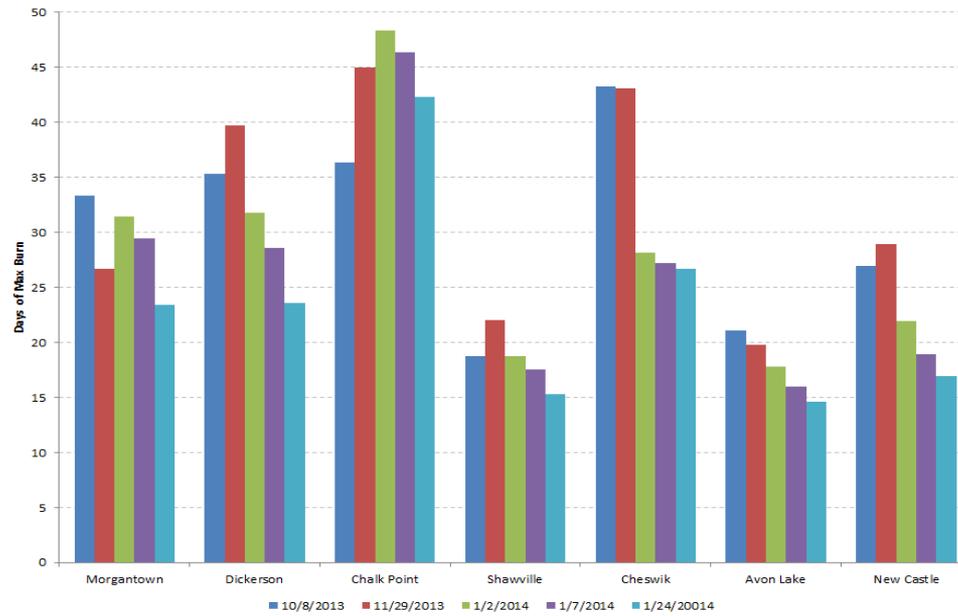
# Cold Weather Observations: Oil & Other Liquid Fuels (Cont'd)

## ***Future is Grim for Oil-Fired Units:***

- ISO-NE “Performance Incentives” program is the death knell for many oil-fired steam units.
- “Carrying costs” of oil is extremely high.
  - Difficult to predict necessary inventory levels. Utilization of oil-fired capacity is typically extremely high or extremely low.
  - ISO-NE fuel inventory program worked, but created market distortions.
  - Need market mechanism to allow cost recovery.
  - NRG’s Bowline facility burned circa 2007 oil this winter.
- Not all dual-fuel units are created equal:
  - Modern combined cycles typically have less oil storage capacity than oil-fired steam units.
  - Existing dual-fuel and oil-fired units are often permitted to burn liquid fuels in many more hours than newly permitted units.

# Cold Weather Observations: Coal

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\*Source Fuelworx



	Road/River Closures	Longer Cycle/Transit Time	Longer Unloading Time	Crew and Fuel Handling Manpower
By Delivery Mode				
Railroad		X	X	X
River	X	X	X	X
Truck	X	X	X	X

- **Railroad Impacts:** Extreme cold results in shorter trains and slower speeds driven by the locomotive's inability to maintain pressure in the air brakes.
- **River Impacts:** Ice creates safety hazards for unloading barges and sustained cold closes operations (as was experienced on the Allegheny River). When the ice melts the river rises and currents are too swift, further hampering deliveries.
- **Truck Impacts:** Road closures and equipment breakdowns result in reduced delivery days and longer transit time.
- **Plant Impacts:** Frozen coal and frozen switches lengthen unloading hours and fuel handling crews faced challenges being outdoors for long periods of time dumping coal.

Going into Arctic Cold event, most of the plants still maintained 15-20 days of inventory

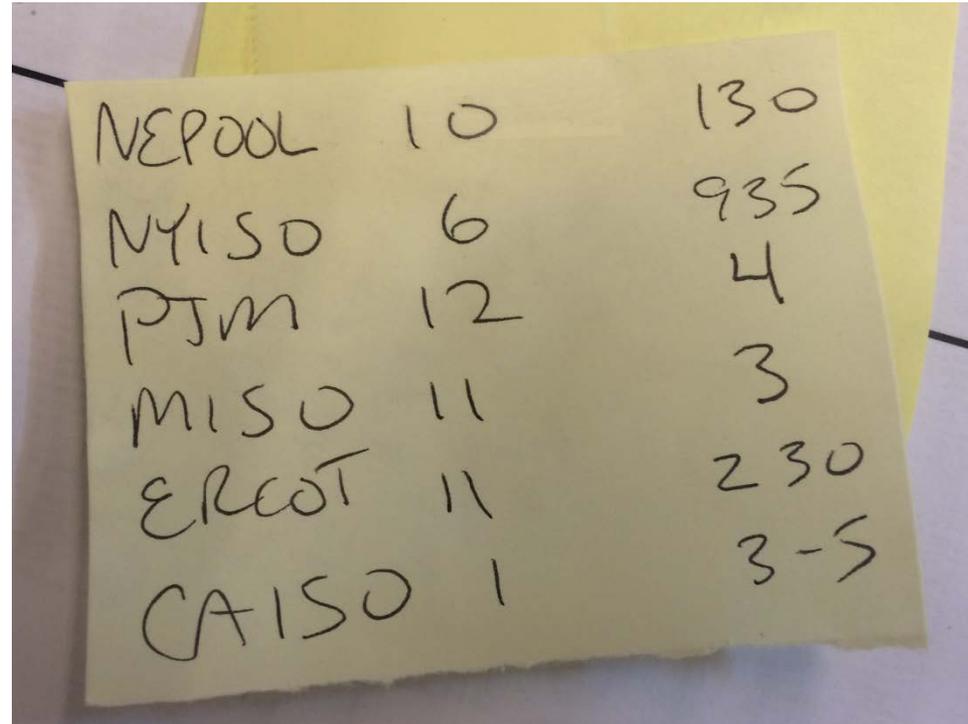
# Recommendation #1: Intraday Bidding & Fuel Switching

- Hourly bidding should be the gold standard.
  - Allow generators to reflect up-to-date cost data.
  - New England expects to have hourly bidding in place by December 2014.
- Intra-day Fuel Switching
  - Allow units to switch from gas to liquid fuel, or vice-versa.
- CAISO is an example of what not to do:
  - CAISO uses 2-4 day old prices.
    - Generators commitment cost bids are capped at the ISO's stale calculation Start-Up and Minimum Load Costs?
    - Recent waiver only addressed a limited set of problems.
  - When gas prices doubled overnight, massive number of generators were dispatched to their minimum load based on out-of-date gas prices.
  - Inefficient pricing created operational problems on the gas system.



# Recommendation #2: Timing, Timing, Timing...

- Generators need to know both Price & Quantity when they place their Day-Ahead offers.
- Electric day should sync with the natural gas day to a greater extent.
- We recommend:
  - Make Day-Ahead Market bids due at 9:30 am.
  - Ensure Day-Ahead Market results released no later than 12:30 pm.
- Fixed-price trades generally start between 9 and 10 am.
- Liquidity at 12:30 is better than liquidity at 4.
- First Timely Cycle needs to be moved to 2 pm EST.



NEPOOL	10	130
NYISO	6	935
PJM	12	4
MISO	11	3
ERCOT	11	230
CAISO	1	3-5

\* Current Day-Ahead Market offer times and when results are released, by market

# Recommendation #3: Split Weekend Packages

- Natural gas trades on Friday for Saturday, Sunday and Monday (and Tuesday on long weekends).
  - Single price, even though the value of Monday gas is far higher.
- Solution: Require separate indexes for Sat/Sun and Monday packages:
  - Each would trade on Friday.
  - Ensures that prices reflect higher load on Monday and lower loads over the weekend.

*Where ICE and Gas Daily go, so goes the industry.*



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# Additional Lesson: Pipeline & ISO Communications Must Involve Generators

- Experienced two ISO/Pipeline communication problems:
  - December event:
    - Conflicting information from CAISO and pipeline companies with regards to adequacy of gas supply and pipeline pressures led to NRG units being curtailed when adequate gas had been procured.
    - Units were then ordered back online late in the day (after supply was sold off to manage imbalance).
  - February event:
    - Pipeline ordered units operating at Pmax to come offline immediately.
    - CAISO bidding rules do not allow updates to reflect this type of event.
- NRG was not included in the decision tree either time.
  - This was a new experience for us, raises the importance of ensuring three-party communications.



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# Pulling it All Together: A Real-Life CAISO Example

- SoCalGas issued curtailment notice on the afternoon of December 6, 2013:
  - DA market results for Saturday had just published
  - Threatened penalties of up to \$100 for un-nominated gas burns (all \$/MMBtu)
  - Weekend gas index price: \$4.67 (SoCal Citygate)
  - NRG paid over \$8.00 for intra-day gas purchases to support same-day Exceptional Dispatches.
    - ***This alone illustrates the problems with the inability to adjust bids!***
- Erratic Dispatch Made Things Worse:
  - Despite NRG having secured adequate gas supply to meet DA awards, CAISO ordered El Segundo units offline, citing operational concerns from SoCal Gas.
  - As a result, on Monday (12/9), NRG disposed of some of its “unneeded” gas (acquired at up to \$8, disposed of between \$5.50 - \$5.80).
  - The ISO ordered the units online again that afternoon.
    - ***Multiple trades of gas taking place at between \$5-8 (next day gas traded at \$7.64), but the market still priced off of a \$4.67 index price!***



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# Response to (Half of) Commissioner Moeller's Supplemental Question

## Announced Deactivations or Possible Deactivations:

Plant	Size	Status	Reason
Chalk Point, Units 1 & 2 (PJM - SWMAAC)	667 MW	Coal	Market & potential MD environmental rules.  Station is fully MATS compliant.
Dickerson, Units 1-3 (PJM – SWMAAC)	537 MW	Coal	Market & potential MD environmental rules.  Station is fully MATS compliant.
Gilbert (PJM – EMAAC)	536 MW	Gas, Partial Deactivation of 98 MW	New Jersey High Energy Demand Days
Glen Gardner (PJM – EMAAC)	160 MW	Gas	New Jersey High Energy Demand Days
Portland (PJM – MAAC)	158 MW	Coal	Settlement with NJ EPA & MATS
Shawville (PJM – MAAC)	597 MW*	Coal	MATS  *Long-term protective layup
Werner (PJM – EMAAC)	212 MW	Oil	New Jersey High Energy Demand Days

## Addition of Natural gas:

Avon Lake (PJM - ATSI)	732 MW	Coal → Adding to Gas	Market & MATS
Dunkirk (New York - ROS)	475 MW*	Coal → Adding to Gas	Market. Station is fully MATS compliant  *Only 75 MW currently active
New Castle (PJM – ATSI)	325 MW	Coal → Adding to Gas	Market & MATS