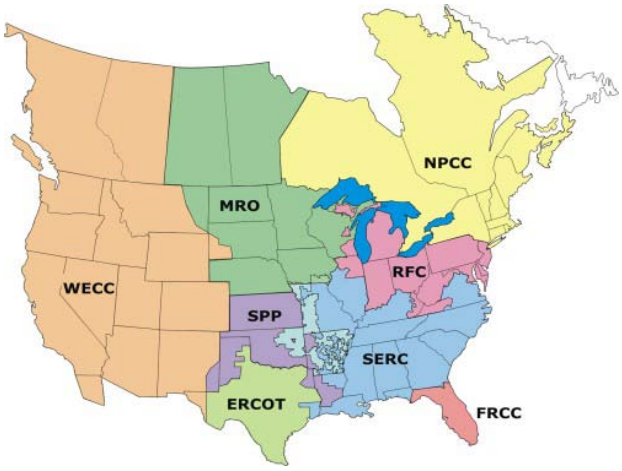
NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

2008-2017 NERC Capacity Margins:
Retrofit of Once-Through Cooling Systems at Existing Generating Facilities

Background

The North American Electric Reliability Corporation's (NERC) mission is to ensure the bulk power system in North America is reliable. To achieve this objective, NERC develops and enforces reliability standards; monitors the bulk power system; assesses and reports on future adequacy; evaluates owners, operators, and users for reliability preparedness; and offers education and certification programs to industry personnel. NERC is a non-profit, self-regulatory organization that relies on the diverse and collective expertise of industry participants that form its various committees and sub-committees. It is subject to oversight by governmental authorities in Canada and the United States (U.S.)[1]



ERCOT Electric Reliability Council of Texas	**RFC** Reliability*First* Corporation
FRCC Florida Reliability Coordinating Council	**SERC** SERC Reliability Corporation
MRO Midwest Reliability Organization	**SPP** Southwest Power Pool, Incorporated
NPCC Northeast Power Coordinating Council, Inc.	**WECC** Western Electricity Coordinating Council

NERC assesses and reports on the reliability and adequacy of the North American bulk power system divided into the eight regional areas. The users, owners, and operators of the bulk power system within these areas account for virtually all the electricity supplied in the U.S., Canada and a portion of Baja California, Mexico.

[1] On June 18, 2007, the U.S. Federal Energy Regulatory Commission (FERC) granted NERC the legal authority to enforce reliability standards with all U.S. owners, operators, and users of the bulk power system, and made compliance with those standards mandatory NERC has similar authority in Ontario and New Brunswick, and is seeking to extend that authority to the other Canadian provinces. NERC will seek recognition in Mexico once the necessary legislation is adopted.

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NERC's primary role in providing reliability assessment is to identify areas of concern to the reliability of the North American bulk power system and to make recommendations for their remedy. NERC cannot order construction of additional generation or transmission or adopt enforceable standards having that effect, as that authority is explicitly withheld by Section 215 of the U.S. Energy Policy Act of 2005[2]. In addition, NERC does not make any projections or draw any conclusions regarding expected electricity prices or the efficiency of electricity markets. The enclosed Special Reliability Assessment provides a high-level view of future resource adequacy.

Special Reliability Assessment[3]

Upon a request from the U.S. Department of Energy's (DOE) Offices of both "Electricity and Energy Reliability" and "Fossil Energy," NERC measured the affects on capacity margins resulting from retrofitting existing plants with open-loop cooling systems to closed-loop systems, or retiring them. This special reliability assessment is part of DOE's response to the U.S. Senate Subcommittee on Energy and Water Appropriation's request to identify the impacts of EPA's rulemaking on Section 316b of the Clean Water Act.

Approach - Preliminary 2008-2017 Long-Term Reliability Assessment data was used (*Reference Case*). The data includes U.S. summer peak demand and capacity. Though this data is subject to change, NERC does not believe any future data enhancements will materially change the assessment results. Specific unit information was received from the U.S. Department of Energy, and EPA Section 316b permitting dates were received from the Edison Electric Institute (EEI), providing the year a decision is required.

Capacity Resources & Margins

Net Internal Demand (MW) — Total Internal Demand reduced by dispatchable controllable (capacity) demand response.

Total Internal Capacity — The Sum of Existing (both Certain and Uncertain) and Planned Capacity.

Existing Capacity
a) Certain — Existing capacity resources reasonably anticipated to be available and operate and that are deliverable to or into the region.
b) Uncertain — Includes mothballed generation and portions of variable generation not included in "Certain"

Planned Capacity — Capacity resources expected to be available for the 2008-2017 Summer peak conditions that have achieved one or more of the following milestones:
a) Construction has started
b) Regulatory permits approved
c) Approved by corporate or appropriate senior management

Proposed Capacity — Capacity resources not listed in the prior categories, but has been identified through one or more of the following sources:
a) Corporate or appropriate senior management announcement
b) Included in integrated resource plan
c) Generator Interconnection Queues

Capacity Purchases and Sales – the following categories may be applied to existing and future capacity calculations.
a) Firm
b) Non-Firm
c) Expected
d) Provisional

Existing Capacity, Planned Capacity and Net Firm Transactions (MW) — Existing capacity resources reasonably anticipated to be available and operate and that are deliverable to or into the region plus net Firm Purchases/Sales.

Net Capacity Resources (MW) — Total Internal Capacity, less Transmission-Limited Resources, all Derates, Energy Only, and Inoperable resources; plus net Firm, Expected and Provisional Purchases/Sales. Net Capacity Resources do not include Non-Firm Purchases/Sales.

Adjusted Potential Resources (MW) — Net Capacity Resources, Existing Uncertain Resources less all Derates, Total Proposed Resources reduced (multiplied) by a confidence factor (percentage); plus Net Non-Firm and Provisional Transactions.

Net Capacity Resources Margin (%) — Net Capacity Resources reduced by the Net Internal Demand; shown as a percent of Net Capacity Resources.

Adjusted Potential Resources Margin (%) — Adjusted Potential Resources reduced by the Net Internal Demand; shown as a percent of Adjusted Potential Resources.

[2] http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_bills&docid=f:h6enr.txt.pdf
[3] This Special Reliability Assessment was approved by NERC's Board of Trustees on September 8, 2008

Reliability is measured by comparing Adjusted Potential Resource Margins between the summer peaks from the 2008-2017 Long-Term Reliability Assessment *Reference Cases* to a case with capacity changes resulting from EPA's Section 316b regulations.

Adjusted Potential Resources (MW) — Net Capacity Resources, Existing Uncertain Resources less all Derates, Total Proposed Resources reduced (multiplied) by a confidence factor (percentage); plus Net Non-Firm and Provisional Transactions.

Net Capacity Resources Margin (%) — Net Capacity Resources reduced by the Net Internal Demand; shown as a percent of Net Capacity Resources.

Adjusted Potential Resources Margin (%) — Adjusted Potential Resources reduced by the Net Internal Demand; shown as a percent of Adjusted Potential Resources.

Region/Sub-region Target Margin (%) — a suitable objective to maintain available capacity resources, determined largely by the type of generation that exists in the region.

NERC Reference Margin Level (%) — either the Target Capacity Margin provided by the region/sub-region or NERC assigned based on capacity mix (i.e. thermal/hydro)

Capacity margins are used to measure the need for additional resources and serves to measure the bulk power system's ability to supply the aggregate electric power and energy requirements of the electricity consumers, accounting for scheduled and reasonably expected unscheduled outages of system components. Capacity margins measure supply that could be available to cover random factors such as generating equipment force outages, demand forecast errors, weather extremes, and capacity service schedule slippage.

Capacity margin is calculated by reducing the peak capacity by peak demand and normalizing it by peak capacity. Capacity margins are expressed as percent and reference margins are calculated using the peak load and capacity of the *Reference Case*.

Assumptions – The following assumptions were used in this assessment:

Assumptions specified by DOE:

- Close-loop cooling systems will be added to all nuclear units.
- Capacity factors can be used as a proxy for economic suitability for retrofit
- Unit Retirements/Retrofits were based on capacity factors from 2006:
  - Units with a capacity factor less than 0.35 are assumed to be retired.
  - Units with a capacity factor greater than or equal to 0.35 were derated by 4 percent of maximum rated (nameplate) capacity.
  - 60 percent of retirements/retrofits was projected to begin in 2013, 20 percent in 2014 and 20 percent in 2015.
- Plants deemed "difficult to retrofit" due to geographical limitations (i.e. land-locked, space and permitting constraints) could result in early retirement.[4] This assessment does not assume their early retirement.
- No new plants are built to replace capacity lost to retired units or auxiliary loads.
- Retrofits are instantaneous, with no capacity short-falls due to plant shutdowns.

[4] Identifying plants that are "difficult to retrofit" would necessitate a site-specific survey of all plants with open-loop cooling systems. While this assessment does not provide site-specific analysis, some plants with capacity factors greater the 0.35 have been identified as "difficult to retrofit", such as, Eddystone #1 and #2, Fisk Street, Joliet 9 and 29, Crawford, and Will County.

- Plants with a zero capacity factor (inactive or not yet built) are not assessed. These plants are not included in the region's *Reference Case*.

Assumptions specified by NERC:

- The NERC Reference Margin Level adopted the regional/subregional Target Capacity Margin. If not available, the NERC Reference Margin Level is based on supply-side fuel: 13 percent for thermal systems and 9 percent for hydro.
- Unit Retirement/Retrofit capacity reduction comparison is based against "Adjusted Potential Resources", calculated with all Existing Capacity and probable Planned Additions, Proposed Additions, and Net Transactions.
- Units already expected to retire between 2010 and 2015 were not considered part of the capacity reduction as they are already factored into the region's projections.[5]

The difference in Adjusted Potential Resources margins represents the percent reduction a region would experience over the three-year retirement and retrofit time period, based on the previously stated assumptions. Reliability assessment is performed only for the U.S Adjusted Potential Resource Capacity Margins measuring the region's capacity margin against a pre-specified target margin. Falling below the NERC Reference Margin Level may indicate the need for more resources, which, if not acquired, might suggest a higher risk to bulk power system reliability.

NERC-US Impacts - Based on the aforementioned assumptions, NERC-US impacts were calculated. U.S. resource margins drop from 14.7 percent to 10.4 percent when both the retired units and auxiliary loads due to retrofitting were compared to the *Reference Case* (see Figure 1).

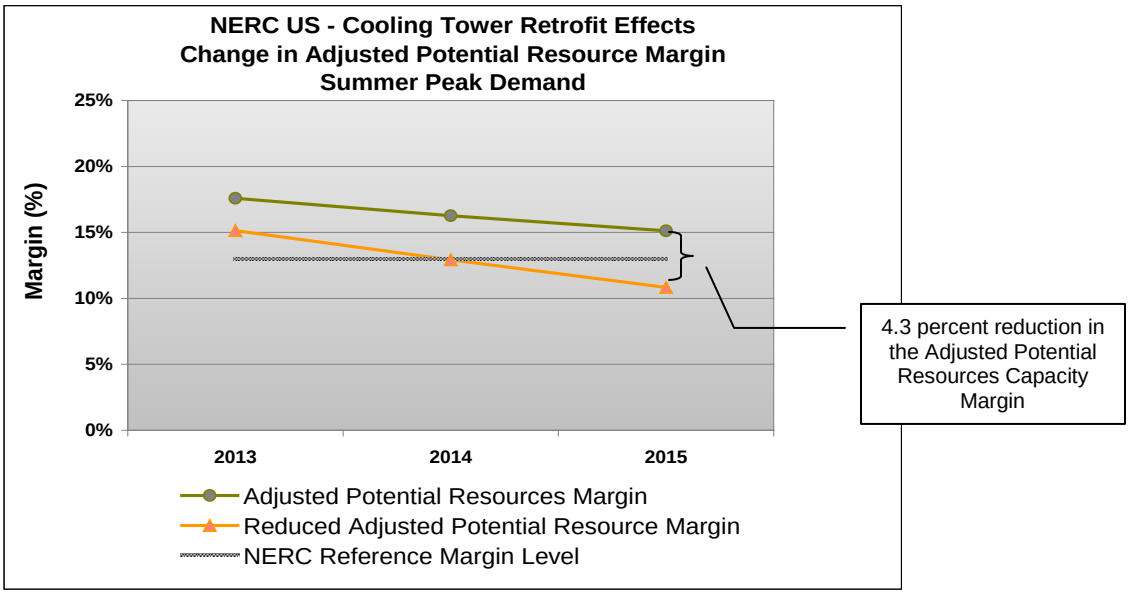

Figure 1: NERC-US Summer Capacity Margin

[5] Plants expected to retire during this time frame with open-loop cooling systems represent a total capacity reduction of 9,500 MW.

NERC-US Regional/Subregional Impacts - Capacity resources for NERC regions are each impacted differently, depending on the vintage and design of their units. In Figure 3, the impact on summer peak capacity margins of retirements and retrofitting are provided.

A significant finding is the capacity reductions due to auxiliary loads and parasitic losses caused by equipment retrofitting is about 9,300 MW. Approximately 39,500 MW of the capacity resources are eliminated by unit retirements (see Figure 2). This 49,000 MW total capacity reduction in resources could reduce NERC-US capacity margins by 4.3 percent.

As a percent of the Adjusted Potential Resources margin, WECC-CA-MX US, ERCOT, NPCC-US, and the SERC-Delta sub-region see the largest impact as most units would be retired due to the low capacity factors units.

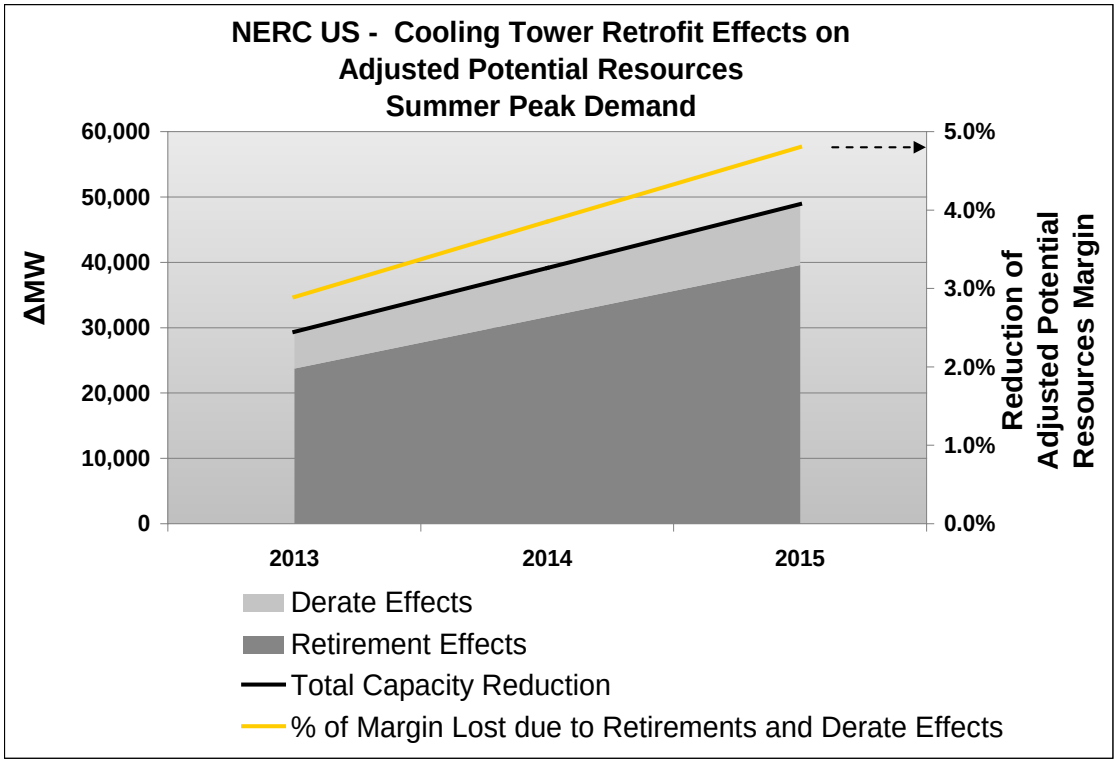

Figure 2: NERC-US Cooling Tower Effects

Table 1 provides a listing of regions/sub-regions whose capacity margins are impacted by plant retirements and retrofits. Note the capacity factor data provided by the U.S. Department of Energy was based on 2006 performance, where natural gas prices were increasing. Natural gas prices can drive capacity factors for gas-fired units and, therefore, many regions with a predominance of natural gas plants see more capacity margin reduction from plant retirements than those regions

with plants fired by other fuels experiencing a 4 percent reduction in capacity to support auxiliary demand supporting retrofit equipment.

Table 1: 2015 US Summer Peak Retrofit/Retirement Effects

	Adjusted Potential Resources (MW)	Reduction due to Retirement (MW)	Derate due to Retrofit (MW)	NERC Reference Margin Level	Adjusted Potential Resources Margin	Margin Reduction	Reduced Margin
United States							
WECC - CA-MX US†	72,293	10,137	289	13.2%	12.7%	14.7%	-2.0%
NPCC - New England	31,673	2,827	428	13.0%	10.0%	10.3%	-0.3%
ERCOT	86,436	10,919	542	11.1%	15.9%	12.9%	3.0%
NPCC US	72,750	6,481	990	13.0%	13.3%	9.9%	3.4%
WECC US†	176,944	10,177	314	12.3%	11.1%	5.6%	5.5%
NPCC - New York	41,077	3,654	561	13.0%	15.9%	9.6%	6.3%
SERC - VACAR	78,182	553	1,032	13.0%	11.0%	1.8%	9.2%
WECC - RMPA†	15,609	40	0	10.5%	10.2%	0.2%	10.0%
SERC - Central	54,548	0	949	13.0%	12.6%	1.5%	11.0%
SERC - Delta	41,259	4,266	466	13.0%	21.5%	10.2%	11.4%
RFC	230,062	3,339	2,863	12.8%	14.5%	2.4%	12.1%
SERC	269,599	6,054	3,307	13.0%	15.6%	3.0%	12.5%
SERC - Southeastern	66,675	675	357	13.0%	13.9%	1.4%	12.6%
MRO US	55,582	529	612	13.0%	15.1%	1.8%	13.3%
FRCC	63,170	1,267	454	13.0%	18.7%	2.3%	16.4%
WECC - NWPP†	51,861	0	25	11.9%	16.9%	0.0%	16.8%
SPP	63,700	817	257	12.0%	24.1%	1.3%	22.8%
SERC - Gateway	28,935	560	502	13.0%	28.8%	2.7%	26.1%
Total-NERC US	**1,018,243**	**39,583**	**9,339**	**13.0%**	**14.7%**	**4.3%**	**10.4%**

The WECC-CA US sub-region sees the largest impact with a reduction of almost 15 percent (10,400 MW), significantly reducing their summer peak capacity margin. NPCC-New England also experiences a significant impact of 10.3 percent. This impact may be the result of the abundant gas-fire plants which have low capacity factors in this assessment indicating a retrofit would not be economically suitable.

ERCOT faces the most substantial impact at the regional level. Retirement and retrofit effects may result in a loss of up to 11,500 MW, reducing their margins almost 13 percent.

Some regions starting above the NERC Reference Margin Level in the *Reference Case* fall below as a direct result of this analysis: ERCOT, RFC, and SERC. These regions may require additional resources to accommodate the potential retirements/retrofits from the Section 316b Phase II action.

† Adjusted Potential Resource Margins are subject to change, as updated capacity information is expected.

Similarly, the full region of SERC shows a total capacity reduction of about 9,300 MW, most coming from the SERC-Delta (South-Central U.S.) sub-region. However, the impact on the Adjusted Potential Resources capacity margin is only 3 percent due to its overall large demand and capacity base line in the *Reference Case* for the region.

Transmission Reliability Impacts - Though NERC did not perform detailed analysis of the transmission impacts resulting from the loss of capacity, it is expected that the volatility and predictability of intra-regional and inter-regional transmission limits could change. For example, NPCC-US experiences a potential reduction of up to 10 percent of their capacity margin due to unit retirements and auxiliary loads (7,500 MW) while RFC experiences a reduction of less than 3 percent (6,200 MW). System flows from West to East along the interface between RFC and NPCC-US already has shown congestion[6] and has been named a National Interest Electricity Transmission Corridor (NIETC).[7] One would expect that this capacity margin reduction could further aggravate the congestion on this corridor.

More transmission may also be needed to serve replacement supply or demand-side resources that will be added and ancillary services. Retired plants might be replaced by new resources, in which generation may be distant from the load (i.e. wind or other renewables). Detailed transmission system studies may be needed to measure reliability impacts and system reinforcement requirements resulting from specific capacity reductions.

Conclusion

NERC reviewed the impact of either retrofitting units with existing once-through-cooling systems to closed-loop cooling systems (4 percent reduction in nameplate capacity) or unit retirements (capacity factor less than 0.35) on NERC-US and regional capacity margins for 2008-2017. 60 percent of retirements/retrofits were projected to begin in 2013, 20 percent in 2014 and the remaining 20 percent in 2015. This was retirement/retrofit process was consistently performed in each sub-region.

Based on a worst case view, NERC-US Adjusted Potential Resources may be impacted up to 49,000 MW, reducing the Adjusted Potential Resource Margin by 4.3 percent and some areas may require more resources to offset capacity reductions and maintain the reliability of the bulk power system. Some sub-regions experience significant impacts such as California, New England, Texas, South-Central and New York. These regions/subregions may require additional resources to accommodate the potential retirements/retrofits from the Section 316b Phase II action.

Transmission congestion and reliability might be aggravated and detailed system transmission studies may be needed to determine bulk power system reliability resulting from the loss of the specific units studied.

[6] http://nietc.anl.gov/documents/docs/NIETC_MidAtlantic_Area_Corridor_Map.pdf
[7] http://www.oe.energy.gov/nietc.htm