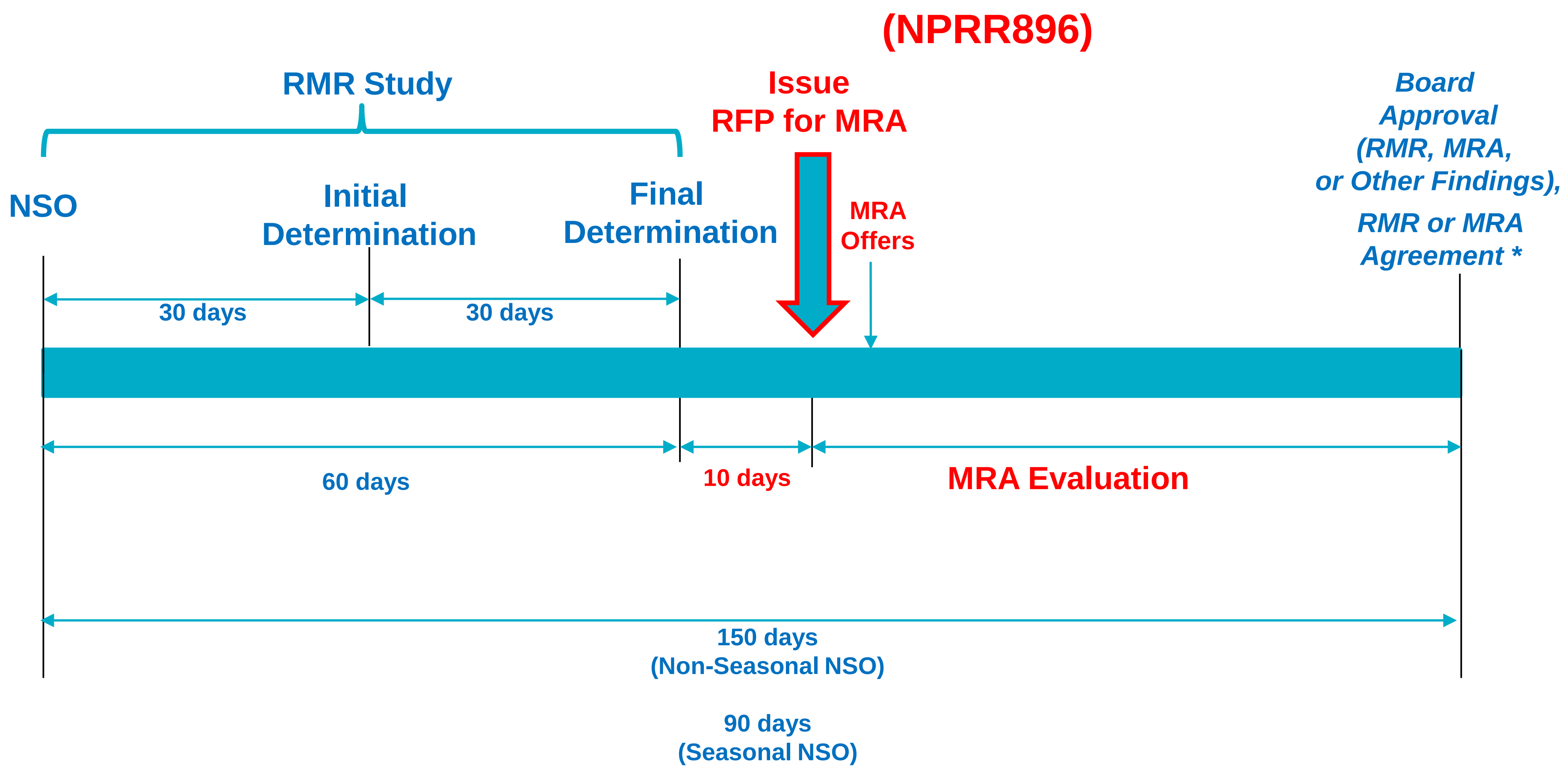
Outcome of RMR Determination, MRA Evaluation Process and Methodology - Transmission Planning in ERCOT

ERCOT Transmission Planning

November 16, 2018

Timeline of Overall Process



* Per ERCOT Nodal Protocol Section 3.14.1.2(9), the RMR or MRA agreement may be executed after the 150 or 90 days period.

Outcome of RMR Determination

- Within 60 days, ERCOT completes its reliability analysis and issues a market notice describing the results of its reliability analysis

- If it is determined that the proposed suspension of the Generation Resource would result in a performance deficiency (Criteria: Nodal Protocol Section 3.14.1.2), then within 10 days after the final assessment, ERCOT shall issue a Request for Proposals (RFP) for Must-Run Alternatives (MRAs).

- ERCOT shall include in the RFP reasonably available information that would enable potential MRAs to assess the feasibility of submitting a proposal

Key Information Available in RFP (NPRR896)

- ERCOT shall specify the following information in the RFP.
  - Expected number of hours that an MRA would be needed during the contract period, and the hours of the day, by season, that the MRA would be required to be available.
    - Study case and historical weather data will be used to estimate the information. More details are in the next slides
  - Shift factors associated with each bus where potential MRA would help relieve performance deficiency. Shift factors can be used for determining the approximate capacity of potential MRA Resources.
    - Study case will be used to calculate shift factors.

Methodology to Estimate Hours, Days, and Seasons

- Suppose that an RMR study was done using a summer peak case and identified criteria violations.

  - Step 1

    RMR Study Case(s) → Estimate critical load level with no criteria violations

    i. Reduce the load in the area of concern until there is no criteria violation to identify a load level with no criteria violations.
    ii. Suppose it is found that the critical load level without any criteria violations is 24,362 MW for the study area.

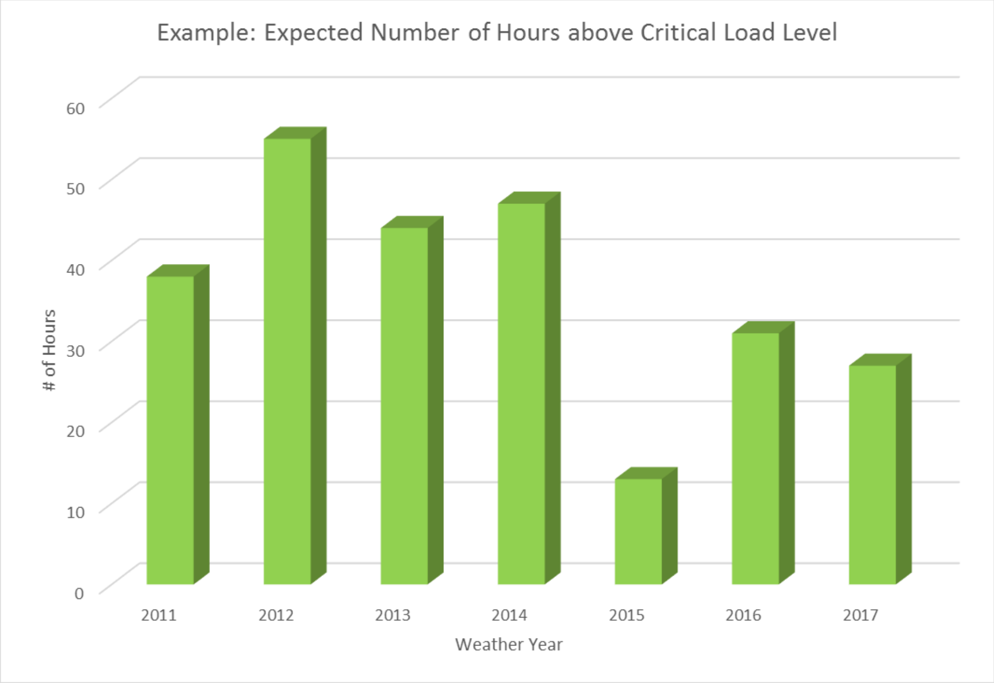
  - Step 2

    Load Forecast (Historical Weather Data) → Estimate when and how long the critical load level would appear during the study year

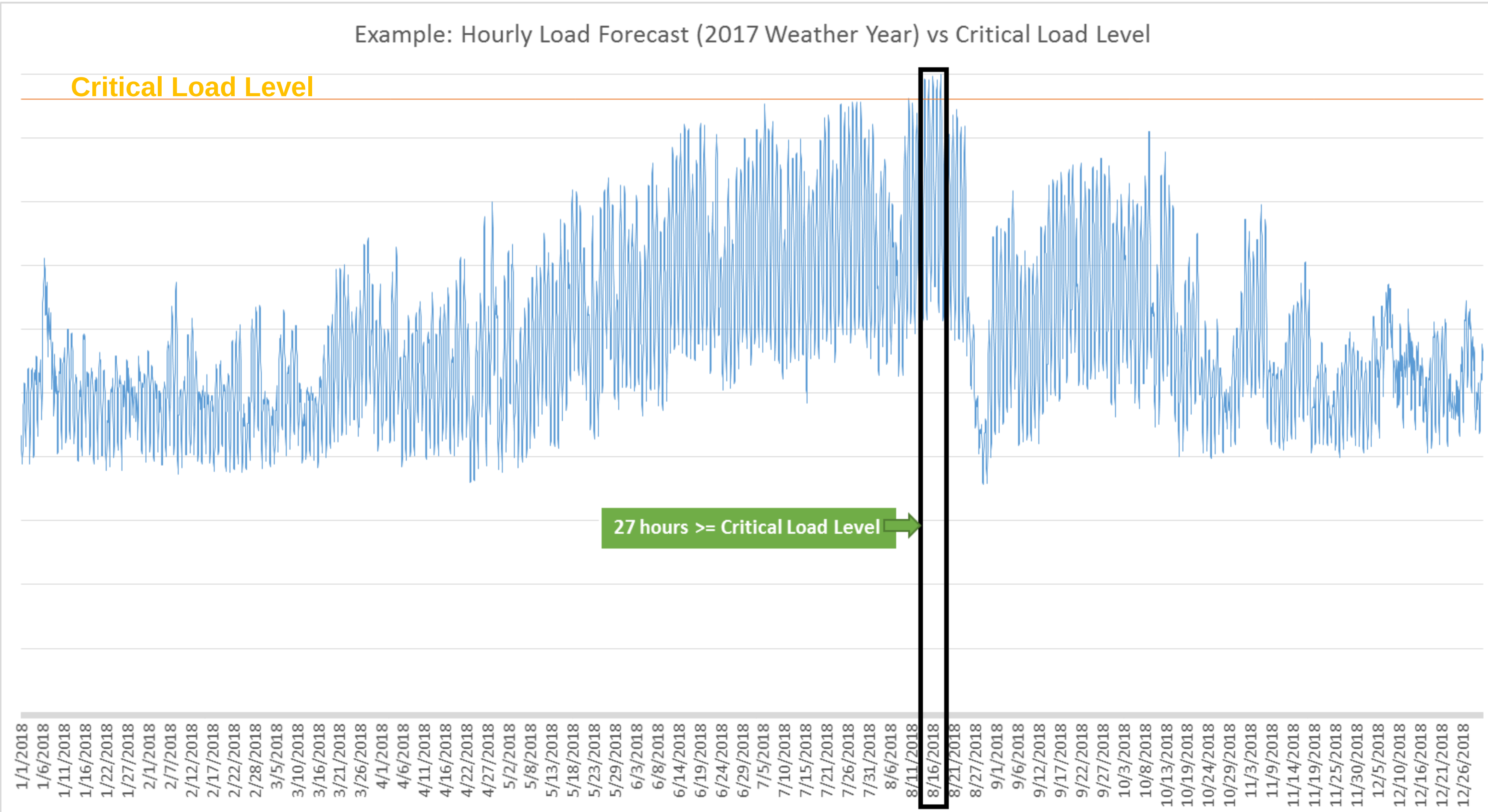
    i. Study area load(s) forecasted using historical weather data.
    ii. Identify hours, dates, and seasons above the critical load level, i.e. 24,362 MW in Step 1

Example – Expected Number of Hours above Critical Load Level

Weather Year	Number of hours (Load Level ≥ Critical Load Level)
2011	38
2012	55
2013	44
2014	47
2015	13
2016	31
2017	27
Average	37



Example – Expected Days, Hours, and Season



Example – Shift Factors for Estimating Capacity

Bus Number	Name	Area Num	Area Name	Shift Factor	Load Zone	Substation
44900	ZENITH__345A	4	CNP_TSP	-19.0%	LZ_HOUSTON	ZEN
44910	ZENITH__138A	4	CNP_TSP	-18.3%	LZ_HOUSTON	ZEN
45812	FRYRD09_138X	4	CNP_TSP	-18.1%	LZ_HOUSTON	FRY
49085	ZENITH_A1TER	4	CNP_TSP	-18.1%	LZ_HOUSTON	ZEN
44901	ZENITSTR	4	CNP_TSP	-18.1%	LZ_HOUSTON	ZEN
45811	FRYRD76_138X	4	CNP_TSP	-18.0%	LZ_HOUSTON	FRY
45801	GERTIE218000	4	CNP_TSP	-18.0%	LZ_HOUSTON	GE
45802	GERTIE768010	4	CNP_TSP	-17.9%	LZ_HOUSTON	GE
45711	CYFAIR218035	4	CNP_TSP	-17.7%	LZ_HOUSTON	CYF
45500	T_H_W__345B	4	CNP_TSP	-17.7%	LZ_HOUSTON	THW
45503	T_H_WSTR	904	E_CNP_TSP	-17.7%	LZ_HOUSTON	THW
45504	T_H_WSTR	904	E_CNP_TSP	-17.7%	LZ_HOUSTON	THW
45505	T_H_WSTR	904	E_CNP_TSP	-17.7%	LZ_HOUSTON	THW
110052	THW_THWGT51	904	E_CNP_TSP	-17.7%	LZ_HOUSTON	THW
110053	THW_THWGT52	904	E_CNP_TSP	-17.7%	LZ_HOUSTON	THW
110054	THW_THWGT53	904	E_CNP_TSP	-17.7%	LZ_HOUSTON	THW
110055	THW_THWGT54	904	E_CNP_TSP	-17.7%	LZ_HOUSTON	THW
110056	THW_THWGT55	904	E_CNP_TSP	-17.7%	LZ_HOUSTON	THW
110057	THW_THWGT56	904	E_CNP_TSP	-17.7%	LZ_HOUSTON	THW
49071	T_H_W__A3TER	4	CNP_TSP	-17.5%	LZ_HOUSTON	THW
45502	T_H_WSTR	4	CNP_TSP	-17.5%	LZ_HOUSTON	THW
45953	CKLUGE__138A	4	CNP_TSP	-17.4%	LZ_HOUSTON	KL
45712	CYFAIR768030	4	CNP_TSP	-17.4%	LZ_HOUSTON	CYF
45940	KLEIN__138A	4	CNP_TSP	-17.4%	LZ_HOUSTON	KI
45952	KLUGE__138B	4	CNP_TSP	-17.4%	LZ_HOUSTON	KL
45510	T_H_W__138A	4	CNP_TSP	-17.4%	LZ_HOUSTON	THW
45512	T_H_W95_8265	4	CNP_TSP	-17.4%	LZ_HOUSTON	THW
46660	WILLOW__8010	4	CNP_TSP	-17.4%	LZ_HOUSTON	WLO
45651	BAMMEL__138A	4	CNP_TSP	-17.3%	LZ_HOUSTON	BA
45700	CAMRON__138A	4	CNP_TSP	-17.3%	LZ_HOUSTON	CI
45921	JESTER678030	4	CNP_TSP	-17.3%	LZ_HOUSTON	JES
45922	JESTER818000	4	CNP_TSP	-17.3%	LZ_HOUSTON	JES
49039	T_H_W__A1TER	4	CNP_TSP	-17.3%	LZ_HOUSTON	THW
45501	T_H_WSTR	4	CNP_TSP	-17.3%	LZ_HOUSTON	THW
46551	VETRAN678020	4	CNP_TSP	-17.3%	LZ_HOUSTON	VET
46552	VETRAN818005	4	CNP_TSP	-17.3%	LZ_HOUSTON	VET
45782	GEARS95_8030	4	CNP_TSP	-17.2%	LZ_HOUSTON	GZ
45862	HIDDEN958015	4	CNP_TSP	-17.2%	LZ_HOUSTON	HV
45515	T_H_W__138E	4	CNP_TSP	-17.2%	LZ_HOUSTON	THW
45511	T_H_W81_8090	4	CNP_TSP	-17.2%	LZ_HOUSTON	THW
45516	T_H_WSTR	904	E_CNP_TSP	-17.2%	LZ_HOUSTON	THW

- Shift factor at this location is approximately negative 19% to the constraint under contingency.

  If 100 MW of capacity can be injected from an MRA available at this location, it would reduce the flow on the overloaded element by approximately 19 MW.

- This will help prospective MRA resource(s) estimate capacity needed at each location or combinations of locations.

MRA Evaluation Process and Methodology - Transmission Planning in ERCOT

RMR and MRA Evaluation Process – ERCOT Planning

MRA A,
MRA B,
MRA C,
…,
MRA K

- Review Eligibility
- Reliability Analysis and Load Shedding Analysis
- Cost Analysis

<Example of Cost Comparison>

Options	Bidding Cost ($)	Cost of Load at Risk ($)	Total Cost ($)
MRA B	20	-	20
MRA D	25	10	35
MRA E + MRA K	15	3	18
RMR	30	-	30
Do-Nothing	-	20	20

Methodology to Estimate Cost of Load at Risk

Load Shedding Analysis

- Conduct a load shedding analysis with various options (e.g. MRA, Do-nothing Option) and estimate the amount of MW load that needs to be shed to mitigate criteria violations.
- Use RMR study case(s) and estimate critical load level of the study area with no criteria violations

Review Load Forecast (Historical Weather Data)

- Using the critical load level above, estimate expected number of hours with criteria violations based on the review of study area loads forecasted using historical weather data

Cost of Load at Risk

- \$9,000 per MWh = Value of Lost Load (VOLL)
- Probability of Contingency causing criteria violations. Outage statistics can be obtained from sources such as NERC TADS or GADS.

- ❑ Cost of Load at Risk = Probability of Contingency x VOLL x MW Load at Risk X Expected Number of Hours

Formula – Cost of Load at Risk

Cost of Load at Risk =

$$\boldsymbol{P_{n0} * \sum_{all\ i} (VOLL * L_i * H_i) + P_{n1} * \sum_{all\ j} (VOLL * L_j * H_j) + \sum_{all\ k} \left(P_k * \sum_{all\ s1} VOLL * (L_{k,s1} * H_{k,s1}) \right) + \sum_{all\ l} \left(P_l * \sum_{all\ s2} VOLL * (L_{l,s2} * H_{l,s2}) \right)}$$

Where,

- P_{n0} is the probability of shedding load under pre-contingency condition (i.e. P_{n0} = ~ 1.0)*,
- P_{n1} is the probability of shedding load under N-1 contingency condition (i.e. P_{n1} = ~ 1.0)*,
- P_k is the probability of shedding load under the prior outage of k^{th} G-1 in anticipation of next N-1 contingency (i.e. P_k= probability of G-1),
- P_l is the probability of shedding load under the prior outage of l^{th} X-1 in anticipation of next critical N-1 contingency (i.e. P_l = probability of X-1),
- $VOLL$ is the value of lost load (i.e. $ 9,000 / MWh),
- L is the MW load at risk under each contingency condition,
- H is the hours with load at risk load under each contingency condition,
- i, j, s_1 *and* s_2 are the assumed number of incremental load shedding levels
- o and x are the total number contingency causing RMR criteria violations under G-1 or X-1

Note: Probability of shedding load under N-0 and N-1 was assumed to be approximately 1.0 based on the assumption that the load shedding for critical N-0 and N-1 issues would occur under pre-contingency condition.

Example

- Suppose that an NSO was submitted for the retirement starting from Jan 2018. RMR Study was conducted using the 2018 summer peak case which has 25,362 MW of peak load in the study area. Suppose that we identified two G-1+ N-1 contingencies causing criteria violations.

Example

Step 1: Load Shedding Analysis for Do-Nothing Option or MRA(s) that partially address criteria violations.

- Load Shedding Analysis was performed and it was found that the load in the study area needs to be reduced as follows under each of the two contingencies

a) Contingency 1 (G_1-1 + N-1) needs 1000 MW load shedding to eliminate the criteria violations

25,362 MW – 24,362 MW = 1000 MW

b) Contingency 2 (G_2-1 + N-1) needs 500 MW load shedding to eliminate the criteria violations

25,362 MW – 24,862 MW = 500 MW

Example

Step 2: Review Study Area Load Forecast

- Expected number of hours with criteria violations can be obtained using the critical load level and based on the review of study area loads forecasted using historical weather data

Weather Year	Number of hours (Study Area Load ≥ 24,862 MW Critical Load Level)	Number of hours (Study Area Load ≥ 24,362 MW Critical Load Level)
2011	10	38
2012	17	55
2013	8	44
2014	15	47
2015	3	13
2016	12	31
2017	18	27
Average	**12**	**37**

Example

Step 3: Compute Cost of Load at Risk

- Assume the probability of generator outage associated with Contingency 1: 0.00065664
- Assume the probability of generator outage associated with Contingency 2: 0.004877
- Value of Lost Load (VOLL): $9,000 per MWhr
- Now, use formula to compute the cost of load at risk

❑ If more accuracy is desired, split the range of critical load level into multiple levels. For example, split the range of the critical load level into two incremental ranges (i.e. 25,362 ~ 24,862 MW and 24,862 ~ 24,362 MW) for Contingency 1. Then, the amount of load at risk at each incremental range is

- The amount of load shedding for the first range =

  1000 MW / 2 =500 MW <u>for 12 hours</u>
- the amount of load shedding for the second range =

  1000 MW / 2 = 500 MW <u>for 37 hours</u>

Example

$$\textbf{Expected Cost of Load at Risk for contingency 1} = P_1 * \sum_{s1=1}^{q} VOLL * (L_{1,s1} * H_{1,s1})$$

$$= 0.00065664 * (9{,}000 * 500 * 12 + 9{,}000 * 500 * 37) = \$\ 144{,}789$$

$$\textbf{Expected Cost of Load at Risk for contingency 2} = P_2 * \sum_{s1=1}^{q} VOLL * (L_{1,s1} * H_{1,s1})$$

$$= 0.004877 * (9{,}000 * 500 * 12) = \$\ 263{,}358$$

For this example, the cost of load at risk associated with Do-Nothing option can be estimated as follows:

= Cost of Load at Risk Under Contingency 1 + Cost of Load at Risk Under Contingency 2

= $144,789 + $ 263,358 = $408,147

Questions?

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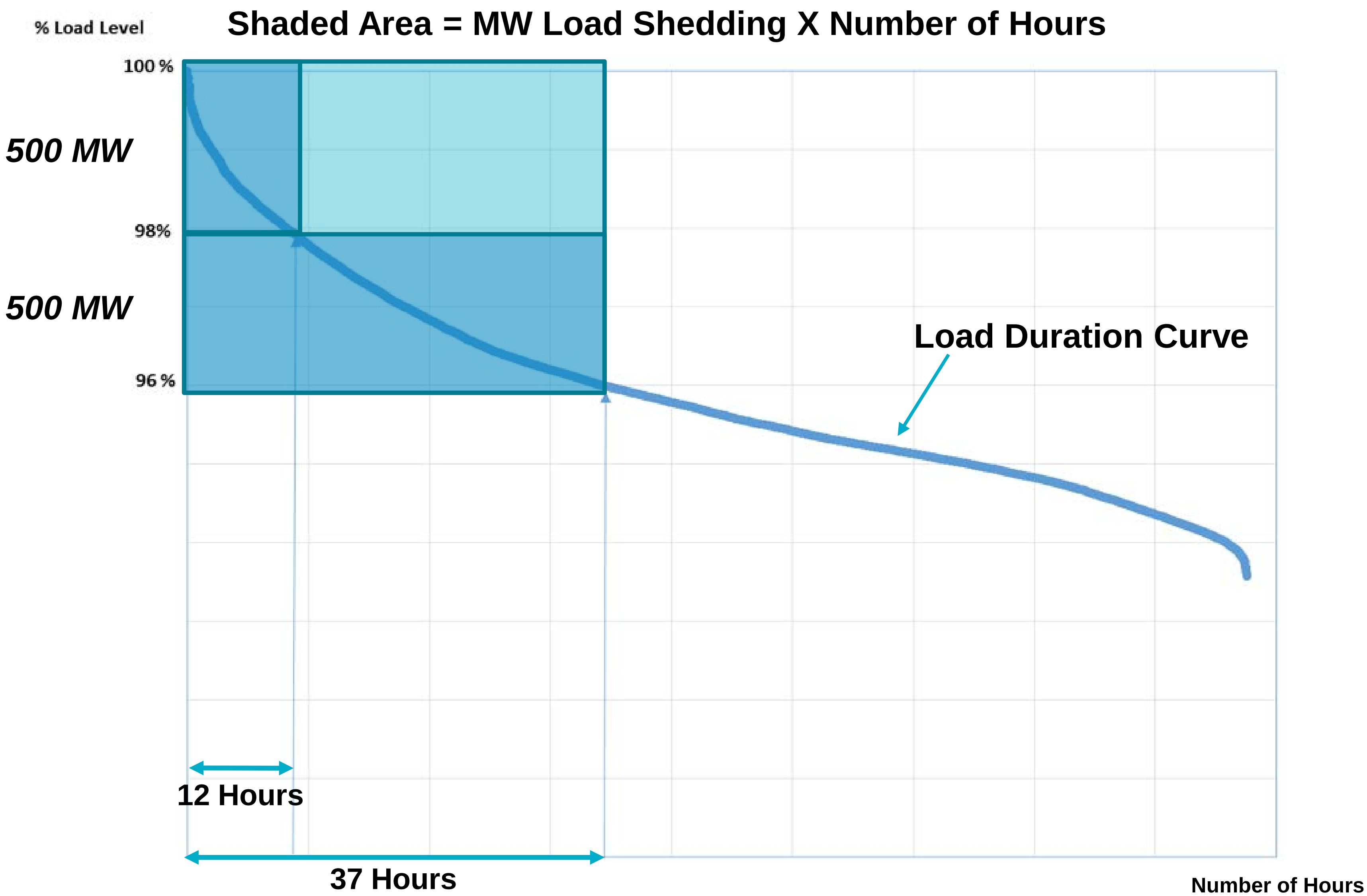
Appendix



% Load Level
Shaded Area = MW Load Shedding X Number of Hours
100 %
500 MW
98%
500 MW
96 %
Load Duration Curve
12 Hours
37 Hours
Number of Hours

Appendix

Reference for VOLL:
"Methodology for Implementing ORDC to Calculate Real-Time Reserve Price Adder" available at http://www.ercot.com/mktrules/obd/obdlist