

## Nodal Protocol Revision Request

<b>NPRR Number</b>		<b>NPRR Title</b>	<b>Create a Lower Rio Grande Valley Hub</b>
<b>Date Posted</b>			

<b>Requested Resolution</b>	Normal
<b>Nodal Protocol Sections Requiring Revision</b>	3.5.2.6, Lower Rio Grande Valley 138/345 kV Hub (LRGV 138/345) (new) 3.5.2.6, ERCOT Hub Average 345 kV Hub (ERCOT 345) 3.5.2.7, ERCOT Bus Average 345 kV Hub (ERCOT 345 Bus)
<b>Related Documents Requiring Revision/Related Revision Requests</b>	None
<b>Revision Description</b>	This Nodal Protocol Revision Request (NPRR) creates a trading Hub "Lower Rio Grande Valley 138/345 kV Hub (LRGV 138/345)" in the ERCOT lower rio grande valley. The NPRR also excludes this new Hub from the existing ERCOT-wide Hub average and Bus average calculations in Sections 3.5.2.6 and 3.5.2.7.
<b>Reason for Revision</b>	<input type="checkbox"/> Addresses current operational issues. <input type="checkbox"/> Meets Strategic goals (tied to the <a href="#">ERCOT Strategic Plan</a> or directed by the ERCOT Board). <input checked="" type="checkbox"/> Market efficiencies or enhancements <input type="checkbox"/> Administrative <input type="checkbox"/> Regulatory requirements <input type="checkbox"/> Other: (explain) <i>(please select all that apply)</i>
<b>Business Case</b>	The additional Hub will allow additional trading liquidity and forward price discovery for the Lower Rio Grande Valley area. Hubs may also reduce risks to Market Participants by increased ability to hedge Congestion risks by having uniform delivery point.

<b>Sponsor</b>	
<b>Name</b>	
<b>E-mail Address</b>	
<b>Company</b>	

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<b>Phone Number</b>	
<b>Cell Number</b>	
<b>Market Segment</b>	

Market Rules Staff Contact	
<b>Name</b>	
<b>E-Mail Address</b>	
<b>Phone Number</b>	

Proposed Protocol Language Revision
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[3.5.2.6 Lower Rio Grande Valley Hub \(LRGV 138/345\)](#)

(1) [The Lower Rio Grande Valley Hub 138/345 kV Hub is composed of the following listed Hub Buses:](#)

No.	ERCOT Operations Hub Bus	kV	Hub
1	<u><a href="#">ADERHOLD</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
2	<u><a href="#">AIRPORT</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
3	<u><a href="#">ALBERTA</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
4	<u><a href="#">ALTON MV</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
5	<u><a href="#">AZTECA</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
6	<u><a href="#">BATES</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
7	<u><a href="#">BENTSEN</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
8	<u><a href="#">CAMWIND</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
9	<u><a href="#">CAUSEWAY</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
10	<u><a href="#">CITRUSCY</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
11	<u><a href="#">COFFPORT</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
12	<u><a href="#">DUKE</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
13	<u><a href="#">ELGATO</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
14	<u><a href="#">ELSA</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
15	<u><a href="#">FILTER P</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
16	<u><a href="#">FM 802</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>
17	<u><a href="#">FRONTERA</a></u>	<u><a href="#">138</a></u>	<u><a href="#">LRGV</a></u>

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18	<a href="#">GANDY</a>	<a href="#">138</a>	<a href="#">LRGV</a>
19	<a href="#">GARCENO</a>	<a href="#">138</a>	<a href="#">LRGV</a>
20	<a href="#">GARZA</a>	<a href="#">138</a>	<a href="#">LRGV</a>
21	<a href="#">GOODWIN</a>	<a href="#">138</a>	<a href="#">LRGV</a>
22	<a href="#">HAINE DR</a>	<a href="#">138</a>	<a href="#">LRGV</a>
23	<a href="#">HALL ACR</a>	<a href="#">138</a>	<a href="#">LRGV</a>
24	<a href="#">HARLSW</a>	<a href="#">138</a>	<a href="#">LRGV</a>
25	<a href="#">HEC</a>	<a href="#">138</a>	<a href="#">LRGV</a>
26	<a href="#">HIDALGO</a>	<a href="#">138</a>	<a href="#">LRGV</a>
27	<a href="#">KEY SW</a>	<a href="#">138</a>	<a href="#">LRGV</a>
28	<a href="#">L FRESNO</a>	<a href="#">138</a>	<a href="#">LRGV</a>
29	<a href="#">L GRULLA</a>	<a href="#">138</a>	<a href="#">LRGV</a>
30	<a href="#">L MILPAS</a>	<a href="#">138</a>	<a href="#">LRGV</a>
31	<a href="#">LA PALMA</a>	<a href="#">138</a>	<a href="#">LRGV</a>
32	<a href="#">LASPULGA</a>	<a href="#">138</a>	<a href="#">LRGV</a>
33	<a href="#">LAURELES</a>	<a href="#">138</a>	<a href="#">LRGV</a>
34	<a href="#">LISTON</a>	<a href="#">138</a>	<a href="#">LRGV</a>
35	<a href="#">LOMA ALT</a>	<a href="#">138</a>	<a href="#">LRGV</a>
36	<a href="#">LV1</a>	<a href="#">138</a>	<a href="#">LRGV</a>
37	<a href="#">LV5</a>	<a href="#">138</a>	<a href="#">LRGV</a>
38	<a href="#">MARCONI</a>	<a href="#">138</a>	<a href="#">LRGV</a>
39	<a href="#">MAYBERRY</a>	<a href="#">138</a>	<a href="#">LRGV</a>
40	<a href="#">MCOLL RD</a>	<a href="#">138</a>	<a href="#">LRGV</a>
41	<a href="#">MERETT</a>	<a href="#">138</a>	<a href="#">LRGV</a>
42	<a href="#">MESQUITE</a>	<a href="#">138</a>	<a href="#">LRGV</a>
43	<a href="#">MIDTOWN</a>	<a href="#">138</a>	<a href="#">LRGV</a>
44	<a href="#">MILHWY</a>	<a href="#">138</a>	<a href="#">LRGV</a>
45	<a href="#">MILITARY</a>	<a href="#">138</a>	<a href="#">LRGV</a>
46	<a href="#">MOORE FL</a>	<a href="#">138</a>	<a href="#">LRGV</a>
47	<a href="#">MV BURNS</a>	<a href="#">138</a>	<a href="#">LRGV</a>
48	<a href="#">MV CNTRA</a>	<a href="#">138</a>	<a href="#">LRGV</a>
49	<a href="#">MV DOEDN</a>	<a href="#">138</a>	<a href="#">LRGV</a>
50	<a href="#">MV ERAY2</a>	<a href="#">138</a>	<a href="#">LRGV</a>
51	<a href="#">MV HBRG4</a>	<a href="#">138</a>	<a href="#">LRGV</a>
52	<a href="#">MV HW511</a>	<a href="#">138</a>	<a href="#">LRGV</a>
53	<a href="#">MV LASAR</a>	<a href="#">138</a>	<a href="#">LRGV</a>
54	<a href="#">MV PALM4</a>	<a href="#">138</a>	<a href="#">LRGV</a>
55	<a href="#">MV RAYTP</a>	<a href="#">138</a>	<a href="#">LRGV</a>
56	<a href="#">MV RIOHO</a>	<a href="#">138</a>	<a href="#">LRGV</a>

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57	<a href="#">MV VALV4</a>	<a href="#">138</a>	<a href="#">LRGV</a>
58	<a href="#">MV WEDN4</a>	<a href="#">138</a>	<a href="#">LRGV</a>
59	<a href="#">MV WESL4</a>	<a href="#">138</a>	<a href="#">LRGV</a>
60	<a href="#">MVHILINE</a>	<a href="#">138</a>	<a href="#">LRGV</a>
61	<a href="#">MVRANGER</a>	<a href="#">138</a>	<a href="#">LRGV</a>
62	<a href="#">N ALAMO</a>	<a href="#">138</a>	<a href="#">LRGV</a>
63	<a href="#">N MCALLN</a>	<a href="#">138</a>	<a href="#">LRGV</a>
64	<a href="#">N MERCED</a>	<a href="#">138</a>	<a href="#">LRGV</a>
65	<a href="#">NEDIN</a>	<a href="#">138</a>	<a href="#">LRGV</a>
66	<a href="#">NWESLACO</a>	<a href="#">138</a>	<a href="#">LRGV</a>
67	<a href="#">OLEANDER</a>	<a href="#">138</a>	<a href="#">LRGV</a>
68	<a href="#">OLMITO</a>	<a href="#">138</a>	<a href="#">LRGV</a>
69	<a href="#">P ISABEL</a>	<a href="#">138</a>	<a href="#">LRGV</a>
70	<a href="#">PALMASVC</a>	<a href="#">138</a>	<a href="#">LRGV</a>
71	<a href="#">PALMHRTP</a>	<a href="#">138</a>	<a href="#">LRGV</a>
72	<a href="#">PALMHURS</a>	<a href="#">138</a>	<a href="#">LRGV</a>
73	<a href="#">PALMITO</a>	<a href="#">138</a>	<a href="#">LRGV</a>
74	<a href="#">PALMVIEW</a>	<a href="#">138</a>	<a href="#">LRGV</a>
75	<a href="#">PALOALTO</a>	<a href="#">138</a>	<a href="#">LRGV</a>
76	<a href="#">PAREDES</a>	<a href="#">138</a>	<a href="#">LRGV</a>
77	<a href="#">PHARMVEC</a>	<a href="#">138</a>	<a href="#">LRGV</a>
78	<a href="#">PHARR</a>	<a href="#">138</a>	<a href="#">LRGV</a>
79	<a href="#">PHARRSVC</a>	<a href="#">138</a>	<a href="#">LRGV</a>
80	<a href="#">PLMHSTT1</a>	<a href="#">138</a>	<a href="#">LRGV</a>
81	<a href="#">POLK AVE</a>	<a href="#">138</a>	<a href="#">LRGV</a>
82	<a href="#">PRICE RD</a>	<a href="#">138</a>	<a href="#">LRGV</a>
83	<a href="#">RAYMND2</a>	<a href="#">138</a>	<a href="#">LRGV</a>
84	<a href="#">REDFISH</a>	<a href="#">138</a>	<a href="#">LRGV</a>
85	<a href="#">REDGATE</a>	<a href="#">138</a>	<a href="#">LRGV</a>
86	<a href="#">REDTAP</a>	<a href="#">138</a>	<a href="#">LRGV</a>
87	<a href="#">RIO GRAN</a>	<a href="#">138</a>	<a href="#">LRGV</a>
88	<a href="#">RIOHONDO</a>	<a href="#">138</a>	<a href="#">LRGV</a>
89	<a href="#">ROMA</a>	<a href="#">138</a>	<a href="#">LRGV</a>
90	<a href="#">ROMA SW</a>	<a href="#">138</a>	<a href="#">LRGV</a>
91	<a href="#">S MCALLN</a>	<a href="#">138</a>	<a href="#">LRGV</a>
92	<a href="#">S MISSIN</a>	<a href="#">138</a>	<a href="#">LRGV</a>
93	<a href="#">S PADRE</a>	<a href="#">138</a>	<a href="#">LRGV</a>
94	<a href="#">S SNROSA</a>	<a href="#">138</a>	<a href="#">LRGV</a>
95	<a href="#">SANROMAN</a>	<a href="#">138</a>	<a href="#">LRGV</a>

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96	<a href="#">SCARBIDE</a>	<a href="#">138</a>	<a href="#">LRGV</a>
97	<a href="#">SE EDINB</a>	<a href="#">138</a>	<a href="#">LRGV</a>
98	<a href="#">SHARYLND</a>	<a href="#">138</a>	<a href="#">LRGV</a>
99	<a href="#">SILASRAY</a>	<a href="#">138</a>	<a href="#">LRGV</a>
100	<a href="#">SIOUX</a>	<a href="#">138</a>	<a href="#">LRGV</a>
101	<a href="#">SIXTH_ST</a>	<a href="#">138</a>	<a href="#">LRGV</a>
102	<a href="#">SOUTH_PL</a>	<a href="#">138</a>	<a href="#">LRGV</a>
103	<a href="#">SOUTHMOS</a>	<a href="#">138</a>	<a href="#">LRGV</a>
104	<a href="#">STEWART</a>	<a href="#">138</a>	<a href="#">LRGV</a>
105	<a href="#">STILLMAN</a>	<a href="#">138</a>	<a href="#">LRGV</a>
106	<a href="#">SUNCHSE</a>	<a href="#">138</a>	<a href="#">LRGV</a>
107	<a href="#">TAYLOR</a>	<a href="#">138</a>	<a href="#">LRGV</a>
108	<a href="#">TITAN_SU</a>	<a href="#">138</a>	<a href="#">LRGV</a>
109	<a href="#">VCAVAZOS</a>	<a href="#">138</a>	<a href="#">LRGV</a>
110	<a href="#">W_MCALLN</a>	<a href="#">138</a>	<a href="#">LRGV</a>
111	<a href="#">WATERPRT</a>	<a href="#">138</a>	<a href="#">LRGV</a>
112	<a href="#">WESLACO</a>	<a href="#">138</a>	<a href="#">LRGV</a>
113	<a href="#">WESLAU</a>	<a href="#">138</a>	<a href="#">LRGV</a>
114	<a href="#">WESMER</a>	<a href="#">138</a>	<a href="#">LRGV</a>

(2) [The Lower Rio Grande Valley 138/345 kV Hub Price uses the aggregated Shift Factors of the Hub Buses for each hour of the Settlement Interval of the DAM in the Day-Ahead and is the simple average of the time weighted Hub Bus prices for each 15-minute Settlement Interval in Real-Time, for each Hub Bus included in this Hub.](#)

(3) [The Day-Ahead Settlement Point Price of the Hub for a given Operating Hour is calculated as follows:](#)

$$\text{DASPP}_{LRGV\ 138/345} = \frac{\text{DASL} - (\text{DAHUBSF}_{LRGV\ 138/345,\ c} * \text{DASP}_c)}{\text{if HBBC}_{LRGV\ 138/345} \neq 0}$$

$$\text{DASPP}_{LRGV\ 138/345} = \text{DASPP}_{ERCOT345Bus}, \text{ if HBBC}_{LRGV\ 138/345} = 0$$

Where:

$$\text{DAHUBSF}_{LRGV\ 138/345,\ c} = \sqrt{(\text{HUBDF}_{hb,\ LRGV\ 138/345,\ c} * \text{DAHBSF}_{hb,\ LRGV\ 138/345,\ c})}$$

$$\text{DAHBSF}_{hb,\ LRGV\ 138/345,\ c} = \sqrt{(\text{HBDF}_{pb,\ hb,\ LRGV\ 138/345,\ c} * \text{DASF}_{pb,\ hb,\ LRGV\ 138/345,\ c})}$$

$$\text{HUBDF}_{hb,\ LRGV\ 138/345,\ c} = \text{IF}(\text{HB}_{LRGV\ 138/345,\ c} = 0, 0, 1 / \text{HB}_{LRGV\ 138/345,\ c})$$

$$\text{HBDF}_{pb,\ hb,\ LRGV\ 138/345,\ c} = \text{IF}(\text{PB}_{hb,\ LRGV\ 138/345,\ c} = 0, 0, 1 / \text{PB}_{hb,\ LRGV\ 138/345,\ c})$$

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The above variables are defined as follows:

Variable	Unit	Definition
DASPP <small>LRGV 138/345</small>	\$/MWh	Day-Ahead Settlement Point Price—The DAM Settlement Point Price at the Hub, for the hour.
DASL	\$/MWh	Day-Ahead System Lambda—The DAM Shadow Price for the system power balance constraint for the hour.
DASP <sub>c</sub>	\$/MWh	Day-Ahead Shadow Price for a binding transmission constraint—The DAM Shadow Price for the constraint <i>c</i> for the hour.
DAHUBSF <small>LRGV 138/345,c</small>	none	Day-Ahead Shift Factor of the Hub —The DAM aggregated Shift Factor of a Hub for the constraint <i>c</i> for the hour.
DAHBSF <small>hb, LRGV 138/345,c</small>	none	Day-Ahead Shift Factor of the Hub Bus—The DAM aggregated Shift Factor of a Hub Bus <i>hb</i> for the constraint <i>c</i> for the hour.
DASF <small>pb,hb, LRGV 138/345,c</small>	none	Day-Ahead Shift Factor of the power flow bus—The DAM Shift Factor of a power flow bus <i>pb</i> that is a component of Hub Bus <i>hb</i> for the constraint <i>c</i> for the hour.
HUBDF <small>hb, LRGV 138/345,c</small>	none	Hub Distribution Factor per Hub Bus in a constraint—The distribution factor of Hub Bus <i>hb</i> for the constraint <i>c</i> for the hour.
HBDF <small>pb, hb, LRGV 138/345,c</small>	none	Hub Bus Distribution Factor per power flow bus of Hub Bus in a constraint—The distribution factor of power flow bus <i>pb</i> that is a component of Hub Bus <i>hb</i> for the constraint <i>c</i> for the hour.
<i>pb</i>	none	An energized power flow bus that is a component of a Hub Bus for the constraint <i>c</i> .
PB <small>hb, LRGV 138/345,c</small>	none	The total number of energized power flow buses in Hub Bus <i>hb</i> for the constraint <i>c</i> .
<i>hb</i>	none	A Hub Bus that is a component of the Hub with at least one energized power flow bus for the constraint <i>c</i> .
HBBC <small>LRGV 138/345</small>	none	The total number of Hub Buses in the Hub with at least one energized component in each Hub Bus in base case.
HB <small>LRGV 138/345,c</small>	none	The total number of Hub Buses in the Hub with at least one energized component in each Hub Bus for the constraint <i>c</i> .
<i>c</i>	none	A DAM binding transmission constraint for the hour caused by either base case or a contingency.

(4) The Real-Time Settlement Point Price of the Hub for a given 15-minute Settlement Interval is calculated as follows:

$$\begin{aligned}
 \text{RTSPP}_{LRGV\ 138/345} &= \text{Max} [-\$251, (\text{RTSVPOR} + \text{RTRDP} + \\
 &\quad \frac{(\text{HUBDF}_{hb, LRGV\ 138/345} * ((\text{RTHBP}_{hb, LRGV\ 138/345, y} * \text{TLMP}_y) / (\text{TLMP}_y)))}{\text{HB}_{LRGV\ 138/345}})], \text{ if } \text{HB}_{LRGV\ 138/345} \neq 0 \\
 \text{RTSPP}_{LRGV\ 138/345} &= \text{RTSPP}_{ERCOT345Bus}, \text{ if } \text{HB}_{LRGV\ 138/345} = 0
 \end{aligned}$$

Where:

$$\text{RTSVPOR} = \sqrt{(\text{RNWF}_y * \text{RTORPA}_y)}$$

$$\text{RTRDP} = \sqrt{(\text{RNWF}_y * \text{RTORDPA}_y)}$$

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$$\text{RNWF}_y = \text{TLMP}_y / \text{TLMP}_y$$

$$\text{RTHBP}_{hb, LRGV 138/345, y} = \sqrt{(\text{HBDf}_{b, hb, LRGV 138/345} * \text{RTLMP}_{b, hb, LRGV 138/345, y})}$$

$$\text{HUBDF}_{hb, LRGV 138/345} = \text{IF}(\text{HB}_{LRGV 138/345} = 0, 0, 1 / \text{HB}_{LRGV 138/345})$$

$$\text{HBDf}_{b, hb, LRGV 138/345} = \text{IF}(\text{B}_{hb, LRGV 138/345} = 0, 0, 1 / \text{B}_{hb, LRGV 138/345})$$

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The above variables are defined as follows:

Variable	Unit	Description
<u>RTSPP</u> <sub>LRGV138/345kV</sub>	\$/MWh	<u>Real-Time Settlement Point Price</u> —The Real-Time Settlement Point Price at the Hub for the 15-minute Settlement Interval.
<u>RTRSVPOR</u>	\$/MWh	<u>Real-Time Reserve Price for On-Line Reserves</u> —The Real-Time Reserve Price for On-Line Reserves for the 15-minute Settlement Interval.
<u>RTORPA</u> <sub>y</sub>	\$/MWh	<u>Real-Time On-Line Reserve Price Adder per interval</u> —The Real-Time On-Line Reserve Price Adder for the SCED interval y.
<u>RTRDP</u>	\$/MWh	<u>Real-Time On-Line Reliability Deployment Price</u> —The Real-Time price for the 15-minute Settlement Interval, reflecting the impact of reliability deployments on energy prices that are calculated from the Real-Time On-Line Reliability Deployment Price Adder.
<u>RTORDPA</u> <sub>y</sub>	\$/MWh	<u>Real-Time On-Line Reliability Deployment Price Adder</u> —The Real-Time price adder that captures the impact of reliability deployments on energy prices for the SCED interval y.
<u>RNWF</u> <sub>y</sub>	none	<u>Resource Node Weighting Factor per interval</u> —The weight used in the Resource Node Settlement Point Price calculation for the portion of the SCED interval y within the Settlement Interval.
<u>RTHBP</u> <sub>hb, LRGV138/345kV, y</sub>	\$/MWh	<u>Real-Time Hub Bus Price at Hub Bus per SCED interval</u> —The Real-Time energy price at Hub Bus hb for the SCED interval y.
<u>RTLMP</u> <sub>b, hb, LRGV138/345kV, y</sub>	\$/MWh	<u>Real-Time Locational Marginal Price at Electrical Bus of Hub Bus per interval</u> —The Real-Time LMP at Electrical Bus b that is a component of Hub Bus hb for the SCED interval y.
<u>TLMP</u> <sub>y</sub>	second	<u>Duration of SCED interval per interval</u> —The duration of the portion of the SCED interval y within the 15-minute Settlement Interval.
<u>HUBDF</u> <sub>hb, LRGV138/345kV</sub>	none	<u>Hub Distribution Factor per Hub Bus</u> —The distribution factor of Hub Bus hb.
<u>HBDf</u> <sub>b, hb, LRGV138/345kV</sub>	none	<u>Hub Bus Distribution Factor per Electrical Bus of Hub Bus</u> —The distribution factor of Electrical Bus b that is a component of Hub Bus hb.
<u>y</u>	none	A SCED interval in the 15-minute Settlement Interval. The summation is over the total number of SCED runs that cover the 15-minute Settlement Interval.
<u>b</u>	none	An energized Electrical Bus that is a component of a Hub Bus.
<u>B</u> <sub>hb, LRGV138/345kV</sub>	none	The total number of energized Electrical Buses in Hub Bus hb.
<u>hb</u>	none	A Hub Bus that is a component of the Hub.
<u>HB</u> <sub>LRGV138/345kV</sub>	none	The total number of Hub Buses in the Hub with at least one energized component in each Hub Bus.

## Nodal Protocol Revision Request

### 3.5.2.6 ERCOT Hub Average 345 kV Hub (ERCOT 345)

- (1) The ERCOT Hub Average 345 kV Hub price, for both Day-Ahead and Real-Time, is the simple average of four prices from the applicable time period: the North 345 kV Hub price, the South 345 kV Hub price, the Houston 345 kV Hub price, and the West 345 kV Hub price. The Panhandle 345 kV Hub and the Lower Rio Grande Valley Hub are not included in the ERCOT Hub Average 345 kV Hub price.
- (2) The Day-Ahead Settlement Point Price for the Hub “ERCOT 345” for a given Operating Hour is calculated as follows:

$$\text{DASPP}_{\text{ERCOT345}} = \frac{(\text{DASPP}_{\text{North345}} + \text{DASPP}_{\text{South345}} + \text{DASPP}_{\text{Houston345}} + \text{DASPP}_{\text{West345}})}{4}$$

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The above variables are defined as follows:

Variable	Unit	Definition
DASPP <sub>ERCOT345</sub>	\$/MWh	Day-Ahead Settlement Point Price at ERCOT 345—The DAM Settlement Point Price at ERCOT 345 Hub for the hour.
DASPP <sub>North345</sub>	\$/MWh	Day-Ahead Settlement Point Price at North 345—The DAM Settlement Point Price at the North 345 Hub for the hour.
DASPP <sub>South345</sub>	\$/MWh	Day-Ahead Settlement Point Price at South 345—The DAM Settlement Point Price at the South 345 Hub for the hour.
DASPP <sub>Houston345</sub>	\$/MWh	Day-Ahead Settlement Point Price at Houston 345—The DAM Settlement Point Price at the Houston 345 Hub for the hour.
DASPP <sub>West345</sub>	\$/MWh	Day-Ahead Settlement Point Price at West 345—The DAM Settlement Point Price at the West 345 Hub for the hour.

- (3) The Real-Time Settlement Point Price for the Hub “ERCOT 345” for a given 15-minute Settlement Interval is calculated as follows:

$$\text{RTSPP}_{\text{ERCOT345}} = \frac{(\text{RTSPP}_{\text{North345}} + \text{RTSPP}_{\text{South345}} + \text{RTSPP}_{\text{Houston345}} + \text{RTSPP}_{\text{West345}})}{4}$$

The above variables are defined as follows:

Variable	Unit	Definition
RTSPP <sub>ERCOT345</sub>	\$/MWh	Real-Time Settlement Point Price at ERCOT 345—The Real-Time Settlement Point Price at ERCOT 345 Hub for the 15-minute Settlement Interval.
RTSPP <sub>North345</sub>	\$/MWh	Real-Time Settlement Point Price at North 345—The Real-Time Settlement Point Price at the North 345 Hub for the 15-minute Settlement Interval.
RTSPP <sub>South345</sub>	\$/MWh	Real-Time Settlement Point Price at South 345—The Real-Time Settlement Point Price at the South 345 Hub for the 15-minute Settlement Interval.
RTSPP <sub>Houston345</sub>	\$/MWh	Real-Time Settlement Point Price at Houston 345—The Real-Time Settlement Point Price at the Houston 345 Hub for the 15-minute Settlement Interval.
RTSPP <sub>West345</sub>	\$/MWh	Real-Time Settlement Point Price at West 345—The Real-Time Settlement Point Price at the West 345 Hub for the 15-minute Settlement Interval.



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### 3.5.2.7 ERCOT Bus Average 345 kV Hub (ERCOT 345 Bus)

- (1) The ERCOT Bus Average 345 kV Hub is composed of the Hub Buses listed in Section 3.5.2.1, North 345 kV Hub (North 345); Section 3.5.2.2, South 345 kV Hub (South 345); Section 3.5.2.3, Houston 345 kV Hub (Houston 345); and Section 3.5.2.4, West 345 kV Hub (West 345). The Panhandle 345 kV Hub [and the Lower Rio Grande Valley Hub are](#), not included in the ERCOT Bus Average 345 kV Hub price.
- (2) The ERCOT Bus Average 345 kV Hub uses the aggregated Shift Factors of the Hub Buses for each hour of the Settlement Interval of the DAM in the Day-Ahead and is the simple average of the time weighted Hub Bus prices for each 15-minute Settlement Interval in Real-Time, for each Hub Bus included in this Hub.
- (3) The Day-Ahead Settlement Point Price of the Hub for a given Operating Hour is calculated as follows:

Deleted: is

$$\text{DASPP}_{ERCOT345Bus} = \text{DASL} - \sum_c (\text{DAHUBSF}_{ERCOT345Bus,c} * \text{DASP}_c),$$

if  $\text{HBBC}_{ERCOT345Bus} \neq 0$

$$\text{DASPP}_{ERCOT345Bus} = 0, \text{ if } \text{HBBC}_{ERCOT345Bus} = 0$$

Where:

$$\text{DAHUBSF}_{ERCOT345Bus,c} = \frac{\sum_{hb} (\text{HUBDF}_{hb,ERCOT345Bus,c} * \text{DAHBSF}_{hb,ERCOT345Bus,c})}{\text{HB}}$$

$$\text{DAHBSF}_{hb,ERCOT345Bus,c} = \frac{\sum_{pb} (\text{HBDF}_{pb,hb,ERCOT345Bus,c} * \text{DASF}_{pb,hb,ERCOT345Bus,c})}{\text{PB}}$$

$$\text{HUBDF}_{hb,ERCOT345Bus,c} = \text{IF}(\text{HB}_{ERCOT345Bus,c} = 0, 0, 1 / \text{HB}_{ERCOT345Bus,c})$$

$$\text{HBDF}_{pb,hb,ERCOT345Bus,c} = \text{IF}(\text{PB}_{hb,ERCOT345Bus,c} = 0, 0, 1 / \text{PB}_{hb,ERCOT345Bus,c})$$

The above variables are defined as follows:

Variable	Unit	Definition
$\text{DASPP}_{ERCOT345Bus}$	\$/MWh	Day-Ahead Settlement Point Price—The DAM Settlement Point Price at the Hub, for the hour.
DASL	\$/MWh	Day-Ahead System Lambda—The DAM Shadow Price for the system power balance constraint for the hour.
$\text{DASP}_c$	\$/MWh	Day-Ahead Shadow Price for a binding transmission constraint—The DAM Shadow Price for the constraint $c$ for the hour.
$\text{DAHUBSF}_{ERCOT345Bus,c}$	none	Day-Ahead Shift Factor of the Hub —The DAM aggregated Shift Factor of a Hub for the constraint $c$ for the hour.
$\text{DAHBSF}_{hb,ERCOT345Bus,c}$	none	Day-Ahead Shift Factor of the Hub Bus—The DAM aggregated Shift Factor of a Hub Bus $hb$ for the constraint $c$ for the hour.
$\text{DASF}_{pb,hb,ERCOT345Bus,c}$	none	Day-Ahead Shift Factor of the power flow bus—The DAM Shift Factor of a

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Variable	Unit	Definition
		power flow bus $pb$ that is a component of Hub Bus $hb$ for the constraint $c$ for the hour.
HUBDF <sub><math>hb, ERCOT345Bus, c</math></sub>	none	<i>Hub Distribution Factor per Hub Bus in a constraint</i> —The distribution factor of Hub Bus $hb$ for the constraint $c$ for the hour.
HBDF <sub><math>pb, hb, ERCOT345Bus, c</math></sub>	none	<i>Hub Bus Distribution Factor per power flow bus of Hub Bus in a constraint</i> —The distribution factor of power flow bus $pb$ that is a component of Hub Bus $hb$ for the constraint $c$ for the hour.
$pb$	none	An energized power flow bus that is a component of a Hub Bus for the constraint $c$ .
PB <sub><math>hb, ERCOT345Bus, c</math></sub>	none	The total number of energized power flow buses in Hub Bus $hb$ for the constraint $c$ .
$hb$	none	A Hub Bus that is a component of the ERCOT Bus Average 345 kV Hub (ERCOT 345 Bus) with at least one energized power flow bus for the constraint $c$ . The Hub “ERCOT 345 Bus” includes any Hub Bus defined in the Hub “North 345”, “South 345”, “Houston 345” and “West 345”.
HBBC <sub><math>ERCOT345Bus</math></sub>	none	The total number of Hub Buses in the ERCOT Bus Average 345 kV Hub (ERCOT 345 Bus) with at least one energized component in each Hub Bus in base case. The Hub “ERCOT 345 Bus” includes any Hub Bus defined in the Hub “North 345”, “South 345”, “Houston 345” and “West 345”.
HB <sub><math>ERCOT345Bus, c</math></sub>	none	The total number of Hub Buses in the ERCOT Bus Average 345 kV Hub (ERCOT 345 Bus) with at least one energized component in each Hub Bus for the constraint $c$ . The Hub “ERCOT 345 Bus” includes any Hub Bus defined in the Hub “North 345”, “South 345”, “Houston 345” and “West 345”.
$c$	none	A DAM binding transmission constraint for the hour caused by either base case or a contingency.

- (4) The Real-Time Settlement Point Price of the Hub for a given 15-minute Settlement Interval is calculated as follows:

$$\begin{aligned}
 \mathbf{RTSPP}_{ERCOT345Bus} &= \mathbf{Max} [-\$251, (\mathbf{RTRSVPOR} + \mathbf{RTRDP} + \\
 &\quad \sum_{hb} (\mathbf{HUBDF}_{hb, ERCOT345Bus} * (\sum_y (\mathbf{RTHBP}_{hb, ERCOT345Bus, y} * \\
 &\quad \mathbf{TLMP}_y) / (\sum_y \mathbf{TLMP}_y)))] , \text{ if } \mathbf{HB}_{ERCOT345Bus} \neq 0 \\
 \mathbf{RTSPP}_{ERCOT345Bus} &= \mathbf{0}, \text{ if } \mathbf{HB}_{ERCOT345Bus} = \mathbf{0}
 \end{aligned}$$

Where:

$$\mathbf{RTRSVPOR} = \sum_y (\mathbf{RNWF}_y * \mathbf{RTORPA}_y)$$

$$\mathbf{RTRDP} = \sum_y (\mathbf{RNWF}_y * \mathbf{RTORDPA}_y)$$

$$\mathbf{RNWF}_y = \mathbf{TLMP}_y / \sum_y \mathbf{TLMP}_y$$

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$$RTHBP_{hb, ERCOT345Bus, y} = \sum_b (HBDF_{b, hb, ERCOT345Bus} * RTLMP_{b, hb, ERCOT345Bus, y})$$

$$HUBDF_{hb, ERCOT345Bus} = 1 / (HB_{North345} + HB_{South345} + HB_{Houston345} + HB_{West345})$$

If Electrical Bus  $b$  is a component of “North 345”

$$HBDF_{b, hb, ERCOT345Bus} = IF(B_{hb, North345}=0, 0, 1 / B_{hb, North345})$$

Otherwise

If Electrical Bus  $b$  is a component of “South 345”

$$HBDF_{b, hb, ERCOT345Bus} = IF(B_{hb, South345}=0, 0, 1 / B_{hb, South345})$$

Otherwise

If Electrical Bus  $b$  is a component of “Houston 345”

$$HBDF_{b, hb, ERCOT345Bus} = IF(B_{hb, Houston345}=0, 0, 1 / B_{hb, Houston345})$$

Houston345)

Otherwise

$$HBDF_{b, hb, ERCOT345Bus} = IF(B_{hb, West345}=0, 0, 1 / B_{hb, West345})$$

The above variables are defined as follows:

Variable	Unit	Description
RTSPP <sub>ERCOT345Bus</sub>	\$/MWh	<i>Real-Time Settlement Point Price</i> —The Real-Time Settlement Point Price at the Hub, for the 15-minute Settlement Interval.
RTRSVPOR	\$/MWh	<i>Real-Time Reserve Price for On-Line Reserves</i> —The Real-Time Reserve Price for On-Line Reserves for the 15-minute Settlement Interval.
RTORPA <sub>y</sub>	\$/MWh	<i>Real-Time On-Line Reserve Price Adder per interval</i> —The Real-Time On-Line Reserve Price Adder for the SCED interval $y$ .
RTRDP	\$/MWh	<i>Real-Time On-Line Reliability Deployment Price</i> —The Real-Time price for the 15-minute Settlement Interval, reflecting the impact of reliability deployments on energy prices that are calculated from the Real-Time On-Line Reliability Deployment Price Adder.
RTORDPA <sub>y</sub>	\$/MWh	<i>Real-Time On-Line Reliability Deployment Price Adder</i> —The Real-Time price adder that captures the impact of reliability deployments on energy prices for the SCED interval $y$ .
RNWF <sub>y</sub>	none	<i>Resource Node Weighting Factor per interval</i> —The weight used in the Resource Node Settlement Point Price calculation for the portion of the SCED interval $y$ within the Settlement Interval.
RTHBP <sub>hb, ERCOT345Bus, y</sub>	\$/MWh	<i>Real-Time Hub Bus Price at Hub Bus per SCED interval</i> —The Real-Time energy price at Hub Bus $hb$ for the SCED interval $y$ .
RTLMP <sub>b, hb, ERCOT345Bus, y</sub>	\$/MWh	<i>Real-Time Locational Marginal Price at Electrical Bus of Hub Bus per interval</i> —The Real-Time LMP at Electrical Bus $b$ that is a component of Hub Bus $hb$ , for the SCED interval $y$ .
TLMP <sub>y</sub>	second	<i>Duration of SCED interval per interval</i> —The duration of the portion of the SCED interval $y$ within the 15-minute Settlement Interval.
HUBDF <sub>hb, ERCOT345Bus</sub>	none	<i>Hub Distribution Factor per Hub Bus</i> —The distribution factor of Hub Bus $hb$ .
HBDF <sub>b, hb, ERCOT345Bus</sub>	none	<i>Hub Bus Distribution Factor per Electrical Bus of Hub Bus</i> —The distribution factor of Electrical Bus $b$ that is a component of Hub Bus $hb$ .

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Variable	Unit	Description
<i>y</i>	none	A SCED interval in the 15-minute Settlement Interval. The summation is over the total number of SCED runs that cover the 15-minute Settlement Interval.
<i>b</i>	none	An energized Electrical Bus that is a component of a Hub Bus.
<b>B</b> <i>hb, North345</i>	none	The total number of energized Electrical Buses in Hub Bus <i>hb</i> that is a component of “North 345.”
<b>B</b> <i>hb, South345</i>	none	The total number of energized Electrical Buses in Hub Bus <i>hb</i> that is a component of “South 345.”
<b>B</b> <i>hb, Houston345</i>	none	The total number of energized Electrical Buses in Hub Bus <i>hb</i> that is a component of “Houston 345.”
<b>B</b> <i>hb, West345</i>	none	The total number of energized Electrical Buses in Hub Bus <i>hb</i> that is a component of “West 345.”
<i>hb</i>	none	A Hub Bus that is a component of the Hub.
<b>HB</b> <i>North345</i>	none	The total number of Hub Buses in “North 345.”
<b>HB</b> <i>South345</i>	none	The total number of Hub Buses in “South 345.”
<b>HB</b> <i>Houston345</i>	none	The total number of Hub Buses in “Houston 345.”
<b>HB</b> <i>West345</i>	none	The total number of Hub Buses in “West 345.”

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