

# Assessment of Market Reform Options to Enhance Reliability of the ERCOT System

Prepared for the Public Utility Commission of Texas

November 2022



Energy+Environmental Economics



**This report is prepared by:**

Energy and Environmental Economics, Inc. (E3)

Zach Ming

David Delgado

Nick Schlag

Arne Olson

Astrapé Consulting

Nick Wintermantel

Alex Dombrowsky

Rajaz Amitava

**This report is prepared for:**

The Public Utility Commission of Texas (PUCT)

# Table of Contents

|  |           |
|--|-----------|
| <b>Acronyms</b>  | <b>v</b>  |
| <b>Glossary</b>  | <b>vi</b> |
| <b>1 Executive Summary</b>   | <b>1</b>  |
| <b>1.1 Methods and Assumptions</b>   | <b>2</b>  |
| <b>1.2 Analytical Results</b>  | <b>5</b>  |
| <b>1.3 Sensitivity Analysis</b>  | <b>6</b>  |
| <b>1.4 Key Findings</b>  | <b>7</b>  |
| <b>1.5 E3 Recommendation</b>   | <b>9</b>  |
| <b>2 Introduction</b>  | <b>11</b> |
| <b>3 Description of Market Design Alternatives</b>   | <b>13</b> |
| <b>3.1 Load-Serving Entity Reliability Obligation (LSERO)</b>                                  | <b>16</b> |
| <b>3.2 Forward Reliability Market (FRM)</b>  | <b>18</b> |
| <b>3.3 Performance Credit Mechanism (PCM)</b>  | <b>21</b> |
| <b>3.4 Backstop Reliability Service (BRS)</b>  | <b>25</b> |
| <b>3.5 Dispatchable Energy Credits (DECs)</b>  | <b>27</b> |
| <b>3.6 Dispatchable Energy Credit and Backstop Reliability Service Hybrid (DEC/BRS Hybrid)</b> | <b>29</b> |
| <b>4 Methodology and Assumptions</b>   | <b>30</b> |
| <b>4.1 Analytical Approach</b>   | <b>30</b> |
| 4.1.1 SERVVM Loss of Load Probability Model  | 30        |
| 4.1.2 Analysis Under Market Equilibrium Conditions   | 31        |
| 4.1.3 Future Scenarios Tested  | 32        |
| <b>4.2 Key Assumptions</b>   | <b>33</b> |
| 4.2.1 Load Forecast  | 33        |
| 4.2.2 Ancillary Services   | 35        |
| 4.2.3 Energy-Only Market Design and Phase I Enhancements                                       | 36        |
| 4.2.4 Resource Portfolios  | 37        |
| 4.2.5 Renewable Profiles   | 39        |
| 4.2.6 Fuel Prices  | 40        |
| 4.2.7 Planned and Unplanned Outages  | 41        |
| <b>4.3 Model Outputs</b>   | <b>42</b> |
| 4.3.1 Reliability Metrics  | 42        |
| 4.3.2 Cost Metrics   | 43        |

|          |   |           |
|----------|---|-----------|
| <b>5</b> | <b>Results</b>  | <b>45</b> |
| 5.1      | Energy-Only Design  | 45        |
| 5.2      | Alternative Market Designs  | 48        |
| 5.2.1    | Resource Portfolio  | 50        |
| 5.2.2    | Reliability   | 52        |
| 5.2.3    | Cost Metrics  | 54        |
| <b>6</b> | <b>Sensitivity Analysis</b>   | <b>66</b> |
| 6.1      | High Renewables   | 66        |
| 6.1.1    | Energy-Only Design  | 67        |
| 6.1.2    | Alternative Market Designs  | 68        |
| 6.2      | High Gas Price  | 68        |
| 6.2.1    | Energy-Only Design  | 68        |
| 6.2.2    | Alternative Market Designs  | 69        |
| 6.3      | No ORDC   | 70        |
| 6.3.1    | Energy-Only Design  | 70        |
| 6.3.2    | Alternative Market Designs  | 71        |
| 6.4      | Low Cost of Retention Equilibrium   | 72        |
| 6.4.1    | Energy-Only Design  | 72        |
| 6.4.2    | Alternative Market Designs  | 73        |
| 6.5      | LSERO, FRM, and PCM Technology Eligibility  | 74        |
| <b>7</b> | <b>Qualitative Review</b>   | <b>76</b> |
| 7.1      | Market Power Risk   | 77        |
| 7.2      | Market Competition & Efficiency   | 79        |
| 7.3      | Implementation Timeline   | 81        |
| 7.4      | Administrative Complexity   | 83        |
| 7.5      | Real-Time Performance Incentives and Penalties  | 84        |
| 7.6      | Ability to Address Extreme Weather Events   | 86        |
| 7.7      | Cost and Revenue Stability  | 88        |
| 7.8      | Load Migration  | 89        |
| 7.9      | Demand Response   | 90        |
| 7.10     | Prior Precedent   | 91        |
| <b>8</b> | <b>Additional Considerations and Implementation Options</b>                             | <b>92</b> |
| 8.1      | Load-Serving Entity Reliability Obligation (LSERO) and Forward Reliability Market (FRM) | 92        |
| 8.1.1    | Resource Accreditation  | 92        |
| 8.1.2    | Allocation of System Need to LSEs   | 94        |

|            |  |            |
|------------|--|------------|
| 8.1.3      | Generator Performance Penalties _____                      | 96         |
| 8.1.4      | LSE Compliance Penalties in LSERO Framework _____          | 98         |
| 8.1.5      | Zonal/Geographic Construct _____                           | 98         |
| 8.1.6      | Seasonality _____  | 101        |
| 8.1.7      | Forward Procurement Timing _____                           | 102        |
| 8.1.8      | Market Power Mitigation _____                              | 104        |
| <b>8.2</b> | <b>Performance Credit Mechanism (PCM) _____</b>            | <b>105</b> |
| 8.2.1      | Demand Curve Determination _____                           | 105        |
| 8.2.2      | LSE Performance Credit Obligation Determination _____      | 106        |
| 8.2.3      | Generator Performance Credit Production Structure _____    | 106        |
| 8.2.4      | Zonal/Geographic Structure _____                           | 107        |
| 8.2.5      | Seasonality _____  | 107        |
| 8.2.6      | Procurement Timing _____                                   | 107        |
| 8.2.7      | Market Power Mitigation _____                              | 108        |
| <b>8.3</b> | <b>Backstop Reliability Service (BRS) _____</b>            | <b>108</b> |
| 8.3.1      | Procurement Mechanism _____                                | 108        |
| 8.3.2      | Cost Allocation _____                                      | 109        |
| 8.3.3      | Generator Performance Penalties _____                      | 110        |
| 8.3.4      | Forward Procurement Timing and Contracting _____           | 111        |
| 8.3.5      | Contract Duration _____                                    | 111        |
| 8.3.6      | Seasonality _____  | 112        |
| 8.3.7      | Retention of Energy Margins _____                          | 112        |
| <b>8.4</b> | <b>Dispatchable Energy Credits (DEC) _____</b>             | <b>112</b> |
| 8.4.1      | Procurement Mechanism _____                                | 113        |
| 8.4.2      | LSE Showing Timing _____                                   | 113        |
| 8.4.3      | DEC Eligibility Criteria and Generation Requirements _____ | 113        |
| 8.4.4      | DEC Time Window Qualification _____                        | 114        |
| 8.4.5      | DEC Generation Requirements _____                          | 115        |
| 8.4.6      | System DEC Requirements _____                              | 115        |
| 8.4.7      | LSE Compliance Penalties _____                             | 116        |
| 8.4.8      | Distortionary Effect on Energy Markets _____               | 116        |
| <b>9</b>   | <b>Conclusion _____</b>                                    | <b>118</b> |
| <b>10</b>  | <b>E3 Recommendation _____</b>                             | <b>120</b> |

## Acronyms

| Acronym | Definition                                   |
|---------|--|
| 4CP     | 4 Coincident Peak                            |
| AS      | Ancillary Services                           |
| BRS     | Backstop Reliability Service                 |
| CDR     | Capacity, Demand and Reserves (ERCOT Report) |
| CONE    | Cost of New Entry                            |
| CT      | Combustion Turbine                           |
| DEC     | Dispatchable Energy Credit                   |
| ECRS    | ERCOT Contingency Reserve Service            |
| ERS     | Emergency Response Service                   |
| EFOR    | Equivalent Forced Outage Rate                |
| EFORd   | Equivalent Forced Outage Rate on Demand      |
| ELCC    | Effective Load Carrying Capability           |
| ERCOT   | Electric Reliability Council of Texas        |
| EUE     | Expected Unserved Energy                     |
| E3      | Energy and Environmental Economics, Inc.     |
| FFRS    | Fast Frequency Response Service              |
| FRM     | Forward Reliability Market                   |
| IMM     | Independent Market Monitor                   |
| ISO     | Independent System Operator                  |
| LOLE    | Loss of Load Expectation                     |
| LOLH    | Loss of Load Hours                           |
| LOLP    | Loss of Load Probability                     |
| LR      | Load Resource                                |
| LSE     | Load Serving Entity                          |
| LSERO   | Load Serving Entity Reliability Obligation   |
| ORDC    | Operating Reserve Demand Curve               |
| PBPC    | Power Balance Penalty Curve                  |
| PCM     | Performance Credit Mechanism                 |
| PRD     | Price Responsive Demand                      |
| PUCT    | Public Utility Commission of Texas           |
| PUNS    | Private Use Networks                         |
| REC     | Renewable Energy Credit                      |
| RPS     | Renewable Portfolio Standard                 |
| RRS     | Responsive Reserve Service                   |
| SERVM   | Strategic Energy & Risk Valuation Model      |
| TDSP    | T&D Service Providers                        |

## Glossary

---

- + **1-Day-in-10-Years:** Shorthand for a common electricity industry reliability standard that specifies that an electricity system must have sufficient generating resources to serve load all but one day every ten years. This standard is equivalent to 0.1 days per year loss of load expectation.
- + **Accreditation:** The process by which a generating unit is assigned a value that quantifies its contribution to system reliability. An accredited generator has *Effective Capacity* (see definition below).
- + **Ancillary Services:** The services necessary to support grid stability and security, including real-time operating reserves that maintain reliability despite expected and unexpected fluctuation in system demand and supply.
- + **Backstop Resources:** Resources that are held in reserve by ERCOT (i.e., not active participants in the electricity market) and are utilized to maintain reliability if needed due to insufficient other resources.
- + **Bilateral Procurement:** Procurement executed through individual contracts between a generator and an LSE.
- + **Capacity Factor:** The ratio of the electrical energy produced by a generating unit for the period considered relative to the electrical energy that could have been produced at continuous full power operation during the same period.
- + **Centralized Procurement:** Procurement executed through a centralized auction for all supply and demand in the market.
- + **Cost of New Entry (CONE):** The levelized all-in cost of a new resource, including capital expenditures, financing costs, and fixed operations and maintenance. This total cost is often normalized by generator capacity (kW) and then amortized over the life (years) of the resource into a final metric of “dollars per kilowatt per year” (\$/kW-yr). In this study, CONE is used primarily in reference to the marginal capacity resource (calculated through modeling to be a natural gas combustion turbine).
- + **Cost of Retention:** The levelized go-forward costs of an existing resource. In this study, the value refers to the levelized go-forward cost of the reference marginal retention resource (coal).
- + **Demand Response:** Reductions in electricity consumption by consumers in response to economic signals, with the goal of reducing usage during high reliability risk hours.
- + **Dispatchable Energy Credit (DEC):** A credit that is generated when energy or ancillary services are produced/provided from an eligible dispatchable resource. In this study, an eligible dispatchable resource must be able to start in 5 minutes or less, have less than a 9,000 Btu/kWh heat rate, and be able to dispatch continuously for 48 hours or more.
- + **Equivalent Forced Outage Rate on Demand (EFORd):** Measure of the probability that a generating unit will be forced offline (not be available due to forced outages or forced derating) when there is demand on the unit to generate; This is an input in reliability modeling and an important determinant of a resource’s Effective Capacity.



Also available as part of the eCourse

[2023 Renewable Energy Law eConference](#)

First appeared as part of the conference materials for the  
18<sup>th</sup> Annual Renewable Energy Law Institute session  
"ERCOT Panel Discussion: Market Redesign"