



Scenario Analysis Natural Gas Risk Study

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Operations

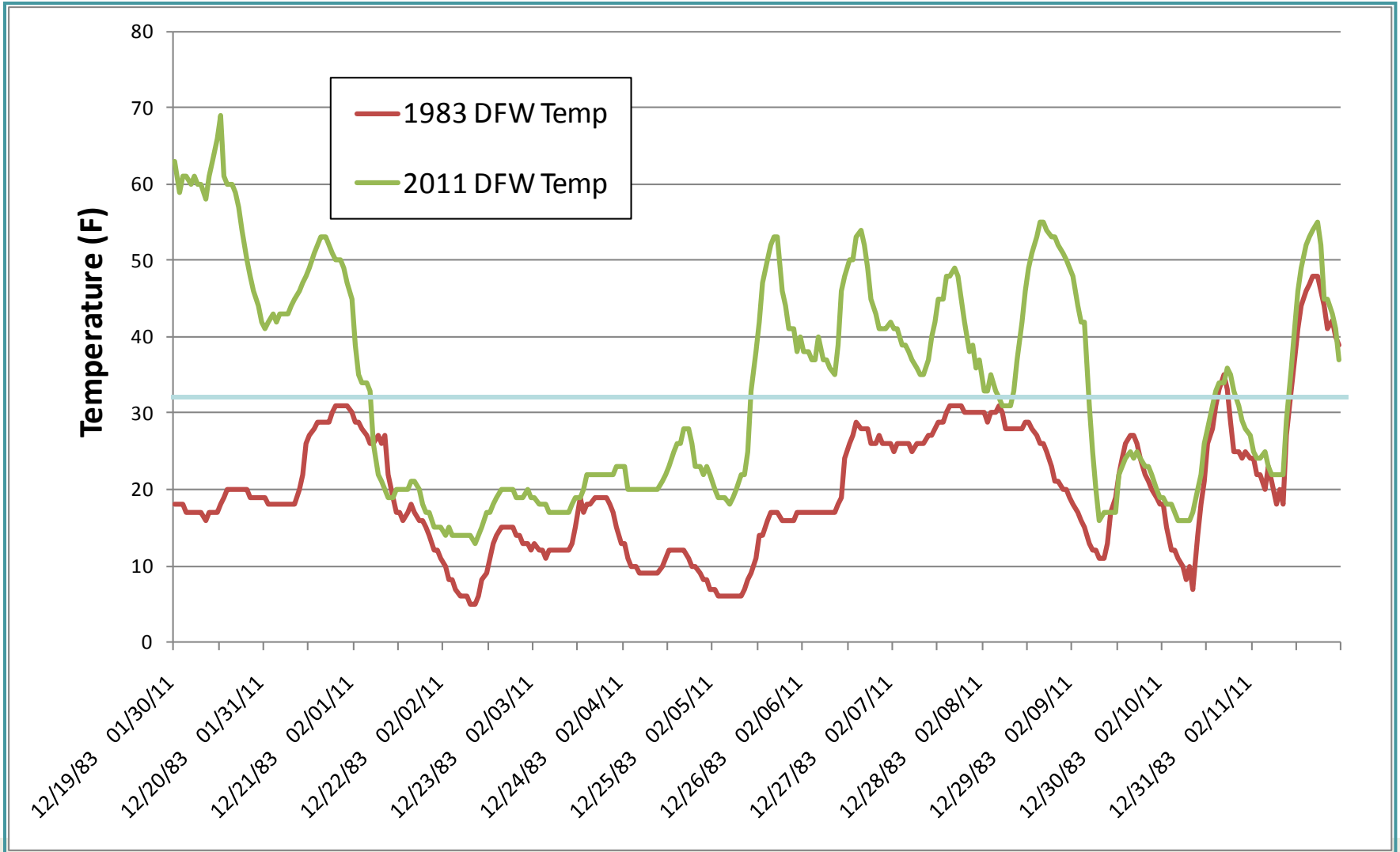
Board of Directors Meeting
April 16-17, 2012

ERCOT Public

- **Board members requested a follow-up to the Black and Veatch (B&V) Gas Curtailment Risk study to look at an extreme scenario of multiple consecutive days of low temperatures to determine at what point there might be a need to shed load.**
- **B&V evaluated how the existing gas supply and pipeline system in ERCOT might perform under weather conditions experienced in December 1983, an extended period of low temperatures.**
- **ERCOT Staff used that information along with projections of load and generation availability with the existing 2012 system under the 1983 weather conditions to determine load shed possibilities.**

Temperatures 1983 Versus 2011

1983 estimated to be a 1 in 50 year event; 2011 a 1 in 20 year event



- **Develop a model for generator Forced Outage Rates (FORs) for reasons other than fuel availability during severe cold weather.**
- **Calculate FORs on existing system using 1983 weather.**
- **Convert natural gas curtailment data from Black and Veatch to hourly megawatts curtailed.**
- **Calculate expected generation capacity available during period with 2012 system, modeled FORs and gas curtailments and historical planned outages.**
- **Calculate Load not Served (Load Shed).**

- **Generator forced outages caused by equipment freezing (sensors, controls, pipes, etc).**
- **Natural Gas Curtailments caused by freezing / condensation of equipment, bottlenecks in delivery system due to increased demand.**
- **Almost all generator outages in February 2011 event caused by generator issues and not fuel curtailments.**

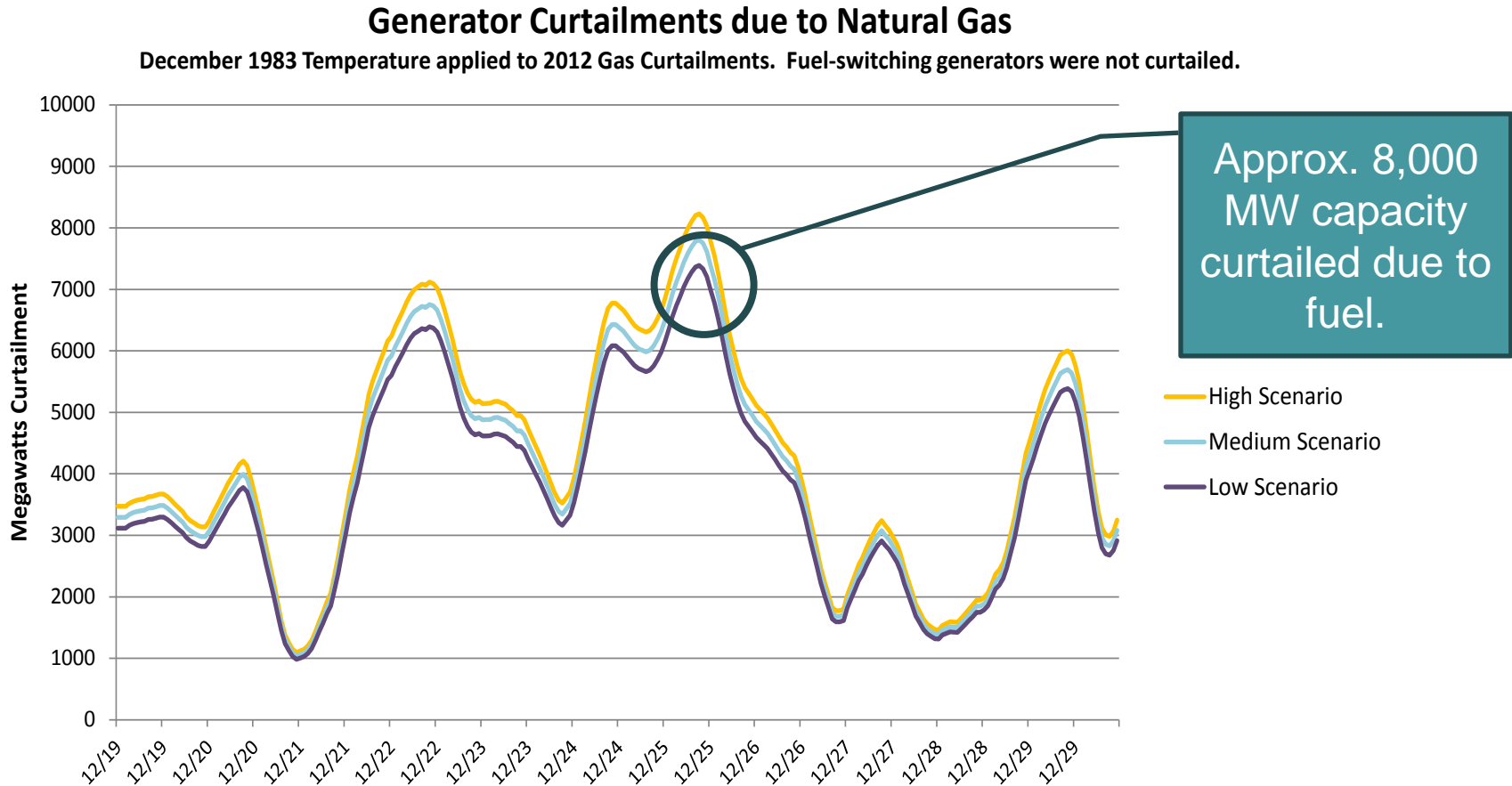
Scenario Development

- **Gas curtailments and generator FORs were varied to develop Low, Med., High scenarios.**
- **Load and wind forecasts were not varied.**
 - Decided to use extreme low temperature (1983) scenario

Scenario	N.G. Curtailments (estimated by B&V)	Generator FORs (estimated by ERCOT)
Low	Low estimate	Low estimate
Medium	Expected	Expected
High	High estimate	High estimate

Study Assumptions -- Natural Gas Curtailments

- **ERCOT converted daily MMBtu curtailment data supplied by Black & Veatch to hourly megawatt values**



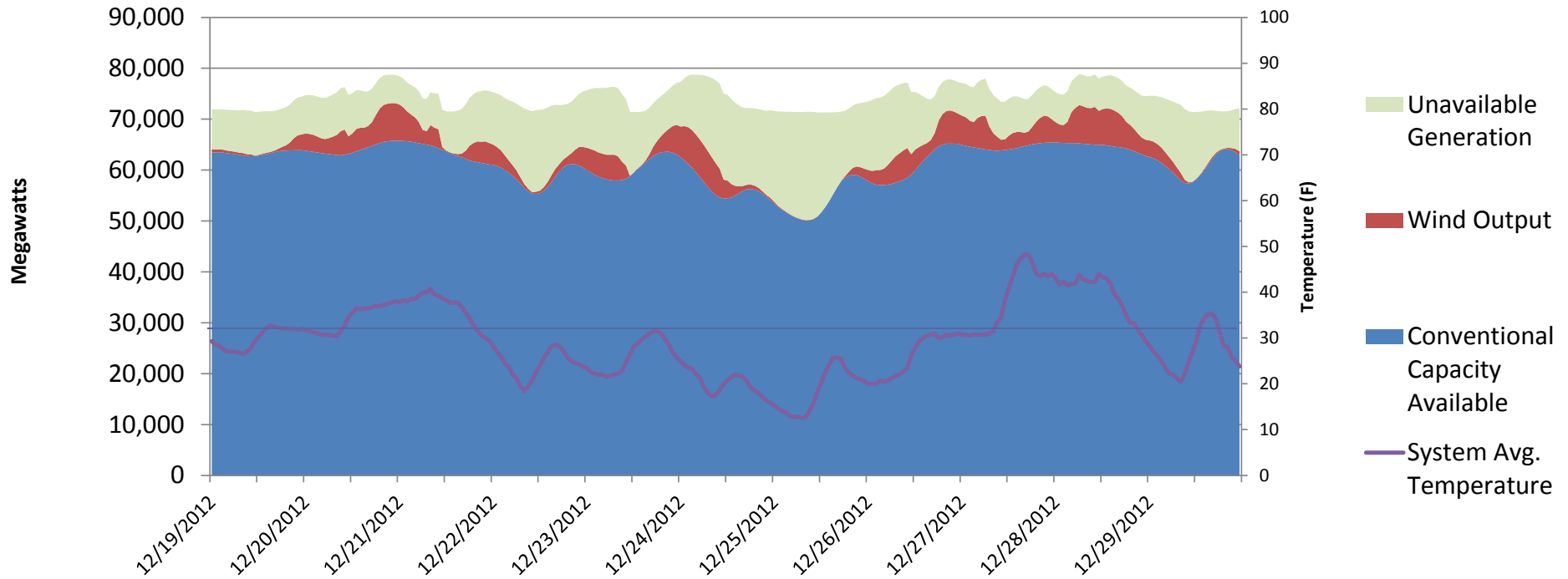
Study Assumptions -- Generator Forced Outage Model

- **Linearly relates Forced Outage Rates to drops in temperature.**
- **Model based on 2011 outages and tended to overstate outages during 2010 and 1989 freezes.**
- **Weatherization practices have improved since 2011.**
 - Improvements estimated from recent surveys / audits.
 - High, Medium, Low scenarios estimated based on information from surveys.

Scenario	Estimated 13°F FOR
Base Weatherization (representative of 2011)	39%
Improved Weatherization – High Scenario	29%
Improved Weatherization – Medium Scenario	23%
Improved Weatherization – Low Scenario	17%

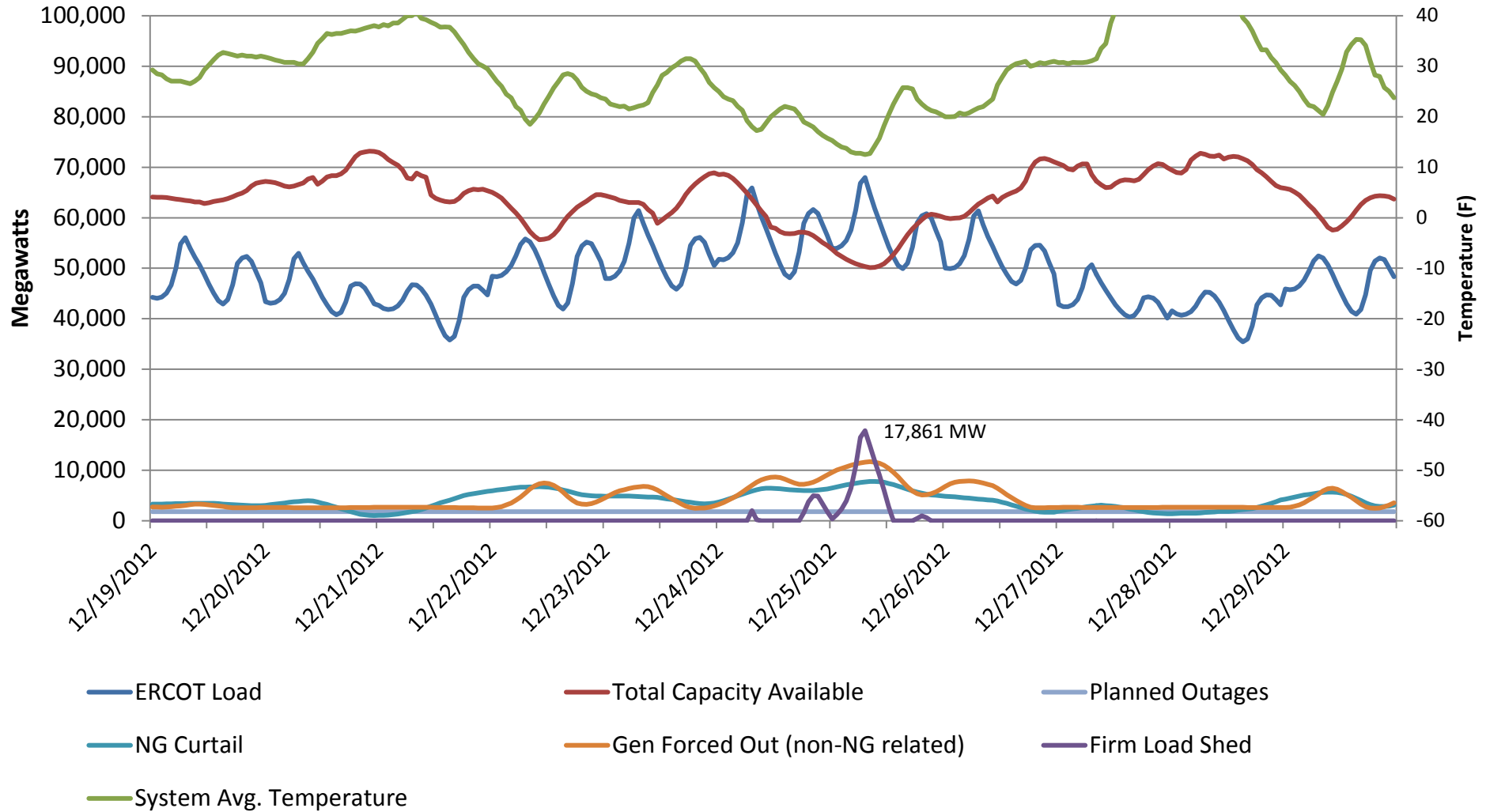
Study Results (Medium Scenario)

Resource Capacity



“Unavailable generation” includes both generator failures and N.G. curtailments. Private Use Network generation and load were excluded from this study.

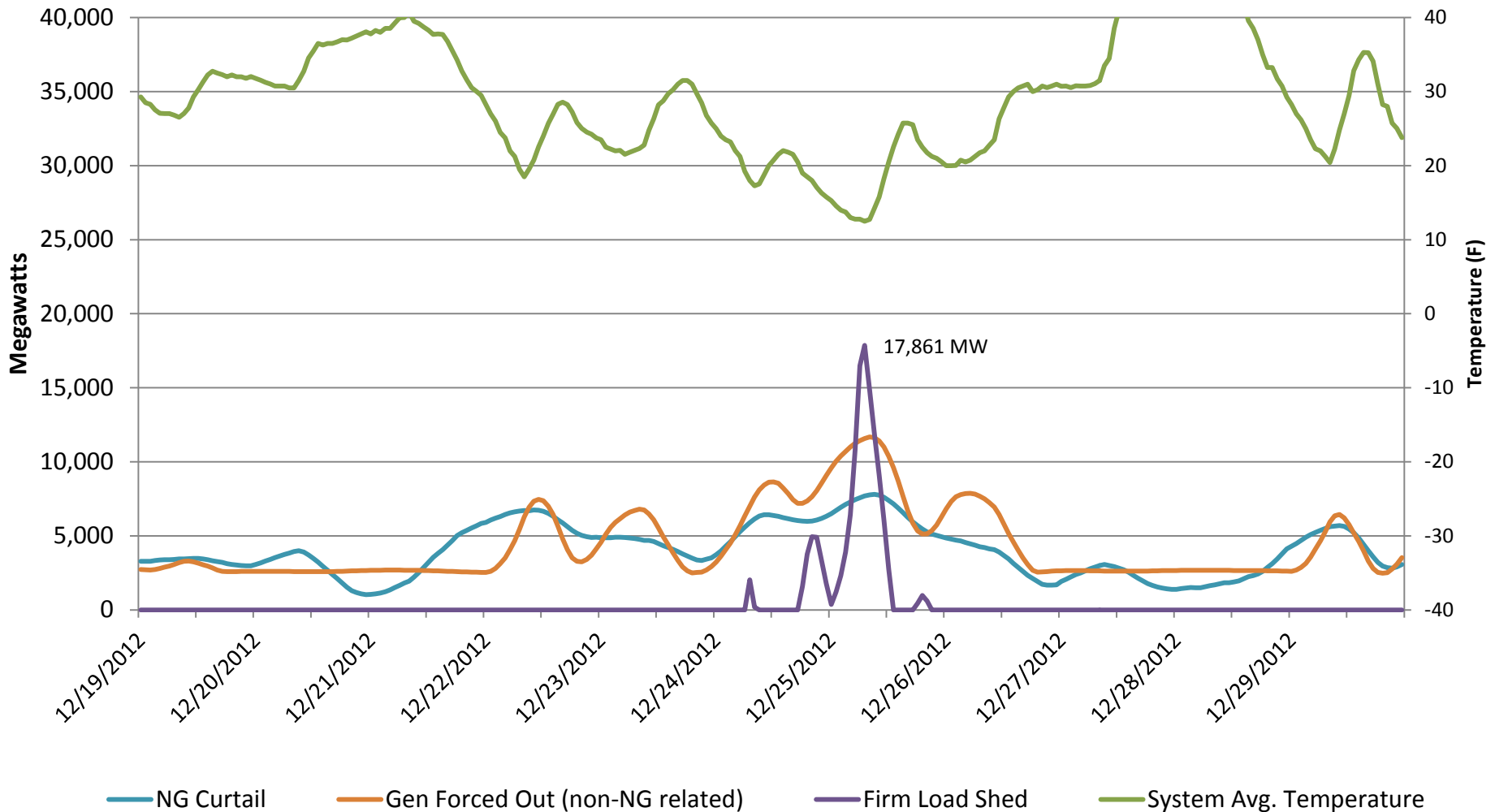
Study Results (Medium Scenario)



Firm load shedding occurs after depleting Load Resources (1150 MW) and EILS (400 MW).

Study Results (Medium Scenario)

Zoom-In



Firm load shedding occurs after depleting Load Resources (1150 MW) and EILS (400 MW).
 Planned Generation Outages (not shown) is estimated constant 1,827 MW.

Discussion of Results

- **Scenario based on an estimated 1 in 50 year event.**
- **Shows system could handle a period of 5 consecutive days with average temperatures hovering around freezing without load shed.**
- **Overall results are generally conservative (i.e. probably overstate possible load shed).**
 - Load forecast assumes no load reduction due to transmission or distribution outages because of icing, wind or overloads or price response.
 - Assumes low wind generation based on 1983 actual winds.
 - Mitigation measures for natural gas curtailment not considered in B&V model (e.g. storage, price response).
 - 2012 system has installed generation reserves close to 13.75% minimum target.

- **Forced outages due to non-fuel related causes expected to be a bigger factor and are more readily mitigated than fuel related outages.**
- **Low installed reserve margins and possible continued drought effects are more immediate concerns. In the short term, focusing on these issues is expected to provide greater reliability benefits than focusing on freezing conditions.**
- **Increased reserve margins will also reduce the impact of freezing conditions.**
- **If natural gas becomes a significantly increased part of fuel mix due to economic and environmental factors, this should be looked at again in 3-5 years.**