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Copyright © 2014 by Southwest Power Pool, Inc. Market Monitoring Unit. All rights reserved.
• The Southwest Power Pool Integrated Marketplace began on March 1, 2014. The new market contains:
  o Day-Ahead Market with Transmission Congestion Rights
  o Reliability Unit Commitment process
  o Real-Time Balancing Market
  o Operating Reserve Market
  o SPP has also taken on the responsibility of being the consolidated Balancing Authority.

• Overall, the Integrated Marketplace has performed well.
  o Load is being served with fewer resources online.
  o Prices are consistent with historical prices in relation to gas costs.

• On March 2 and 3, much of the SPP footprint (along with other areas in the Midwest US) experienced an extreme winter weather event.
  o SPP and Market Participants were operating in a new market, which added to operational challenges
  o Much higher than normal load than is typical for the early March timeframe was experienced during the event
  o Capacity shortage conditions were evident in the market for a few hours due to:
    ▪ gas curtailments
    ▪ forced outages of resources (including frozen wind turbines)
    ▪ units already on planned maintenance as part of the spring season
• The following figure shows the Locational Marginal Price (LMP) for the Day-Ahead Market and the Real-Time Balancing Market. This is calculated by taking the simple average of LMP at the SPP North and SPP South hubs.

• The LMP is made up of
  o Marginal Energy Component (MEC)
  o Marginal Congestion Component (MCC)
  o Marginal Loss Component (MLC)

• Both Real-Time and Day-Ahead prices were higher in March and April than in May.
  o This is partially due to the winter weather event on March 2 and 3.
    ▪ SPP experienced capacity shortage conditions for a few hours.
    ▪ The combination of extremely high load, gas curtailments, forced outages (including some frozen wind turbines), and spring-time planned maintenance outages contributed.
  o March also experienced higher gas prices, which contributed to higher energy prices.

• Monthly average Locational Imbalance Prices (LIP) from the SPP Energy Imbalance Service (EIS) market are shown for February 2014 and prior months.
  o Although LIPs are not directly comparable to LMPs in the Integrated Marketplace, they do provide a frame of reference.
1.1 Day-Ahead and Real-Time Prices

**Day Ahead Prices**

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**Real Time Prices**

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**Legend**

- **DA** - Day-Ahead
- **RT** - Real-Time
- **MEC** - Marginal Energy Component
- **MLC** - Marginal Loss Component
- **MCC** - Marginal Congestion Component

**Notes**

- RT LMP prior to March 2014 is the average LIP (Locational Imbalance Price) from the Energy Imbalance Service (EIS) market.
- SPP State of the Market Report Spring 2014
• The following price contour maps provide an overall picture of congestion and price patterns in the footprint.
  o Blue represents lower prices and red represents higher prices.
  o Significant color changes across the map signify constraints that limit the transmission of electricity from one area to another.
  o Some other factors that can influence congestion and resulting prices are generator and transmission outages, weather events, differences in fuel prices and differences in temperatures across the footprint.

• Overall, pricing patterns between Day-Ahead and Real-Time are similar.
  o Pricing patterns are similar to what has been observed in the EIS market, with less expensive generation in the north and wind generation in the west-central part of the footprint.
  o The southwestern corner of the footprint continues to experience the highest average prices in SPP.
1.3 Day-Ahead and Real-Time Price Divergence

- The following figure shows the Day-Ahead to Real-Time price divergence at the SPP system level.
  - Price divergence % is calculated as \([\text{RT Monthly Average LMP} / \text{DA Monthly Average LMP}] - 1\].
  - The divergence (absolute) is calculated by taking the absolute value of the divergence for each interval.

- The SPP Markets are experiencing some divergence between Day-Ahead and Real-Time.
  - This price divergence can be at least partially explained by the significant price volatility in the Real-Time Market.
1.3 Day-Ahead and Real-Time Price Divergence

**Prices**

Divergence % is calculated as (RT LMP / DA LMP) - 1

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<td>Divergence %</td>
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The next metric presents gas cost from the Panhandle Eastern Pipeline (PEPL) compared to electricity prices in the SPP footprint.

- Although the cost at PEPL is not necessarily representative of the costs that may be experienced by a particular market participant or resource, the cost serves as a proxy for the overall gas costs experienced across the footprint.

Overall, gas prices and Real-Time prices are highly correlated in SPP.

- Workably competitive markets should experience highly correlated gas costs and energy prices in general.
- This trend has carried over from the EIS market into the Integrated Marketplace.
- This pattern changed in May, when gas costs and LMP (both Day-Ahead and Real-Time) diverged.
- Although electricity prices and gas costs are highly correlated over time, some periods experience divergence.

Gas costs were higher in the March-May 2014 compared to the same time period in 2013.
# Electricity Prices and Gas Costs

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<td>4.22</td>
<td>4.83</td>
<td>8.00</td>
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*RT LMP prior to March 2014 is the average LIP (Locational Imbalance Price) from the Energy Imbalance Service (EIS) market.

Gas Cost is represented by cost at the Panhandle Eastern Pipeline.

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*SPP State of the Market Report*

Spring 2014
1.5 Average Real-Time LMP by Load-Serving Entity

- Pricing patterns in the Integrated Marketplace have generally stayed consistent with that experienced in the EIS Market.
  - The far southwest portion of the SPP footprint generally experiences the highest average prices.
  - Entities in Nebraska and the west central portion of the footprint generally experience the lowest average prices.
  - These differences are driven by congestion patterns and high levels of low-cost generation.

- The differences in Real-Time LMP experienced by load serving entities has increased significantly in the spring quarter as compared to the winter quarter.
  - The difference between the highest cost load area and the lowest cost load area expressed as a percent of system average price increased to 43% for the spring period, compared to only 20% for the winter period.
Average Real-Time LMP by Load-Serving Entity

Average is for the period from March - May. Only load-serving entities are included.
Volatility is represented using the coefficient of correlation, which is the standard deviation divided by the mean for the period for each load-serving entity.

Although overall volatility is higher than experienced in the EIS market, the relative patterns remain similar.

- The entities in the northern portion of the footprint tend to experience the lowest average prices while they typically see the most volatility in pricing.
- Some higher volatility in the Integrated Marketplace can be attributed to scarcity pricing.
Volatility is for the period from March - May.
• The next figure shows monthly average Day-Ahead and Real-Time prices for the two Trading Hubs in SPP: the North and South hubs.
  o A trading hub is a settlement location consisting of an aggregation of price nodes developed for financial and trading purposes.

• Due to an abundance of lower-cost generation in the northern part of the SPP footprint, prices and the North Hub are consistently lower.

• The North Hub also shows the day-ahead premium in price that is often experienced in other markets.
• The following figures show Marginal Clearing Prices (MCP) for ancillary services in the SPP Integrated Marketplace.
  o Regulation (up and down) is shown as an SPP average.
  o Reserves (spin and supplemental) are shown by reserve zones:
    ▪ Reserve Zone 1 – Nebraska
    ▪ Reserve Zone 2 – Western Kansas, Oklahoma panhandle, Texas panhandle
    ▪ Reserve Zone 3 – Western Texas (south of panhandle), Eastern New Mexico
    ▪ Reserve Zone 4 – Eastern Kansas, Missouri, Arkansas, Oklahoma (outside of panhandle), NE Texas, Louisiana

• With the extreme winter weather event on March 2 and 3, those dates experienced unusually high ancillary service prices, driving up the average cost for March above the months that followed.

• Reserve Zones 1 and 4 have identical values, so Zone 1 does not show up on the Spinning and Supplemental Reserves chart that follows.
1.8 Ancillary Service Prices - Regulation

PRICES

Regulation

$/MWh


Reg Down

Reg Up

Spring 2014
Reserve Zone 1 and Reserve Zone 4 have the same prices for both Spinning and Supplemental, therefore the line for Zone 1 is not visible.
The impact of a constraint on the market can be illustrated by its shadow price. In other words, shadow prices reflect the intensity of congestion on the pathway represented by the flowgate.

- The shadow price indicates the marginal value of an additional MW of relief on a constraint in reducing the total production costs.
- The shadow price is also a key determinant in the Marginal Congestion Component of the LMP for each pricing point.

The Integrated Marketplace has experienced similar patterns as the EIS market.

- The Texas Panhandle is the most congested area with the Osage Switch - Canyon East flowgate experiencing the highest shadow prices in both DA and RT. Limited import capability and low cost generation north of the constraint are key factors driving this congestion.
- The Omaha-Kansas City corridor is the second most congested area. It is impacted by the large amount of low cost generation to the north and limited transfer capability to move power to the rest of SPP. Unaccounted for flow from outside SPP is another major factor affecting this area.

Other areas also experience congestion, which can be caused by many factors, including transmission and generation outages (planned or unplanned), weather events, and external impacts.
### 2.1 Congestion by Shadow Price

#### Flowgate Name | Region | Intervals Congested Includes Both Breached and Binding Intervals
--- | --- | ---
OSGCANBUSDEA | Texas Panhandle | Osage Switch - Canyon East (115) ftlo Bushland - Deaf Smith (230)
TEMP06_18995 | Central Kansas | Smokey Hills - Summit (230) ftlo Mullegren - Circle (230)
WDWFPLWDWTAT | Western Oklahoma | Woodward - FPL Switch (138) ftlo Woodward EHV - Tatonga (345)
LATSTRSTJHAW* | KC - Omaha Corridor | Iatan - Stranger Creek (345) ftlo St. Joe - Hawthorn (345)
TEMP14_20121 | Wichita area | Gordon Evans - Maize (138) ftlo Wichita - Benton (345)
SHAXFRTUCOKU | Texas Panhandle | Shamrock Xfmr (115/69) ftlo Elk City Xfmr (230/138)
TEMP15_20172 | Western Nebraska | Snake Creek - Alliance (115) ftlo Stegall - Wayside (230)
TEMP44_20033 | Central Oklahoma | Woodring Xfmr (345/138) ftlo Sooner Xfmr (345/138)
TEMP33_19963 | Central Oklahoma | Woodring Xfmr (345/138) ftlo Woodring - Cimarron (345)
NEORIVNEOBLC | SE Kansas | Neosho - Riverton (161) ftlo Neosho - Blackberry (345)

* Reciprocally Coordinated Flowgate with MISO

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### Shadow Price ($/MWh)

| Flowgate Name | Region | Intervals Congested Includes Both Breached and Binding Intervals |
--- | --- | ---
OSGCANBUSDEA | Texas Panhandle | Osage Switch - Canyon East (115) ftlo Bushland - Deaf Smith (230)
TEMP06_18995 | Central Kansas | Smokey Hills - Summit (230) ftlo Mullegren - Circle (230)
WDWFPLWDWTAT | Western Oklahoma | Woodward - FPL Switch (138) ftlo Woodward EHV - Tatonga (345)
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NEORIVNEOBLC | SE Kansas | Neosho - Riverton (161) ftlo Neosho - Blackberry (345)

* Reciprocally Coordinated Flowgate with MISO
• One way to analyze transmission congestion is to study the total incidence of intervals in which a flowgate was either breached or binding.
  o A breached condition is one in which the load on the flowgate exceeds the effective limit.
  o A binding flowgate is one in which flow over the element has reached but not exceeded its effective limit.

• Figure 2.2, Congestion by Interval, shows the percent of intervals by month that had at least one breach, had only binding flowgates (but no breaches), or had no flowgates that were breached or binding (uncongested).

• Real-Time intervals of breached and binding flowgates in the Integrated Marketplace appear to be in line with historical trends.
  o The Real-Time Market seems to be experiencing an overall trend of increased breaches between November 2013 and May 2014.
  o Issues driving this increase include increasing wind generation on, line outages related to transmission upgrades and unaccounted flows from adjacent systems.

• Note that the Spring Comparison figures represent March-May for each year.
2.2 Congestion by Interval

Day Ahead

Real Time

SPRING Comparison

SPP State of the Market Report
Spring 2014
• Total monthly generation is shown, broken down by fuel type of resources.
  o Renewable included solar, biomass and other renewable resources (not including wind and hydro)
  o Other includes fuel oil and miscellaneous
  o Gas-CC represents natural gas combined-cycle units
  o Gas-SC includes all other natural gas simple-cycle units

• Monthly generation shown prior to March 2014 is from the SPP EIS market.

• Note that the Spring comparison figures represent March-May for each year.
3.1 Generation by Fuel Type (Real-Time)

**SPP State of the Market Report**
Spring 2014
• The following figure shows wind generation and the wind capacity factor for the past 15 months.
  o Note that the wind capacity factor is not directly comparable between the EIS Market and the Integrated Marketplace because resources that were pseudo-tied out of SPP were removed from the capacity calculation beginning in March.

• Wind generation continues to increase across the SPP footprint, with nearly 15% of all generation produced by wind resources during the Spring 2014 season compared to 13% in 2013 and 8% in 2012.

• Note that the Spring comparison figures represent March-May for each year.
3.2 Wind Generation and Capacity Factor (Real-Time)

GW (Average Hourly Generation)

Wind Generation

Capacity Factor

SPP State of the Market Report
Spring 2014
3.3 Fuel on the Margin (Real-Time)

- The next figure shows the fuel types of marginal units in the Real-Time Balancing Market.
  - Marginal units set the Locational Marginal Price in each five minute interval.
  - During congested periods, the market is effectively segmented into several sub-areas, each with its own marginal resource.
  - During non-congested periods, one resource sets the price for the entire market, thus that resource is marginal for the interval.
  - When there is congestion, there can be more than one marginal unit during a five-minute interval.

- Gas-fired generators set prices in SPP the majority of the time.

- In the Integrated Marketplace, wind resources are the margin more than in the EIS Market. The “other” fuel type category, consisting primarily of oil-fired units, also shows up in the spring period as being on the margin around 1-3% of all intervals.

- Note that the Spring comparison figures represent March-May for each year.
• The following figure shows ramp available to the system as standardized by available capacity, compared to the average online capacity.
  o Ramp rates play a key role in Market operations because they place limits on how quickly a unit can respond to changes in loading conditions and the need for redispatch to manage congestion.

• Note that the Spring comparison figures represent March-May for each year.
3.4 Ramp Rate Availability (Real-Time)

SPP State of the Market Report
Spring 2014
The next figure shows the monthly average available ramp per interval along with the number of intervals with a ramp deficiency each month.

- If ramp rates are too low, the market cannot respond quickly enough to manage system changes and ramp deficiencies will occur. Deficiencies result in price spikes that indicate a need for additional ramp.

- Note that the Spring comparison figures represent March-May for each year.
3.5 Ramp Availability and Deficiency Intervals (Real-Time)

SPRING Comparison

- Up Ramp Deficiency Intervals
- Down Ramp Deficiency Intervals
- MW Ramp Available per Minute

SPP State of the Market Report
Spring 2014
3.6 Imports and Exports (Real-Time)

- The following figure shows the average hourly (MW) for exports and imports for each month.

- Overall, the SPP Market has experienced a pattern of increasing imports and decreasing exports.

- Directly comparable data is not available prior to the start of the Integrated Marketplace on March 1, 2014.
3.6 Imports and Exports (Real-Time)
• The next figure shows load scheduling for the peak hour.
  o Under-scheduling load can cause SPP to commit more expensive peaking resources in real-time in order to satisfy load.
  o Some real-time commitments may be made regardless of load scheduling due to the need to address reliability concerns, relieve local congestion or meet ramp demands.
  o Over-scheduling load can suppress real-time price signals by overstating load.

• The overall percentage of scheduling for the three month spring period was 99.8%, essentially indicating that all load is included in the Day-Ahead market.
4.1 Day-Ahead Load Scheduling

UNIT COMMITMENT

**SPRING Comparison**

- **Day-Ahead Demand**
- **Real-Time Obligation**

![Graph showing comparison between Day-Ahead Demand and Real-Time Obligation for the period March 2013 to May 2014. The graph indicates a steady increase in Real-Time Obligation with a peak of 101.9% in March 2014, followed by 99.0% in April 2014, and 98.6% in May 2014.]

SPP State of the Market Report
Spring 2014
• The next figure shows the Real-Time average hourly offered capacity for the peak hour.
  o Capacity above the line indicates that there is generally sufficient available capacity to meet peak load obligations.

• Although levels fluctuate from month to month, coal and gas resources typically account for 80-90% of offered capacity during peak hours.
The following figure shows the Real-Time Average Peak Hour Headroom.
- SPP calculates the amount of capacity headroom required for the Operating Day to ensure that unit commitment is sufficient to reliably serve load in Real-Time while maintaining the Operating Reserve requirements.

Overall, average monthly Peak Hour Headroom is increasing slightly.
- In March, Headroom during the peak hour averaged 185 MW. In May, Headroom increased to 217 MW on average.
5.1 Virtual Transactions

- Virtual trading in the Day-Ahead Market facilitates convergence between the Day-Ahead and Real-Time prices.
  - Virtual trading helps improve the efficiency of the Day-Ahead Market and moderates market power.

- Virtual transactions scheduled in the Day-Ahead Market are settled in the Real-Time Market.
  - Virtual demand bids are profitable when the Real-Time energy price is higher than the Day-Ahead price.
  - Virtual supply offers are profitable when the Day-Ahead energy price is higher than the Real-Time price.

- The following figure shows cleared and uncleared virtual demand bids and supply offers.
  - Cleared demand bids have steadily increased each month.
  - Cleared supply offers have also been on a upward trend, rising sharply from March to April, then decreasing slightly in May. The sharp increase can be partially attributed to the entrance of new Market Participants at the beginning of April.
Virtual trading in the Day-Ahead Market facilitates convergence between the Day-Ahead and Real-Time prices. Virtual demand bids are profitable when the Real-Time energy price is higher than the Day-Ahead price. Virtual supply offers are profitable when the Day-Ahead energy price is higher than the Real-Time price.

### Demand Bids
- **Cleared Demand Bids**
- **Uncleared Demand Bids**

### Supply Offers
- **Cleared Supply Offers**
- **Uncleared Supply Offers**
Virtual trading in the Day-Ahead Market facilitates convergence between the Day-Ahead and Real-Time prices.
- Cleared Virtual Bids as a percentage of Short-Term Load Forecast increased from 1.8% in March to 2.5% in April but then leveled off in May.
- Cleared Virtual Offers as a percentage of Short-Term Load Forecast almost doubled between March and April (from 3.2% to 6.1%) but then decreased in May.

The SPP market has yet to meet the 10% level seen in other markets.
- March saw the smallest amount of Virtual bids and offers at 5% of Short-Term Load Forecast.
- April had the largest amount of Virtual transactions at 8.6% of Short-Term Load Forecast.
Virtual trading in the Day-Ahead Market facilitates convergence between the Day-Ahead and Real-Time prices. Virtual demand bids are profitable when the Real-Time energy price is higher than the Day-Ahead price. Virtual supply offers are profitable when the Day-Ahead energy price is higher than the Real-Time price.
Virtual trading in the Day-Ahead Market facilitates convergence between the Day-Ahead and Real-Time prices.
  - Participants with physical assets (resources or load) often place transactions in order to hedge physical obligations.
  - In contrast, financial-only participants generally arbitrage prices.

The vast majority of Virtual demand bids are placed by Financial Only participants.
5.3 Virtual Transactions by Participant Type

Virtual trading in the Day-Ahead Market facilitates convergence between the Day-Ahead and Real-Time prices.

Virtual demand bids are profitable when the Real-Time energy price is higher than the Day-Ahead price.

Virtual supply offers are profitable when the Day-Ahead energy price is higher than the Real-Time price.

![Demand Bids Chart]

![Supply Offers Chart]
• The next figure summarizes the monthly profitability of virtual demand bids and supply offers.

• Gross virtual profits for the first three months of the market totaled nearly $37 million, while gross virtual losses totaled almost $30 million.
Virtual trading in the Day-Ahead Market facilitates convergence between the Day-Ahead and Real-Time prices.

Virtual demand bids are profitable when the Real-Time energy price is higher than the Day-Ahead price.

Virtual supply offers are profitable when the Day-Ahead energy price is higher than the Real-Time price.

![Virtual Profit and Losses Bar Chart](chart.png)
• TCR/ARR funding is derived as follows:
  1. Day-ahead revenue is collected daily
  2. TCR holders are paid daily based on awarded TCR MW and Day-ahead clearing prices
     a. Uplift is charged daily
     b. Surpluses are redistributed Monthly and Annually
  3. TCR revenue is collected daily based on TCR MW and TCR ACPs (consistent through month/season)
  4. ARR holders are paid daily based on ARR MW and TCR ACPs (consistent through month/season)
     a. Uplift is charged daily
     b. Surpluses are redistributed Monthly and Annually
6.2 ARR Funding Summary

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A Make Whole Payment is paid to a generator when the market commits a generator with offered costs exceeding the market revenue for the commitment period.

- The Day-Ahead Make Whole Payment applies to commitments from the Day-Ahead Market.
- The RUC Make Whole Payment applies to commitments made in the Day Ahead RUC and Intra-Day RUC processes.

Day-Ahead Make Whole Payments are typically less frequent and lesser in magnitude than in the RUC Make Whole Payments in the Real-Time Market.

In March, RUC Make Whole Payments were particularly high reaching almost $8 million.

- The extreme winter weather event contributed significantly to the March Make Whole Payments. During this time, the footprint experienced capacity shortages, and SPP Operations was forced to commit resources in order to maintain reliability.

As expected, the majority of the RUC Make Whole Payments were paid to gas resources.
The Make Whole Payment Distribution Charge is applied to Asset Owners that receive benefits from units committed in the Day-Ahead and Real-Time Markets.

- The Day-Ahead Make Whole Payment Distribution Amount is an hourly charge or credit based on a daily allocation.
- The total of all Make Whole Payments paid to generation resources is spread among all Asset Owners according to the ratio of the load’s contribution relative to a specific market.
- For the Day-Ahead market, the distribution rate is the sum of all DA Market Make Whole Payments for the day, divided by the total DA Market withdrawals.
- For the Real-Time Market, the distribution rate is the sum of RT Make Whole Payments for the day divided by the total RT Market deviation.
7.2 Make Whole Payment - Distribution Rate

Day-Ahead

$/MWh

RUC

$/MWh
• Each market participant with registered load is required to satisfy the must offer obligation for each asset owner associated with that registered load.

• A market participant is in compliance if:
  o The market participant has offered its available resources for an asset owner with a commitment status of Market, Self, or Reliability; or
  o The market participant has net resource capacity for that asset owner greater than or equal to 90% of its load for that asset owner.

• If a Market Participant is not in compliance with the must-offer obligation, it will be assessed a Day-Ahead Must-Offer (DAMO) penalty.
  o The penalty amount is equal to the Day-Ahead Market LMP associated with the withheld capacity.
  o When Must-Offer Penalty revenues are collected, the revenues are distributed to the Market Participants for an Asset Owner on a pro-rata basis for that Asset Owner's offered Resources. The Market Participant who failed the obligation does not receive a payment.

• Note that in Figure 7.3, penalties reported for April and May have not yet been finalized. These numbers represent estimates.

• Overall, the Day-Ahead Must-Offer failures represent a very small portion of the Day-Ahead Market. During the 4th Quarter of 2014, an analysis of DAMO impacts will be given to the SPP Market Working Group.
Revenue Neutrality Uplift (RNU) ensures settlement payments/receipts for each hourly settlement interval equal zero.
  - Positive RNU - SPP receives insufficient revenue and collects from market participants.
  - Negative RNU - SPP receives excess revenue, which must be credited back to market participants.

Revenue neutrality uplift is comprised by the following components:
  - DA Revenue Inadequacy
  - RT Revenue Inadequacy
  - RT Out of Merit Energy (OOME) Make Whole Payment
  - RT Regulation Deployment Adjustment
  - RT Joint Owned Asset (JOA) Adjustment
  - RT Inadvertent Interchange Adjustment
  - RT Congestion Adjustment

Note that in Figure 7.4, figures shown are from the most recent settlement statements available for that time period.
7.4 Revenue Neutrality Uplift (RNU) UPLIFT

- $2,500
- $2,000
- $1,500
- $1,000
- $500
- $0
- $500

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