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June 1, 2021

To interested parties in PUC Project Nos. 51617 and 51812

Various parties have filed in Project No. 51812 comments and requests for action regarding pricing, settlement, and potential resettlement in the ERCOT wholesale power market. Relatedly, Vistra Corp. commissioned a study to determine what market-clearing prices would have been during February 15-19, 2021 in the absence of the pricing rule that the Commission issued and amended in orders adopted in Project No. 51617 on February 15 and 16, 2021. Vistra Corp. believes the study will be of interest to many parties. The study, entitled *Analysis of ERCOT market prices during February 2021 winter storm event*, is attached to this letter.

Sincerely,

/s/ William A. Moore

William A. Moore

Attachment: *Analysis of ERCOT market prices during February 2021 winter storm event*

Analysis of ERCOT market prices during February 2021 winter storm event

prepared for Vistra Corp.

May 28, 2021

LONDON ECONOMICS

London Economics International LLC ("LEI") was engaged to provide independent, expert economic analysis related to the February 2021 winter storm event in Texas. During the winter storm event, certain orders were issued by the Public Utility Commission of Texas ("PUCT") and executed by the Electric Reliability Council of Texas ("ERCOT") system operator which impacted the price of electric energy.

LEI examined what real time energy prices in ERCOT would have been in the absence of the PUCT Orders and ERCOT's execution of those Orders. LEI's examination was based on data available from the ERCOT system operator; and on ERCOT's rules, also known as the Protocols, which govern the way in which the ERCOT energy market is operated. LEI found that between 22:15 on February 15th and 9:00 on February 19th, energy prices would have averaged $2,404/MWh if not for the PUCT Orders. This market outcome would mean $6,578/MWh lower real time energy prices than the prices reported by ERCOT as a result of the PUCT Orders.

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1 Executive summary

LEI was engaged to provide an independent analysis of energy market outcomes in ERCOT during the week of February 15, 2021, focusing on estimation of what energy prices would have been if the PUCT's Orders *Directing ERCOT to Take Action and Granting Exception to Commission Rules* from February 15th 2021 and February 16th 2021 had not been issued (or are vacated).

1.1 ERCOT's adjustments to energy prices can be reversed

ERCOT made intentional changes to its real-time energy price setting process to implement the PUCT's directive to have energy prices go to $9,000/MWh. ERCOT also disabled the dynamic change to certain price adders in the Scarcity Pricing Mechanism ("SPM"). Overall, the actions taken by the ERCOT system operator to implement the PUCT Orders were straightforward, as described further in Section 3.1. As such, it was also a straightforward matter for LEI to unwind the adjustments and revert back to the real-time energy prices pursuant to the Protocols, namely the real-time ("RT") settlement point prices ("SPPs").

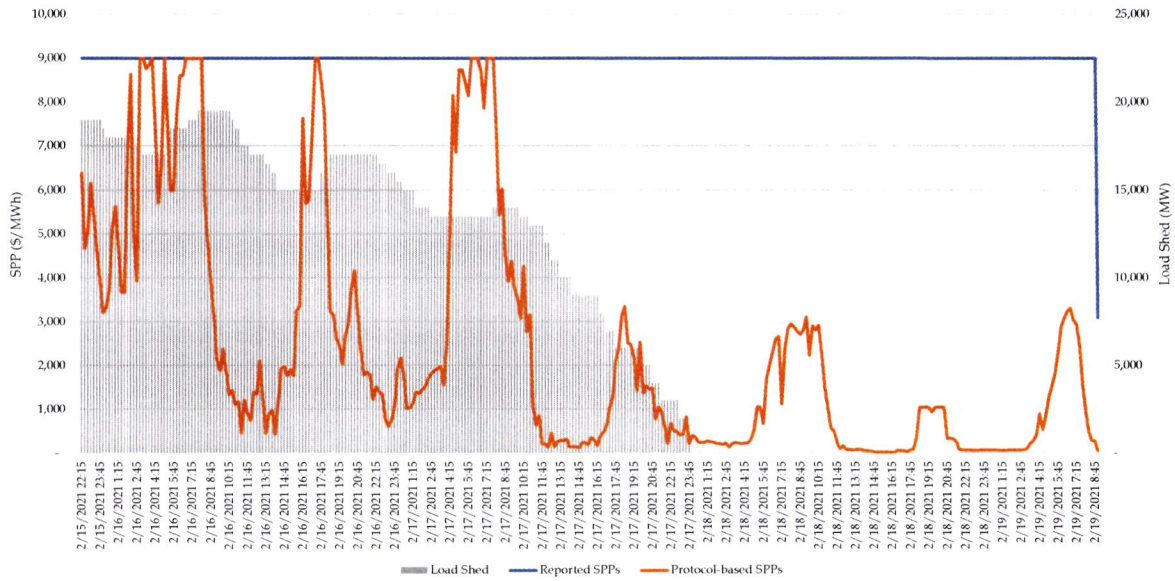
1.2 LEI used publicly available data from ERCOT to reverse ERCOT's adjustments

Relying on published market data from ERCOT, and the extensive and detailed documentation of the market price formation process in the Protocols, LEI performed a simulation analysis of the ERCOT real-time wholesale energy market from 22:15 on February 15, 2021 through 9:00 on February 19, 2021 (the "study period"). The study period was selected to begin with the first period when ERCOT began adjusting the data which determined the RT SPPs and conclude when ERCOT stopped adjusting the RT SPPs.

1.3 RT SPPs would have been substantially lower without the PUCT Orders

LEI's simulation of ERCOT RT SPPs without the PUCT Orders (which are referred to as "Protocol-based SPPs") indicates that prices would have been $2,404/MWh on average, an amount that is $6,578/MWh lower than the RT SPPs established by ERCOT after implementing the PUCT Orders (which are referred to as "Reported SPPs"). As seen in Figure 1 on the next page, the difference between Reported SPPs and the Protocol-based SPPs was the smallest when load shed (i.e., rotating outages) was at a high level (on February 15th after 22:15, and on February 16th), as the Protocol-based SPPs in many hours would have been irrelevant to ERCOT's adjustments because of supply scarcity. When load shed amounts were reduced on February 17th, the Protocol-based SPPs declined quickly owing to the return of more normal supply-demand fundamentals. However, ERCOT's Reported SPPs remained very high. By February 18th, all load shed ended, and the average Protocol-based SPPs further declined to below $1,000/MWh. Therefore, in these latter days of the week, there is a larger difference between the Reported SPPs and the Protocol-based SPPs.

Figure 1. Actual Reported SPPs vs. preliminary Protocol-based SPPs (for ERCOT Hub Average)



Timed weighted average ($/MWh)	15-Feb from 22:15	16-Feb	17-Feb	18-Feb	19-Feb until 9:00	Whole period
Reported SPPs	9,000	9,000	9,000	9,000	8,840	8,982
Protocol-based SPPs	5,168	4,194	2,614	758	965	2,404
Difference	*(3,832)*	*(4,806)*	*(6,386)*	*(8,242)*	*(7,875)*	*(6,578)*

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2 Overview of the PUCT's Orders

The PUCT directed ERCOT to implement two changes that impacted RT SPPs from February 15th to February 19th. The first change required ERCOT to set energy prices at $9,000/MWh when load was being shed. The second directive suspended the Low System-Wide Offer Cap ("LCAP") in ERCOT's Scarcity Pricing Mechanism ("SPM"), a feature of ERCOT's Protocols described in more detail below.

2.1 ERCOT's procedures in emergency situations

To understand the context of the PUCT Orders, is helpful to know about the procedures ERCOT has in place to address emergency situations. On Monday, February 8th, ERCOT issued an Operating Condition Notice ("OCN") for extreme cold weather expected from Thursday, February 11th through Tuesday, February 16th.[1] As seen in Figure 2, an OCN is the first of three levels of communication issued by ERCOT in anticipation of possible Emergency Conditions.[2] The second level is an Advisory, which is issued by the ERCOT control room if reserves fall below 3,000 megawatts ("MW"). The third level is a Watch, and that is issued if reserves fall below 2,500 MW. ERCOT forecasted the need for conservation on February 13th and issued appeals for conservation on February 14th. Nevertheless, rotating outages had to be instituted. Moreover, the scale of the loss of generation on February 15th was so large that ERCOT descended rapidly from Energy Emergency Alert Level 1 ("EEA1") to Energy Emergency Alert Level 3 ("EEA3") in less than two hours during the early morning of February 15th.

[1] ERCOT. "Extreme cold weather expected to result in record electric use in ERCOT region." February 11, 2021. http://www.ercot.com/news/releases/show/224996

[2] ERCOT. Nodal Protocols http://www.ercot.com/mktrules/nprotocols/current

Figure 2. ERCOT Energy Emergency Alert conditions and triggers

Condition	Trigger
Normal	reserves > 3,000 MW
Operating Condition Notice	need for additional resources
Conservation Alert	as needed, when tight operating conditions are expected
Advisory	reserves < 3,000 MW and not expected to recover in 30 minutes
Watch	reserves < 2,500 and not expected to recover in 30 minutes
EEA1: Conservation needed	reserves <2,300 MW and not expected to recover in 30 minutes
EEA2: Conservation critical	physical response capability ("PRC") <1,750 MW and not expected to recover in 30 minutes, or frequency < 59.91 Hz for 15 minutes
EEA3: Rotating outages in progress	PRC < 1,000 MW and not expected to recover in 30 minutes, reserves falling and frequency <59.91 Hz for 30 minutes

Source: http://www.ercot.com/content/wcm/lists/172487/ERCOT_Energy_Emergency_Alert_Communications_Matrix_May_2019_3_.pdf

2.2 PUCT's Orders intended to impact RT energy prices

The PUCT held its first meeting of the crisis on February 15th to address "two significant market anomalies identified during this EEA3 event."[3] The first issue was the relative size of RT SPPs. However, the PUCT reasoned shedding load implies that RT SPPs should clear at scarcity levels, which had been selected to be $9,000/MWh in ERCOT.

The second issue centered around the SPM and the expectation that the peaker net margin ("PNM") earnings threshold would soon be exceeded, triggering LCAP. The PNM refers to peaking units or "peakers," which are generating plants that tend to have high variable costs and therefore only operate during a few very high-demand, high-priced hours each year. The ERCOT market rules are intentionally designed to allow energy prices to rise high enough to incentivize investors to build such units, and/or keep such units running. However, if prices during a given year have been high for a sufficient period and the cumulative PNM crosses the PNM threshold, then the system-wide offer cap would switch over from $9,000/MWh to a lower system-wide cap ("LCAP") value. The concern expressed by Commissioners in the PUCT Order was that, with natural gas prices approaching the triple digits, the LCAP as defined could exceed the system-

[3] PUCT. http://www.puc.texas.gov/agency/broadcasts.aspx, and "Order Directing ERCOT to Take Action and Granting Exception of Commission Rules. Project No. 51617, Item #3. February 15, 2021. https://interchange.puc.texas.gov/Documents/51617_3_1111656.PDF

wide offer cap of $9,000/MWh, so that a switch from $9,000/MWh to LCAP would be contrary to the purpose of the rule.

The two issues addressed at the meeting resulted in an Order on February 15th that directed ERCOT to (1) adjust energy prices to be $9,000/MWh during load shed, (2) correct past prices, and (3) suspend LCAP (see Figure 3). The PUCT issued a follow-up Order on February 16th that rescinded the portion of the Order that directed ERCOT to correct past prices but maintained the other terms of the previous Order.

Figure 3. PUCT Orders issued week of February 14, 2021

Date	Reference number	Title	Issue addressed	Terms of Order
2/15/2021	PUC Project No. 51617, Item #3	Order directing ERCOT to take action and granting exception to Commission rules	Prices across the system were clearing at levels lower than system-wide offer cap, even though firm load was being shed; PUCT reasoned that load shed implies prices should clear at scarcity level	1) Directed ERCOT to ensure firm load shed is accounted for in ERCOT market signals 2) Correct past prices such that firm load shed is accounted for in ERCOT's scarcity price signals
			Very high natural gas prices could result in LCAP higher than HCAP	3) ERCOT shall suspend use of LCAP, and use HCAP (i.e., $9,000/MWh) as the system-wide offer cap
2/16/2021	PUC Project No. 51617, Item #4	Second Order directing ERCOT to take action and granting exception to Commission rules	Prices across the system were clearing at levels lower than system-wide offer cap, even though firm load was being shed; PUCT reasoned that load shed implies prices should clear at scarcity level	1) Maintained the directive to ERCOT to ensure that firm load shed is accounted for in ERCOT market signals 2) Rescinded previous order to correct past prices
			Very high natural gas prices could result in LCAP higher than HCAP	3) Maintained previous order to suspend use of LCAP, and use HCAP (i.e., $9,000/MWh) as the system-wide offer cap

Source: Public Utility Commission of Texas, https://interchange.puc.texas.gov/Documents/51617_3_1111656.PDF and https://interchange.puc.texas.gov/Documents/51617_4_1111709.PDF.

2.3 Load shed began ahead of ERCOT's implementation of the PUCT Order

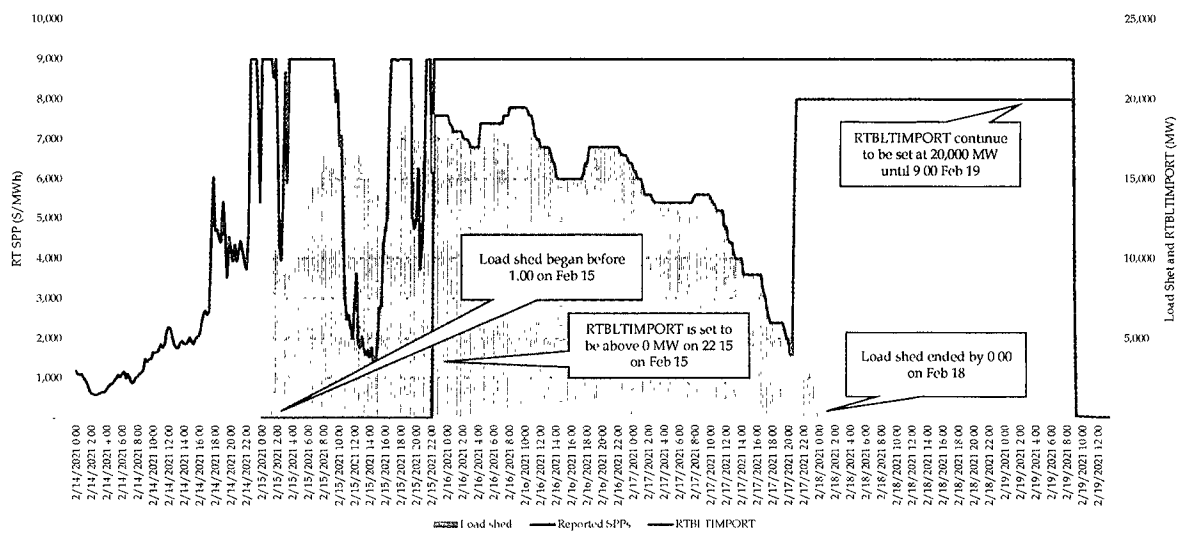
Based on data presented by ERCOT,[4] load shed began on February 15th 2021 sometime between 0:00 (midnight) and 1:00. By 1:20, rotating outages had resulted in 10,800 MW of load shed.[5]

[4] ERCOT. "Review of February 2021 Extreme Cold Weather Event – ERCOT Presentation" February 25, 2021. Slide 15. <http://www.ercot.com/content/wcm/lists/226271/Texas_Legislature_Hearings_2-25-2021.pdf>

[5] Ibid, Slide 11.

ERCOT began adjusting inputs into the market clearing engine (to implement administrative pricing under the first part of the PUCT Order) by 22:15 on February 15th. This is evidenced by a zero value for Real-Time Block Load Transfer Import ("RTBLTIMPORT") through February 15th, until Security Constrained Economic Dispatch ("SCED") Timestamp 22:15:21 when the RTBLTIMPORT value increased to 19,000 MW.[6] Based on information presented by ERCOT on February 25th,[7] load shed dropped to 0 MW by 0:00 am on February 18th, but ERCOT continued to set prices administratively at $9,000/MWh until 9:00 am on February 19th (see Figure 4).

Figure 4. Timeline of load shed and RTBLTIMPORT values



Sources: Load shed data based on ERCOT. "Review of February 2021 Extreme Cold Weather Event – ERCOT Presentation" February 25, 2021. Slide 15. RT SPPs and RTBLTIMPORT based on data titled "Real-Time ORDC and Reliability Deployment Price Adders and Reserves by SCED Interval" available on ERCOT website.

3 Methodology employed

LEI analyzed the outcome for RT SPPs as if the PUCT Orders were not issued, or vacated (referred to as "Protocol-based SPPs" as noted above). To do this, LEI i) examined the method used by ERCOT to adjust prices to implement the PUCT Orders; ii) determined whether this method could, in theory, be reversed; and iii) determined whether enough data were available to reverse the adjustment and recalculate the RT SPPs as if the Orders had not existed. LEI determined that these three conditions were satisfied.

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[6] Based on data titled "Real-Time ORDC and Reliability Deployment Price Adders and Reserves by SCED Interval" available on ERCOT website. <https://mis.ercot.com/public/data-products/markets/real-time-market?id=NP6-323-CD>

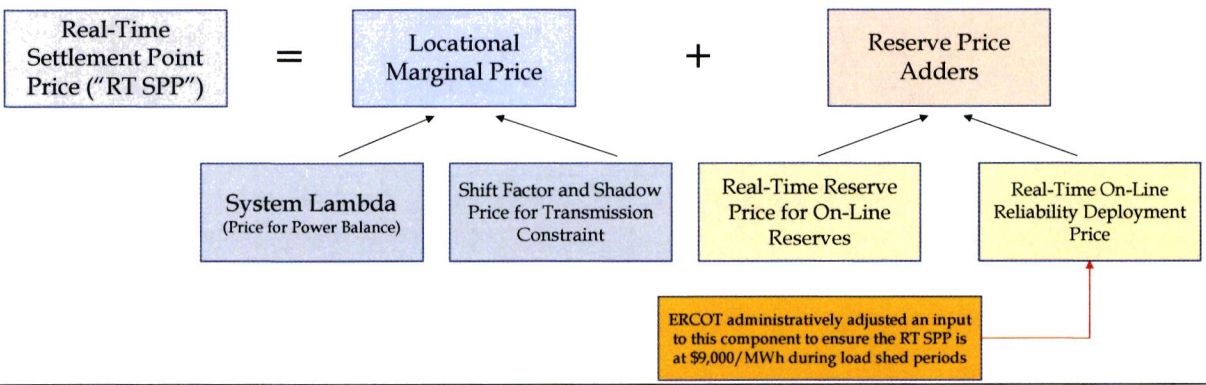
[7] ERCOT. "Review of February 2021 Extreme Cold Weather Event – ERCOT Presentation" February 25, 2021. Slide 15.

3.1 ERCOT's implementation of the PUCT's Orders

3.1.1 Part I of the PUCT Orders required energy prices of $9,000/MWh during load shed

RT SPPs are mainly comprised of two price components: an energy component, and Reserve Price Adders.[8] Reserves are supply resources which are not necessarily providing energy to the market at any given moment but stand ready to quicky begin supplying energy if called upon by ERCOT. The Reserve Price Adders provide revenues for resources which are eligible to quickly provide energy, if called upon. The Reserve Price Adders are in turn comprised of the Real-Time On-Line Reserve Price Adder ("RTORPA"), and the Real-Time On-Line Reliability Deployment Price Adder ("RTORDPA").[9] According to ERCOT's market notice, ERCOT implemented the PUCT Order by administratively adjusting a variable (the RTBLTIMPORT) that would impact the RTORDPA value (see Figure 5).[10]

Figure 5. How ERCOT administratively adjusted RT SPPs



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[8] The RT SPP is comprised of the System Lambda, which is the energy component of the energy price, a congestion component that reflects transmission constraints, and various price adders.

[9] ERCOT notes that reliability deployment suppresses real-time prices, and the purpose of the RTORDPA is to capture the impact of reliability deployment during SCED intervals. (ERCOT Market Education Basic Training Program Module 6 – Real-Time Operations, slide 98). This value is then added back to the SPP to reflect supply scarcity. ERCOT accomplishes this by calculating an alternative market clearing price based on running the SCED but assuming any reliability deployment is added to demand, and then comparing the difference between this new market clearing price (a higher value) with the prevailing RT System Lambda with reliability deployment (a lower value).

[10] ERCOT. "M-C021521-01 Emergency Order of the Public Utility Commission Affecting ERCOT Market Prices" February 15th, 2021. ERCOT implemented the PUCT Order by "making an administrative adjustment to the Generation To Be Dispatched value in the Real-Time Reliability Deployment Price Adder process during all intervals in which ERCOT has directed firm Load shed" and that "to make use of existing system functionality and strictly for purposes of the Real-Time Reliability Deployment Price Adder process, this cumulative MW value will be entered in as a Real-Time Block Load Transfer import (RTBLTIMPORT) and will appear in any associated Market-facing reports as such."

The RTBLTIMPORT was zero throughout February 15th (and all hours in February 2021 prior to February 15th) until SCED Timestamp 22:15:21, when it increased to 19,000 MW, which is the same level of load shed reported in that interval. After that, the RTBLTIMPORT generally followed the amount of load shed until 20:45 (8:45 pm) on February 17th. After 20:45, the RTBLTIMPORT value decoupled from the load shed quantity and was set at 20,000 MW until 9:00 on February 19th.[11]

The purpose of setting a high RTBLTIMPORT was to ensure that the Generation To Be Dispatched ("GTBD") would be high, such that the SCED process used to determine the RTORDPA following Protocol 6.5.7.3.1(2) would result in the prices at the capped level of $9000/MWh.[12]

3.1.2 Part II of the PUCT Orders suspended the LCAP

The second part of the PUCT Orders related to the SPM. Owing to abnormally high natural gas prices, PUCT was concerned that the LCAP would exceed the High System-Wide Offer Cap ("HCAP"), counter to the intention of market designed when the PNM system was first implemented. According to ERCOT's market notice, it implemented this Order by continuing to use the HCAP as the System-Wide Offer Cap ("SWCAP") "until after the Commission's next open meeting."[13] The relationship of SWCAP, HCAP, and LCAP are illustrated in Figure 6.

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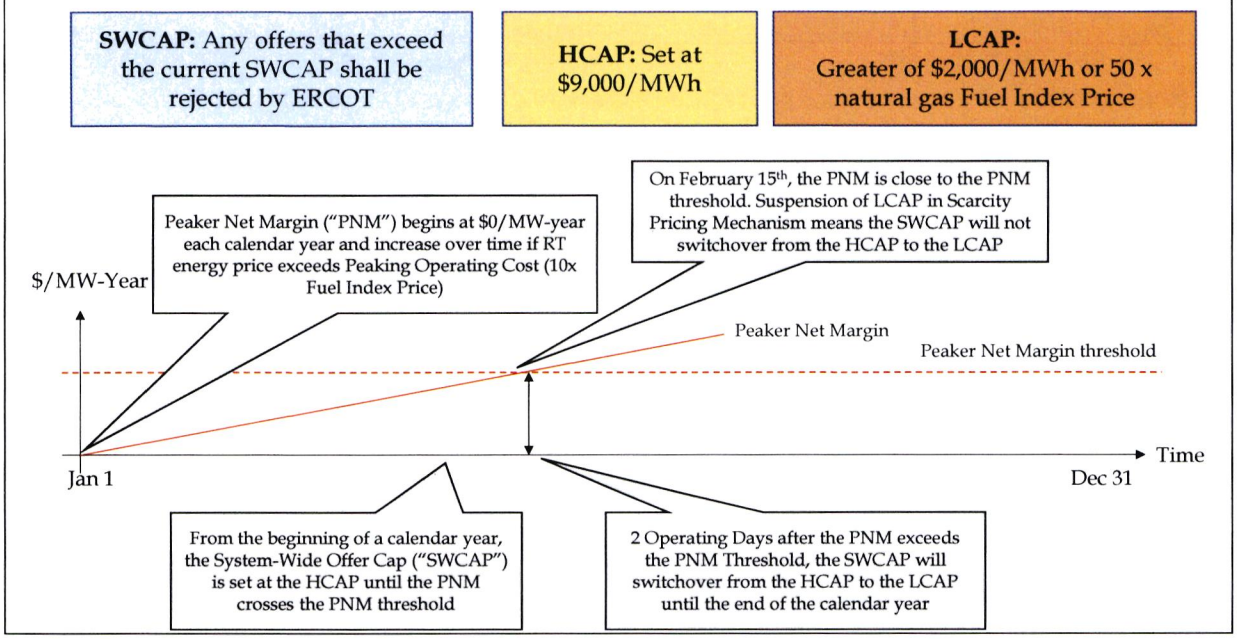
[11] ERCOT. M-C021521-03 Legal. Update: Public Utility Commission Emergency Orders Affecting ERCOT Market Prices February 17, 2021.

[12] If the GTBD is set sufficiently high, then the SCED to determine the impact of reliability deployment will not be able to clear the market, thus guaranteeing the RT SPPs (which is the sum of System Lambda, RTORPA, and RTORDPA) is at the system-wide offer cap.

[13] ERCOT. "M-C021521-01 Emergency Order of the Public Utility Commission Affecting ERCOT Market Prices" February 15th, 2021.

Figure 6. Relationship between SWCAP, HCAP and LCAP



The result of ERCOT's implementation of the Orders was that SWCAP was set at $9,000/MWh through March 4th (for the Day Ahead market) and March 5th (for the RT market) in 2021.[14] The value of the SWCAP directly impacts the RT SPP as ERCOT would reject any supply offers above the SWCAP. It is also a parameter that determines the RTORPA.[15] Therefore, suspending the LCAP in the SPM not only impacted energy market prices during hours that would have been capped by LCAP, but also in hours when the value of RTORPA was non-zero.

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[14] ERCOT Market Order M-B030321-01 "Transition of System-Wide Offer Cap (SWCAP) to Low System-Wide Offer Cap (LCAP)." March 3rd, 2021.

[15] More specifically, ERCOT's *Other Binding Document Revision Request 015 – Linking of VOLL to the Effective SWCAP effective June 12th, 2019* determined that the VOLL used to calculate the RTORPA would be equal to the prevailing SWCAP. According to ERCOT's Methodology for Implementing Operating Reserve Demand Curve to Calculate Real-Time Reserve Price Adder in Section 2.3, the RTORPA is determined as

$$RTORPA = \max(0, VOLL - System\ Lambda) \times 0.5 \times \pi(RTOLCAP) + RTOFFPA$$

This implies that the smaller the VOLL, the smaller is the value of (VOLL – System Lambda), which would lower the value of RTORPA, and vice versa.

3.2 How LEI calculated Protocol-based SPPs

LEI determined that Protocol-based SPPs could be calculated by removing ERCOT's administratively adjusted RTBLTIMPORT value, allowing the SWCAP to switch from HCAP to LCAP according to the Protocols, and then simulating the revised RTORDPA value.

3.2.1 Removing ERCOT's RTBLTIMPORT administrative adjustment

Based on data provided in ERCOT's *Historical Real-Time Operating Reserve Demand Curve ("ORDC") and Reliability Deployment Price Adders and Reserves*, the RTBLTIMPORT values were zero in all hours in the week of February 12th except between 22:15 February 15th to 9:00 February 19th. LEI assumed that all of the non-zero RTBLTIMPORT values were set administratively by ERCOT to comply with the PUCT Orders, and that the RTBLTIMPORT values would have been zero but for the PUCT Orders. When calculating the RTORDPA, LEI used the value of zero for all intervals for the RTBLTIMPORT parameters.

3.2.2 Reversing the $9,000/MWh directive

LEI calculated the RTORDPA value from 22:15 on February 15th to 9:00 on February 19th for each SCED interval[16] using a five-stage process (see Figure 7):

1. First, LEI reconstructed the generation and load resources offer curves using 15-minute interval data from ERCOT's SCED (Step 2) offer data;
2. Next, LEI generated a smoothed supply curve, using linear interpolation of step-wise bid-quantity pairs consistent with the mechanics that ERCOT deploys;[17]
3. Third, using the reported System Lambda, LEI identified the amount of MWs that cleared the market, based on the reconstructed energy offer curve during each 5-minute SCED interval (sometimes more frequently based on actual SCED timestamps, which LEI followed);[18]
4. Fourth, LEI determined a new clearing price for each SCED interval by identifying what prices would clear the energy offer curve if demand exceeded the clearing MW calculated in stage 3 above by the reliability deployment amount suggested by ERCOT (with the administratively adjusted RTBLTIMPORT value set to zero);

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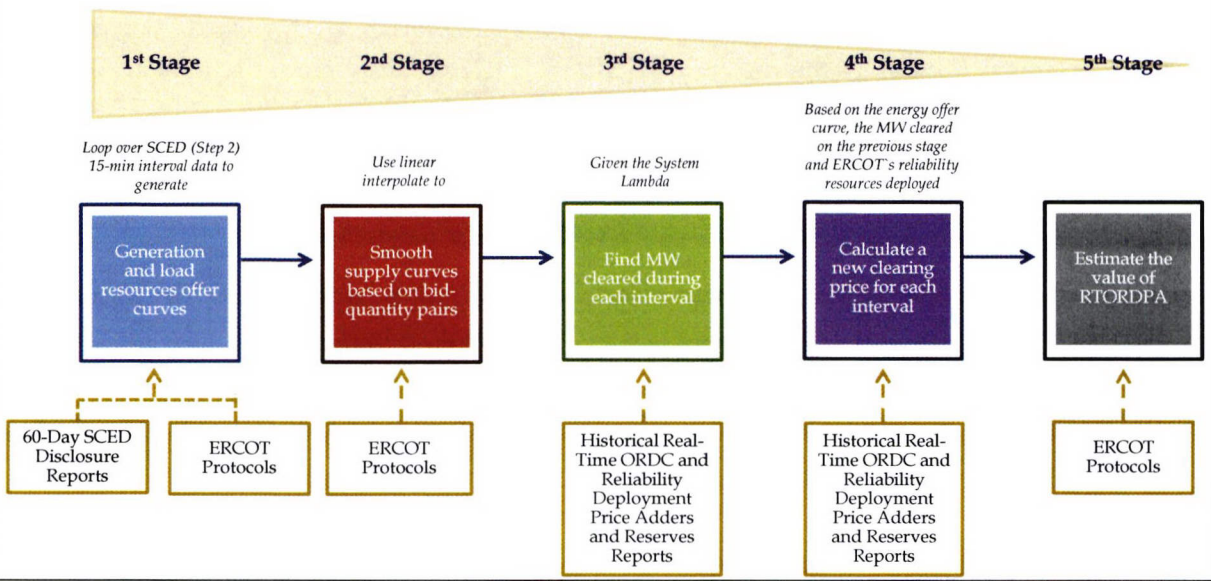
[16] Normally, SCED calculations are run every 5-minutes by US RTOs/ISOs. However, ERCOT can conduct more frequent SCED runs if needed. Based on data available on ERCOT disclosure reports, there were 1,088 SCED runs between February 15th 22:15 to February 19th 9:00.

[17] LEI also verified the accuracy of the constructed offer curves by comparing LEI's reconstructed and smoothed offer curves against the anonymized RT SCED energy offer curves provided in ERCOT's 2-Day DAM and SCED Energy Curves Reports.

[18] Other than the 19 SCED intervals during which System Lambda exceeded the LCAP on February 19th, LEI took the System Lambda published in the *Historical Real-Time ORDC and Reliability Deployment Price Adders and Reserves* by ERCOT as a fixed input, as System Lambda - barring behavioral changes of market participants in the aftermath of the PUCT Orders, should not have been impacted by the changes that ERCOT made to implement the $9,000/MWh directive. For more details, see Section 3.2.2.

5. Lastly, LEI calculated the value of the RTORDPA by following Protocol 6.5.7.3.1(2)(n) to (p), which defines RTORDPA as the minimum of the difference between the System Lambda and the new clearing price determined in LEI's previous stage, and the amount resulting from subtracting the sum of the System Lambda and the RTORPA from the VOLL. The Protocol-based SPP is the sum of the System Lambda, RTORPA, and RTORDPA.

Figure 7. LEI's steps to re-calculate RT SPPs



Note that the ROTRDPA values LEI calculated reflect the updated System Lambda and RTORPA without suspension of the LCAP in the Scarcity Pricing Mechanism. Therefore, LEI also restored the LCAP through the methodology described below in Section 3.2.3.

3.2.3 Restoring the LCAP in the Scarcity Pricing Mechanism

Based on Protocol 4.1.11.1(3), the suspension of LCAP would not affect RT SPP until February 19th, as the realized PNM did not exceed the PNM Threshold until February 19th. In addition, there were no hours after 9:00 am on February 19th with a System Lambda greater than $2,000/MWh (the lower bound of LCAP) or with a non-zero RTORPA value. Therefore, restoring the LCAP only required LEI to recalculate the System Lambda and RTORPA from 0:00 to 9:00 on February 19th.

With LCAP restored, based on Protocol 4.4.11, the daily value of LCAP would be set at the higher of (i) $2,000/MWh for energy and $2,000 per MW per hour for Ancillary Services, or (ii) fifty times the effective daily Fuel Index Price ("FIP"), expressed in dollars per MWh for energy.

The Protocols define FIP as the "daily midpoint or average of the prices for natural gas fuel for the Katy area (Katy Hub), expressed in dollars per million British thermal units ("$/MMBtu").[19] Based on the FIP of $66.36/MMBtu on February 19th,[20] the LCAP would have been set at $3,318/MWh for that day.

To reverse the PUCT Orders related to suspension of LCAP in the SPM, LEI reviewed the System Lambda for all the 5-minute SCED intervals from 0:00 to 9:00 on February 19th and replaced any value that exceeded the LCAP value of $3,318/MWh. There were five (5) 5-minute SCED intervals with System Lambda exceeding this value. LEI then used the values found in ERCOT data files titled *Real-Time ORDC and Reliability Deployment Price Adders and Reserves by SCED Interval* and *LOLP Distribution by Season and TOD Block*[21] as inputs into ERCOT's RTORPA formula to recalculate the value of RTORPA, using the LCAP value of $3,318/MWh as the VOLL.

The updated System Lambda and RTORPA were used as inputs to recalculate the RTORDPA using the methodology described in Section 3.2.2 above.

3.3 Data relied on by LEI to determine Protocol-based SPPs

LEI developed a simulation of the price formation process used by ERCOT in the RT market, built on the specific aspects of the ERCOT Protocols and 15-minute and 5-minute data compiled by ERCOT and released publicly sixty days after real-time market operations.

There were several sources of published ERCOT data that LEI relied on to build the offer curves. The main data source was the *60-Day SCED Disclosure Report*, which contains the generation resource and load resource data in SCED, including the energy offer curves for individual resources used by LEI to reconstruct the SCED energy offer curve for stage 1 and 2 described in Section 3.2.2.

LEI also relied on ERCOT's *2-Day DAM and SCED Energy Curves Reports* to verify that the SCED energy offer curves constructed by LEI based on the 60-Day SCED data were consistent with the anonymized SCED energy offer curve published in ERCOT's 2-Day report.

For 5-minute (or more frequent) SCED interval data, including System Lambda, MWs of reliability deployment, value of RTBLTIMPORT, and ERCOT's published RTORDA and RTORDPA values, LEI relied on data provided in ERCOT's *Historical Real-Time ORDC and Reliability Deployment Price Adders and Reserves*.[22] Also, the parameters for loss of load probability

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[19] ERCOT Nodal Protocols. Page 34. January 1, 2021.

[20] Data provided by ERCOT staff on May 25th 2021, upon Vistra Corp.'s request

[21] Available on ERCOT website
<http://mis.ercot.com/misapp/GetReports.do?reportTypeId=13233&reportTitle=LOLP%20Distribution%20by%20Season%20and%20TOD%20Block&showHTMLView=&mimicKey>

[22] This report shows the sum of each type of available reserves, including total Real-Time reserve amount for On-Line reserves and, total Real-Time reserve amount for Off-Line reserves, and the Real-Time Reserve Price Adders

("LOLP") for inputs into RTORPA calculation is obtained from *LOLP Distribution by Season and TOD Block* provided on ERCOT's website.

For data related to load shed quantity, LEI relied on the presentation titled "Review of February 2021 Extreme Cold Weather Event - ERCOT Presentation" dated February 25, 2021.

Regarding market rules and specific calculation methods for individual RT SPP components, LEI relied on ERCOT's Protocols as of January 21, 2021, as well as presentation materials from ERCOT Market Education, *Methodology for Implementing ORDC to Calculate Real-Time Reserve Price Adder* version 2.6, updated on June 9, 2020.

3.4 Benchmarking LEI's simulator

To verify the accuracy of LEI's simulation of the SCED, LEI conducted a backcast of RT SPPs from 0:00 am to 22:15 on February 15 2021. LEI chose this period for the backcast because these are the only SCED intervals where RTORDPA values were non-zero and at the same time ERCOT had not started administratively adjusting the RTBLTIMPORT values to force RT SPPs to $9,000/MWh.[23] The backcast RT SPPs closely follow the RT SPPs reported by ERCOT during the benchmarking period (see Figure 8). In fact, the average error between the two values during the benchmark period is within +/-1%, which suggests a substantial level of accuracy for the simulator.[24]

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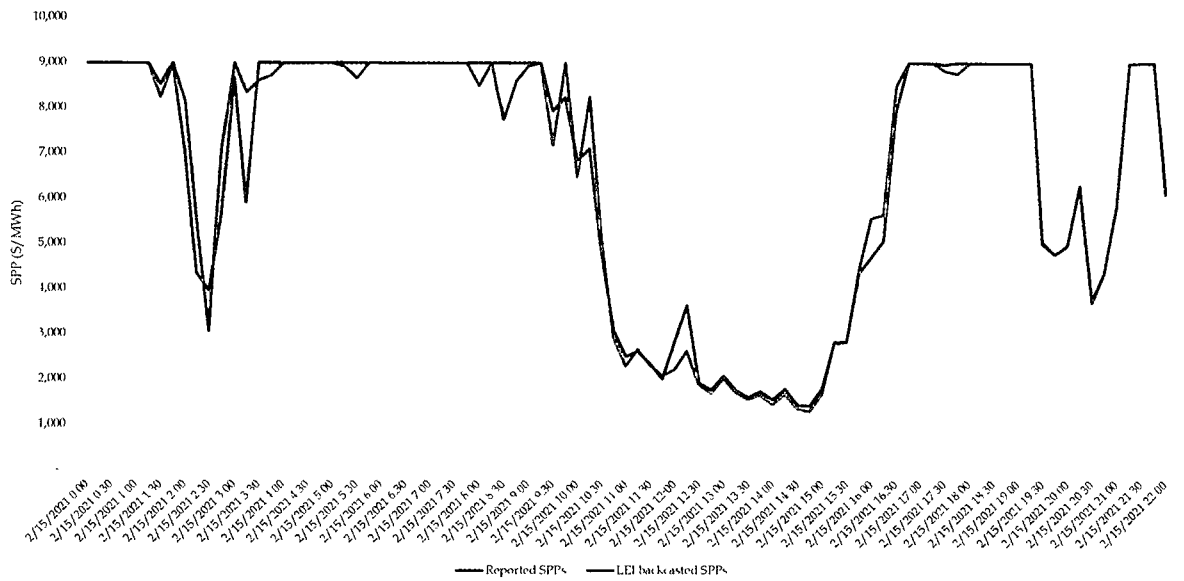
for On-Line Reserves and Real-Time Reserve Price Adders for Off-Line Reserves for all the SCED intervals in the previous week. The report also shows the total RUC/RMR LDL relaxed, total Load Resource MW deployed that is added to the Demand, total ERS MW deployed that is added to the Demand, total LASL, total HASL, and the Real-Time On-Line Reliability Deployment Price Adder for all the SCED intervals in the previous week.

[23] Market rule changes in 2019 and 2020, such as OBDRR017 "Related to NPRR987, BESTF-3 Energy Storage Resource Contribution to Physical Responsive Capability and Real-Time On-Line Reserve Capacity Calculations" and OBDRR020 "RTC - Methodology for Setting Maximum Shadow Prices for Network and Power Balance Constraints" may have impacted how RTORDPA or RT SPPs in general were being cleared, leading to benchmarking LEI's simulator using high-priced hours before 2021 not meaningful

[24] We discuss potential reasons for the 1% difference in Section 4 of this report.

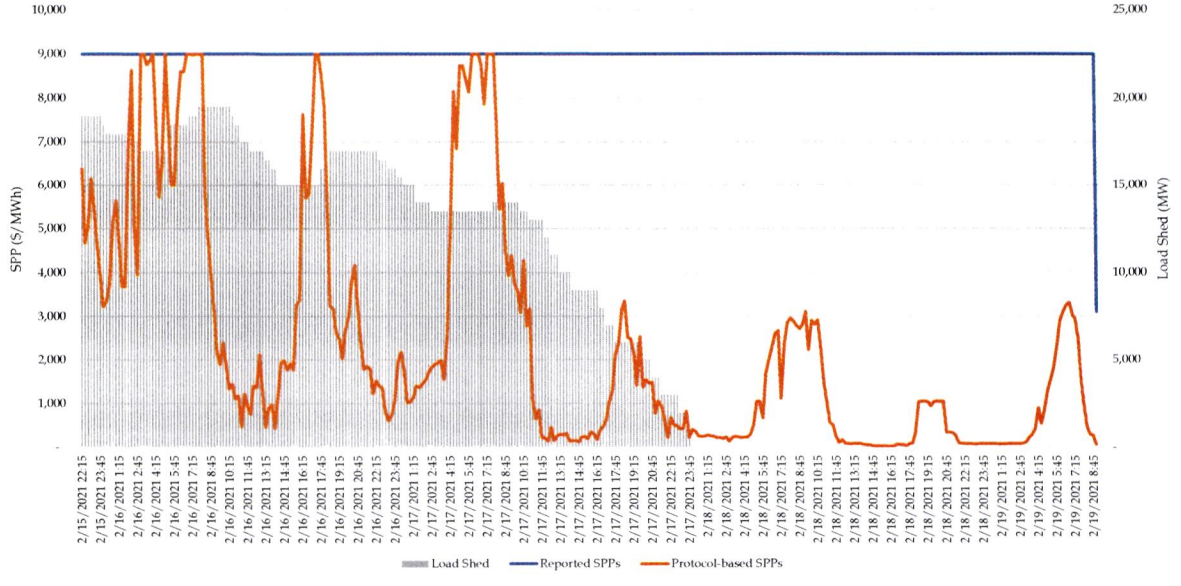
Figure 8. ERCOT reported SPPs vs LEI backcasted SPPs on February 15th, 2021 0:00 to 22:15



4 Preliminary findings

Based on LEI's analysis, Protocol-based SPPs would have averaged $2,404/MWh over the period of 22:15 on February 15, 2021 (when ERCOT started administratively adjusting the RT SPP) through 9:00 on February 19, 2021 (when ERCOT stopped administratively adjusting the RT SPP).[25] A comparison of the Protocol-based SPPs (orange line) and Reported SPPs (blue line) can be found in Figure 9. The average price for RT SPPs is $6,578/MWh lower than the prices which resulted from implementation of the PUCT Orders.[26]

Figure 9. Hub average Reported SPPs vs. Protocol-based SPPs



Timed weighted average ($/MWh)	15-Feb from 22:15	16-Feb	17-Feb	18-Feb	19-Feb until 9:00	Whole period
Reported SPPs	9,000	9,000	9,000	9,000	8,840	8,982
Protocol-based SPPs	5,168	4,194	2,614	758	965	2,404
Difference	*(3,832)*	*(4,806)*	*(6,386)*	*(8,242)*	*(7,875)*	*(6,578)*

As described in Section 3.2, the RT SPP is the sum of the System Lambda, RTORPA, and RTORDPA. When calculating the Protocol-based SPPs, LEI changed the System Lambda for 5 SCED intervals (between 06:35 and 07:00 on February 19th) because reported System Lambda exceeded the LCAP value if LCAP was not suspended. Also, the change of SWCAP value only

[25] LEI focused on this specific time period because it is during these intervals that ERCOT set the RTBLTIMPORT values administratively to be non-zero.

[26] The day of February 18th had the largest price difference between the Reported RT SPPs and the Protocol-based SPPs, mainly because the MWs of reliability deployment on February 18th were low, leading to a relatively small simulated RTORDPA value.

impacted the RTORPA values on February 19th if LCAP were not suspended.[27] In all other periods within the time analyzed, only the RTORDPA value were affected in the Protocol-based SPPs.[28]

During the entire period, except for the final 15-minute interval, the sum of System Lambda, RTORPA, and RTORPA reported by ERCOT was $9,000/MWh. The final 15-interval price was lower than $9,000/MWh because RT SPPs are settled at 15-minute intervals, and only the first SCED interval is at $9,000/MWh. The time-weighted average Protocol-based SPPs over this time period was $2,404/MWh.

Compared to the Reported SPPs, Protocol-based SPPs track the level of load shed more closely (the grey bars in Figure 9 represent load shed, while the orange line is the Protocol-based SPPs and the blue line is the Reported SPPs). When the level of load shed peaked, on February 15th and 16th, the Protocol-based SPPs were also high, at an average price level of $5,168/MWh on February 15th after 22:15, and $4,194/MWh on February 16th. Nevertheless, these prices are substantially lower than the administrative price of $9,000/MWh. Protocol-based SPPs are lower than the VOLL during these initial days, because there was sufficient supply to meet demand (after accounting for load shed).[29] As the level of load shed started to decrease rapidly on February 17th, Protocol-based SPPs also declined. When load shed stopped on February 18th, Protocol-based SPPs dropped further, to an average of $758/MWh. Finally, on February 19th, due to the binding nature of the LCAP (if it had not been suspended), the Protocol-based SPPs would have been less than $3,318/MWh.

As noted previously, LEI benchmarked its simulation model against actual ERCOT hourly price data for February 15th from 0:00 am to 22:15 and found the simulation results were within +/- 1% of reported prices during this benchmark period. The frequency and magnitude of the deviation is relatively small, but could be the result of:

(i) data limitations (we did not have access to 5-minute data for all inputs);
(ii) software limitations (we used a simulator rather than ERCOT's actual SCED program);
(iii) congestion charges (although during emergency conditions, ERCOT has the ability to relax transmission constraints, reducing the impact or congestion on SPPs); and

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[27] The restoration of LCAP in the Scarcity Pricing Mechanism would impact the RT SPPs on February 19th from 0:00 to 9:00. The size of the impact is relatively small (on average less than $100/MWh) as compared to the impact of reversing the $9,000/MWh directive in the PUCT Orders.

[28] If LCAP in the Scarcity Pricing Mechanism was suspended but the part of the PUCT Order that directed energy prices to be set at $9,000/MWh during load shed period were vacated, then the Protocol-based SPP on February 19th from 0:00 am to 9:00 am would be on average <$100/MWh higher than the scenario where LCAP is suspended.

[29] This is because during many hours in February 15th and 16th, and MW of supply offered in the SCED energy offer curve would have been sufficient to meet the GTBD even after adding the amount of real-time reliability deployment.

(iv) an assumption that the PUCT Orders did not impact market participant behavior[30] that would affect dispatch and the market-clearing process.

Despite the factors above, LEI's simulator was able to predict simulated SPPs (hub level) quite precisely.

[30] LEI assumed that market participants would behave in the same way in the Nodal Protocol-based SPPs simulation as they did in the Reported SPPs case; this allowed LEI to use the System Lambda

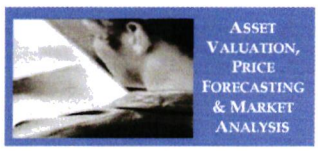
5 Appendix 1: List of acronyms

Acronym	Description
$/MMBtu	Dollars per million British thermal units
AEC	Alberta Energy Commission
EEA1	Energy Emergency Alert Level 1
EEA3	Energy Emergency Alert Level 3
ERCOT	Electric Reliability Council of Texas
ERS	Emergency Response Service
FERC	Federal Energy Regulatory Commission
FIP	Fuel Index Price
GTBD	Generation To Be Dispatched
HASL	High Ancillary Service Limit
HCAP	High System-Wide Offer Cap
LASL	Low Ancillary Service Limit
LCAP	Low System-Wide Offer Cap
LDL	Low Dispatch Limit
LEI	London Economics International LLC
LOLP	Loss of Load Probability
MW	Megawatts
NPRR	Nodal Protocol Revision Requests
NYPSC	New York Public Service Commission
OBDRR	Other Binding Document Revision Request
OCN	Operating Condition Notice
OEB	Ontario Energy Board
ORDC	Operating Reserve Demand Curve
PNM	Peaker Net Margin
PUCT	Public Utility Commission of Texas
RMR	Reliability Must Run
RT	Real-Time
RTBLTIMPORT	Real-Time Block Load Transfer Import
RTOFFCAP	Real-Time Off-Line Reserve Capacity
RTOLCAP	Real-Time On-Line Reserve Capacity
RTORDPA	Real-Time On-Line Reliability Deployment Price Adder
RTORPA	Real-Time On-Line Reserve Price Adder
RUC	Reliability Unit Commitment
SCED	Security Constrained Economic Dispatch
SPM	Scarcity Pricing Mechanism
SPP	Settlement Point Prices
SWCAP	System-Wide Offer Cap
US	United States
TOD	Time of day
VOLL	Value of Lost Load

6 Appendix 2: Introduction to London Economics International LLC

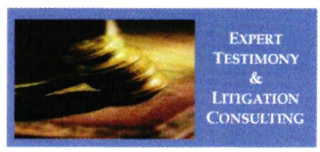
LEI is a global economic, financial, and strategic advisory professional services firm specializing in energy and infrastructure. The firm combines detailed understanding of specific network and commodity industries, such as electricity generation, transmission, and distribution, with a suite of proprietary quantitative models to produce reliable and comprehensible results. LEI's areas of expertise include market design, covering the complex features of both energy and capacity markets (see Figure 10).

Figure 10. LEI's areas of expertise



- **Exhaustive sector knowledge and a suite of state-of-the-art proprietary quantitative modeling tools**
  - Wholesale electricity market models
  - Valuation and economic appraisal
  - Due diligence support
  - Cost of capital database
  - Contract configuration matrices

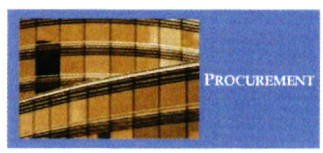
- **Market design, market power and strategic behavior advisory services**
  - Electricity
  - Natural Gas
  - Water
- **Incentive ratemaking**
  - Quantify current and achievable efficiency levels for regulated industries
  - Convert findings into efficiency targets mutually acceptable to utilities and regulators



- **Reliable testimony backed by strong empirical evidence**
- **Expert witness service**
  - Material adverse change
  - Materiality
  - Cost of capital
  - Market power
  - Tax valuations
  - Contract frustration

- **Creating detailed market simulations to identify beneficiaries and quantify costs and benefits from proposed distribution and transmission lines**
  - Valuing D&TS
  - Transmission tariff design
  - Procurement process and contract design

- **Renewable energy policy design, procurement, modeling, and asset valuation**
  - Solar, wind, biomass, and small hydro
  - Demand response
  - Cogeneration
  - Energy efficiency
  - Micro-grids
  - Emissions credits trading
  - Energy storage technologies



- **Designing, administering, monitoring, and evaluating competitive procurement processes**
  - Auction theory and design
  - Process management
  - Document drafting and stakeholder management

The firm has its roots in advising on the initial round of privatization of electricity, gas, and water companies in the United Kingdom. Since then, LEI has advised private sector clients, market institutions, and governments on privatization, asset valuation, tariff design, market design, and strategy development in virtually all deregulated markets worldwide, including the United States, Canada, Europe, Asia, Latin America, Africa, and the Middle East. LEI is active across the power sector value chain and has a comprehensive understanding of the issues faced by investors, utilities, and regulators.

The following attributes make LEI unique:

- *clear, readable deliverables* grounded in substantial topical and quantitative evidence;
- *internally developed proprietary models* for electricity price forecasting incorporating game theory, real options valuation, Monte Carlo simulation, and sophisticated statistical techniques;

- *balance of private sector and governmental clients* enables LEI to effectively advise both regarding the impact of regulatory initiatives on private investment and the extent of possible regulatory responses to individual firm actions;
- *ability to advise on the nuances of electricity market design* LEI has helped both private sector clients and regulators test and critique specific market designs, as well as develop practical and workable designs for energy and capacity markets; and
- *worldwide experience* backed by multilingual and multicultural staff.

6.1 Selected engagements

LEI has extensive experience in analyzing the Texas electricity market, and electricity systems across North America and globally. Our clients include private sector companies and regulatory institutions, as well as both local market participants and foreign companies seeking investment opportunities. We have performed engagements related to wholesale energy and capacity market design, market modeling, asset valuation, regulatory review and rate design, and strategic advisory. The below list details some of the engagements LEI has completed in relation to North American electricity markets, and particularly for Texas.

6.1.1 Price corrections, price outlooks, and price impacts of market design changes

- LEI was asked to review Proposed Rule 25.505 in PUCT Project No. 31972. As part of the Proposed Rule, the PUCT recommended implementation of a Scarcity Pricing Mechanism, to be administered by ERCOT. The proposed SPM was intended to monitor Balancing Energy Services prices and trigger, under certain conditions, the imposition of a temporary decrease in system-wide offer caps. The SPM was intended to be a resource adequacy mechanism for ERCOT's energy-only market, to balance concerns about market power with the need to maintain proper investment signals through legitimate scarcity pricing. LEI recommended several changes to the PUCT Staff's proposed SPM to more accurately represent the proper market definition of wholesale power market competition in Texas and realities of generation investment. LEI's recommendations were filed as expert witness testimony.

- LEI assisted a major investor-owned utility in the review of the PUCT staff Strawman on market power definition. At the client's request, LEI conducted a Granger-price causality analysis for market definition purposes. The analysis was undertaken to determine both the product and geographical market definitions.

- LEI was hired by a large independent power producer to evaluate the impact of potential future carbon regulations on ERCOT's energy markets and on a power generator's portfolio. LEI used its dispatch and simulation model POOLMod to develop forecasts of energy prices in ERCOT under a variety of potential frameworks under which carbon emissions could be regulated. The purpose of this exercise was: a) to evaluate the impact of a carbon rule (of any shape) on wholesale energy prices, and on the performance of the power generator's portfolios; b) to determine the most impactful carbon rule regulatory framework.

- LEI was retained by a US developer to value a three-way high-voltage direct current connection between the Eastern, Western, and ERCOT interconnections. LEI utilized its

proprietary production cost simulation model, POOLMod, to project energy prices in the markets surrounding the proposed project, including Southwest Power Pool, Western Electricity Coordinating Council and ERCOT. LEI was responsible for developing revenue forecasts for the project over a 20-year period. LEI also advised on other financing, regulatory, and development issues related to the project.

- LEI was retained by a large vertically integrated utility to analyze potential implications of Ontario moving to nodal pricing. LEI reviewed the Independent Electricity System Operator's new and historical nodal pricing consultations and assessed differences between historical nodal and settlement prices, internal transmission constraints, inter-jurisdictional trade paths and potential wheel-through transactions. A final paper presented LEI's analysis of potential impacts of nodal pricing and transmission constraints in Ontario on trading with a neighboring jurisdiction.

- LEI was retained by a Canadian industrial conglomerate to estimate damages incurred because of power price changes during the life of a five-year swap agreement, which obligated the client to pay a fixed price in exchange for a floating-rate payment based on an hourly average pool price. LEI first investigated whether a material change in the determination of market-clearing prices in the Power Pool of Alberta had occurred on a specific date, and then estimated the magnitude of the price shift attributable to the change in pricing strategy over the term of the swap agreement and the amount of the resulting damages.

- LEI was commissioned by the US division of a Japanese industrial conglomerate to examine three long-term price forecast scenarios for the ERCOT power market.

- LEI was retained by a major Japanese gas distribution company to evaluate the economics of a wind plant in ERCOT. This engagement involved use of LEI's proprietary production simulation dispatch model to forecast annual, monthly, and hourly energy prices.

- LEI was engaged by a global investment firm to provide a market outlook for three assets located in ERCOT. LEI provided a 10-year detailed market revenue forecast for the three plants under base case assumptions.

- LEI was engaged by a global investment firm to provide a market outlook for a portfolio of assets located in ERCOT. LEI provided a 10-year detailed market revenue forecast for the assets under base case assumptions. LEI also used its Real Options model to estimate a scarcity premium that would be included in addition to the intrinsic energy revenues.

- LEI was hired to forecast the potential energy revenues of two wind farms in Texas. LEI used its proprietary dispatch model, POOLMod, to project energy prices in ERCOT. LEI examined the implications of a Purchase Power Agreement related to the two wind farms.

- LEI was retained by a Japanese power utility to examine the impact of deregulation on final prices to consumers in selected US and international jurisdictions. LEI described the basic elements of restructured power markets along with the theoretical underpinnings for the idea

that restructured power markets lead to lower prices to final consumers. LEI also provided an analysis of actual price activity in jurisdictions with a minimum of two years' experience with restructured power markets and discussed what prices might have been in these regions without deregulation. The results were then compared against theoretical models to identify areas in which restructuring could be improved.

6.1.2 Knowledge of the Texas market

- On behalf of a major investor-owned utility in the US, LEI participated in a PUCT workshop on wholesale market design. LEI presented its views on market monitoring and mitigation, views derived through LEI's extensive experience in advising on the design and implementation of market monitoring and mitigation policies for wholesale electricity markets.

- On behalf of a European utility, LEI assessed the investment environment for transmission in ERCOT. LEI provided a detailed report covering agents and institutions, the regulatory and legal framework, remuneration of investment, and transmission planning.

- LEI was engaged by ERCOT to estimate the VOLL, in aggregate and by customer class, to be used in future studies and regulatory discussions regarding resource adequacy. LEI performed a review of published studies of the VOLL in the US and other countries and assessed their applicability to ERCOT. LEI also reviewed emergency load-shedding practices of distribution service providers. LEI created an initial survey design assessment and a roadmap for survey implementation. LEI developed a list of potential survey questions for each customer class in ERCOT to assess the economic impact of past outages and the willingness to pay to reduce the likelihood of future outages. Finally, LEI worked with ERCOT to create a methodology to develop a sample pool of customers to be surveyed; LEI researched and assessed various tools that could be used to deliver the survey. ERCOT submitted LEI reports to the PUCT in PUCT Project No. 40000.

- LEI was retained by a major investor-owned utility in the US to assess how the hypothetical monopolist's test could be applied for defining the geographical market boundaries for wholesale electricity in ERCOT.

- LEI was retained by a Canadian industrial conglomerate to provide a detailed overview and analysis of the ERCOT power market. Topics covered included market structure, pricing issues for both fuel and electricity, long-run economics, supply/demand balance, and renewable energy requirements.

- LEI prepared a white paper for a northeastern US independent power producer on the extent of competition in the residential and commercial retail electricity market in Texas to support a potential acquisition by the client. LEI analyzed the history and size of the retail electricity market in Texas as well as the characteristics of active participants and customer switching trends. The paper included a review of Department of Justice and Federal Trade Commission Horizontal Merger Guidelines and a Herfindahl-Hirschman Index market share analysis.

- LEI was retained by a large independent power producer to determine its ability to acquire generation in ERCOT zones. LEI worked in conjunction with an engineering firm to conduct a transmission power flow study to establish thermal limits between load zones. LEI then conducted zonal market power analysis and performed a preliminary local market power mitigation assessment.

- LEI was engaged by a large oil and gas producer in West Texas and other regions to provide a workshop on topics related to behind-the-meter solar, with a focus on ERCOT. The topics included examination of the terms of Purchase Power Agreements and virtual Purchase Power Agreements, the value components (Renewable Energy Certificates, net metering, avoided distribution costs) of a typical behind the meter project, and the process of interconnecting with ERCOT and with the transmission and distribution service provider.

- LEI was retained to provide a set of memos for a potential investor in ERCOT: 1) memo on mergers and acquisition activities for the past 5 years and why buyers acquire merchant plants 2) memo on whether the PUCT and ERCOT had considered the need for more peakers or other gas plants to firm up wind and how/whether this is included in decision-making about wind and 3) memo on Competitive Renewable Energy Zones expansion policy examining the decision-making process for Competitive Renewable Energy Zones in the past, and what is likely for the future.

6.1.3 Expert testimony experience

- LEI prepared an independent analysis of the spot market and forward market impacts of outage scheduling practices by a major power producer over the period of 2010-2011; the analysis was filed with the Alberta Utilities Commission ("AUC") as part of a litigated case of alleged market power abuse. [AUC Proceeding No. 3110]

- On behalf of a US utility, LEI examined issues related to the FERC's Standard Market Design and its implications for the client and the ERCOT market. LEI assisted in the preparation of comments for submission to FERC in response to their Standard Market Design Notice of Proposed Rulemaking, and in the course of producing these comments, evaluated specific proposals and benchmarked them against best practices worldwide. LEI has also assisted the client in a variety of litigation matters.

- In response to a PUCT investigation into a client's electric wholesale market activities, LEI conducted a pivotal supplier test for the Balancing Energy Services segment of the ERCOT market.

- LEI was hired by the PUCT to conduct a due diligence review of analyses conducted by a large power utility regarding the impact of termination of certain Purchased Power Agreements on its production costs (Docket No 40979). LEI's scope of work consisted of reviewing the company's inputs, methodology, and interpretation of market rules and results. Findings of LEI's review were summarized in a report submitted to the commission along with LEI's final recommendations regarding the case.

- LEI prepared a report on pricing safeguards in the wholesale market, referred to as the Peaker Entry Test. The report was submitted as a proposal to the PUCT as an alternate to the Commission staff's proposal initially under Project No. 24255, then Project No. 31972. The PUCT adopted a variant of LEI's proposed safeguards for use as pricing safeguards - the Scarcity Pricing Mechanism. Under Project No. 29042, LEI examined the Pivotal Supplier Test and supplied a critique of the PUCT staff's initial market power mitigation proposal. LEI later participated in panel discussions of market monitoring issues, as well as market power safeguards for wholesale electricity markets. LEI also provided testimony in the pricing safeguards proceeding, which looked at alternative tests for market power, analyzed implications on investment, and discussed efficiency consequences of certain bidding behavior. LEI prepared and filed comment testimony and quantitative analysis on questions of market definition and market integration for PUCT review in Project No. 29042. [Project Nos. 24255 and 29042 were later rolled into PUCT Project No. 31972.]

- LEI provided a critical review of the new capacity and energy market design being proposed by the Alberta Electricity System Operator in a written report submitted, on behalf of a market participant, to the Alberta Utilities Commission. LEI identified criteria for evaluation of the new market design, compared the Alberta Electricity System Operator 's proposal against other well-established organized wholesale electricity markets, and then categorized associated rules based on an objective evaluation of both positive and negative features. [AUC Proceeding No. 23757]

- LEI was commissioned by a coalition of community groups to prepare an independent outlook for New York power wholesale market conditions and project the level of congestion anticipated on major transmission interfaces. LEI developed multiple scenarios to illustrate the impact of major drivers on congestion levels. LEI presented the findings at a technical conference organized by the New York Public Service Commission for the purpose of evaluating the benefits of new transmission projects. [NYPSC Case 12-T-0502]

- LEI was retained by a hydroelectric generator to assist in the development of a rate plan, following the formulaic I-X approach. LEI prepared an industry study of total factor productivity trends spanning the North American hydroelectric sector. LEI also recommended an inflation index, which reflected cost drivers relevant to the company while also aligning with the regulatory precedent in Ontario. LEI testified before the Ontario Energy Board. [OEB EB 2012-0340]

- LEI provided testimony on behalf of the New England Power Pool in a "jump ball" filing at FERC regarding the Performance Incentive scheme proposed by ISO-New England. In written testimony submitted to FERC, LEI identified shortcomings in ISO-New England's proposed performance incentive scheme for its forward capacity market. [Docket No. ER14-1050 at FERC]

- LEI prepared testimony and testified on behalf of an independent power producer in relation to a settlement for contravention of Fair, Efficient and Open Competition Regulation related to timing of energy exports. The settlement was crafted by the Market Surveillance Administrator and filed with the Alberta Utilities Commission for approval. LEI assessed the

economic and policy considerations of the settlement and its appropriateness in context of enforcement and sufficiency of penalty payment. [AUC Proceeding No. 1553]

- LEI provided expert testimony before FERC related to a company's sale of capacity commitments in a case of alleged market manipulation. LEI examined market rules, operating procedures, and pricing arrangements in New England and New York, and examined the participation of the company in the capacity markets and compliance offers in the energy markets, commenting on the economic rationale behind the client's must-offer strategies in the energy market for capacity compliance. [FERC Docket No. EL-09-47 and EL-09-48]

- LEI provided testimony regarding the price elasticity of demand for transmission service. In the context of a transmission rate case, and with consideration of alternative transmission rate designs, LEI led an economic analysis that examined the impact on trade from increased transmission costs, involving multi-factor regression analysis of nodal electricity prices, price spreads across markets, and interchange flows (imports and exports) across borders. LEI also considered the impact of the elasticity of demand for transmission services between Canadian provinces and US markets in the Northeast for maximizing revenues in rate setting. LEI presented oral testimony at the Régie de l'Énergie du Québec. [Dossier R-3549-2004]

- LEI was retained by a rural electric co-op to prepare an independent expert assessment of potential stranded costs for its early termination of a wholesale power supply agreement. LEI's analysis was filed with FERC in February 2020. [FERC Docket No. ER20-1041-000]

London Economics International LLC ("LEI") was retained to provide independent, expert economic analysis related to the February 2021 winter storm event in Texas. LEI has made the qualifications noted below with respect to the information contained in this analysis and the circumstances under which the analysis was prepared:

- While LEI has taken all reasonable care to ensure that its analysis in this engagement is complete, power markets are highly dynamic and complex, and thus certain details may or may not be included in LEI's analysis.
- LEI's analysis is not intended to be a complete and exhaustive analysis of the energy market dynamics in Texas. All possible factors of importance to stakeholders and other interested parties may not necessarily have been considered in this report. The provision of an analysis by LEI does not obviate the need for interested parties to make further appropriate inquiries as to the accuracy of the information included therein, and to undertake their own analysis and due diligence.
- No results provided or opinions given in LEI's analysis should be taken as a promise or guarantee as to the occurrence of any future events.
- There can be substantial variation between assumptions and market outcomes analyzed by various consulting organizations specializing in competitive power markets and investments in such markets. Neither LEI nor its employees make any representation or warranty as to the consistency of LEI's analysis with that of other parties.
- The contents of LEI's analysis do not constitute investment advice. LEI, its officers, employees, and affiliates make no representations or recommendations to any party. LEI expressly disclaims any liability for any loss or damage arising or suffered by any third party as a result of that party's or any other party's direct or indirect reliance upon LEI's analysis.