



PJM Fifth Quadrennial Review: E&AS and VRR Curve Discussion

PRESENTED TO

PJM Market Implementation Committee

July 11, 2022

Bringing Ingenuity to Life
paconsulting.com

PA Consulting is the leading North American energy market advisor for financial investors through the clean energy transition.

Since 2011, we have supported more than 700 electric infrastructure purchases, sales, financings, appraisals or development projects in every U.S. power market across all major asset classes.

650+ GW

of North American power transaction support across 700+ deals, [since 2011](#)

200+ GW

of power transaction support in PJM [since 2011 across all technologies](#)

20+ GW

of [combined cycle and combustion turbine development support in PJM since 2011](#)



Our work in the PJM footprint is well beyond transaction advisory:

- We supported PSEG **before the New Jersey Board of Public Utilities** regarding Zero Emissions Credits.
- We supported a winning bidder before the **Maryland Board of Public Service Commission** within the most recent Offshore Wind solicitation.
- We submitted affidavits before FERC in previous PJM CONE assessments.

We have worked on the majority of the largest renewable generation and thermal M&A transactions in North America.



Key Observations and Recommendations

Key Observations	Recommendations
<p><i>New entrants do not enjoy full merchant market exposure/upside</i>; E&AS margins are limited by contracts/hedges necessary to secure financing.</p> <p>The structure of such contracts/hedges typically mutes the ability for new entrants to fully realize upside excursion events in the market.</p>	<p>PA recommends utilizing an E&AS offsets approach grounded in historical (spot) price outcomes—rather than speculative futures—to better capture go-forward, real-world expectations of hedged E&AS margins.</p> <p>Additionally, PA recommends the removal of historical outlier events that would overstate earnings compared to those for a hedged generator.</p>
<p>Variable major maintenance accrual costs are real expenses, in that they are tied to actual plant operations (i.e., run hours and/or starts), and should be factored into a plant’s energy market offers.</p>	<p>PA reinforces the Brattle recommendation to <i>factor-in VOM MM costs</i> into its Net CONE determination.</p>
<p>Differing views on expected E&AS margins can materially impact the VRR curve, especially when the reference resource is a CC and when supply conditions are tight.</p>	<p><i>Keeping the Gross CONE floor</i> to Point A significantly reduces the potential for demand curve volatility, particularly during delivery years with tight reserve margins, when predictability is key.</p>
<p>PJM’s resource mix is undergoing significant transition from coal to renewables and will likely experience much tighter supply conditions in the near future.</p>	<p>To limit capacity price volatility, we recommend <i>maintaining the existing VRR curve (particularly point C)</i>.</p>

E&AS: An approach grounded in historical price outcomes better captures the conservative nature of hedged/contracted new entrant E&AS margins.

Historically forwards have overstated energy margins

In most PJM zones, forwards have historically tended to overstate spark spreads (a proxy for energy margin potential), relative to actual future outcomes. See right. This likely owes to forwards being highly sensitive to prevailing conditions/sentiment at the time of trade, an issue that is further exacerbated during non-normal events (e.g., bombogenesis, geopolitical disturbances, etc.).

A conservative view of E&AS aligns with entrant earnings

Historical prices are likely to provide a less-aggressive view of E&AS offsets potential. This aligns with most new units realizing lower E&AS margins under their hedges (HRCOs, revenue puts, gas netbacks, etc.), trading away merchant upside for stable cash flows, in order to secure development financing.

Historical prices are often the basis for underwriting

Financial entities (e.g., banks, private equity) often underwrite newbuild projects/size debt based on historical pricing outcomes (e.g., holding spark spreads flat) to minimize their risk.

Unusual events do not reflect future earning expectations

When structuring an offtake contract (e.g., HRCO, gas netback, spark spread hedge, etc.), counterparties (e.g., trading desks) do not rely solely on forwards expectations, instead also utilizing historical outcomes to define terms. This is especially true of the currently elevated forwards environment, which necessitates high collateral posting requirements.

Forward (predicted) vs. Spot (actual) ATC Spark Spread Deltas¹

E Hub	2015/16	2016/17	2017/18	2018/19
2018/19	+38%			
2019/20		+33%		
2020/21			+16%	
2021/22				-13%

Negative deltas for 2021/22 actuals are anomalous, and owe to recent run-ups in global commodity markets not captured in 2018/19 trade expectations.

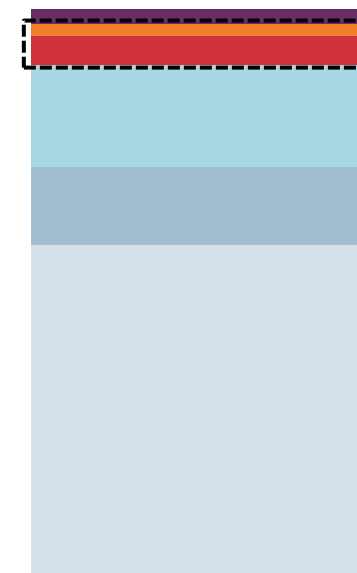
APS	2015/16	2016/17	2017/18	2018/19
2018/19	+26%			
2019/20		+31%		
2020/21			+10%	
2021/22				-26%

¹Trade periods across, future periods down. Source: OTC global holdings, PA Consulting Group analysis. Spark spread = Power Price – 7* Gas Price. E Hub sparks indexed to Transco Z6 NNY gas, and APS sparks indexed to Dominion South gas. Note that outcomes remain directionally consistent for zones not illustrated here (e.g., NI Hub vs. Chicago, W Hub vs. M3, etc.).

E&AS: Variable major maintenance accrual expenses are real costs factored into unit dispatch; thus, PA recommends incorporating them into Net CONE determination.

- **Overview:** A generator operating in PJM's energy market needs to ensure adequate recovery of all its variable dispatch cost components by factoring these items into its energy market offers. *See right.*
- **VOM:** Variable operations and maintenance (VOM) costs are non-fuel, non-emissions expenses that are an important component of a plant's short run marginal costs. Broadly speaking, there are two categories of VOM expenses:
 - **Consumables:** Includes costs associated with disposables, such as chemicals and water.
 - **Major Maintenance (MM):** Represents set-asides/accruals for periodic major turbine overhauls that are *tied to run hours and/or starts* (which induce wear-and-tear on physical equipment).
- **VOM MM:** Variable major maintenance accrual costs are real expenses, in that they are tied to actual plant operations, and are netted-out from a facility's gross margins prior to making equity distributions. While not "cashed" immediately, these expense accruals are typically set-aside in reserve accounts for future use towards significant turbine maintenance events.
 - By including VOM MM in its energy market offers, a plant ensures that it does not induce unnecessary wear-and-tear on its equipment during hours with unfavorable spark spreads.

Illustrative NG CCGT Dispatch Costs (\$/MWh)



- VOM Consumables
- VOM MM: Starts-based
- VOM MM: Hours-based
- Emissions Costs
- Fuel Costs: Variable Non-Commodity
- Fuel Costs: Commodity

PA Consulting reinforces Brattle's recommendation to factor-in VOM MM costs into its Net CONE determination.

VRR: Gross CONE vs Net CONE Multiplier

E&AS uncertainty shows Gross CONE is a necessary floor to incent entry during short supply conditions.

- As discussed previously, a 3-year forward view of E&AS typically overstates margins considerably. While historically-based E&AS estimates are more conservative (and more readily used by financial institutions), they still introduce considerable uncertainty on future earning expectations.
 - Under either E&AS method, market participants will have different views (such as how to price in RGGI or other policy uncertainty), especially when considering post-BRA impacts (such as retirement decisions announced soon after).
- By pegging the VRR curve to the higher of Gross CONE and a Net CONE multiplier, PJM would ensure there aren't scenarios in which participants with different views of E&AS are disincentivized to enter the market.
 - Establishing Gross CONE as a potential floor ensures the investment signal (cost recovery) is strong enough when additional capacity is needed for reliability.
 - Since under-procurement is a more critical issue than over-procurement, it is prudent to set this VRR parameter conservatively. While over-procurement introduces costs, sloped demand curves by definition place value on capacity in excess of the bare minimum.
 - Specifically, we concur with Brattle's recommendation to switch to a 1.75x Net CONE multiplier (from 1.5x) to ensure reliability.

***Recommendation:** We recommend PJM tie its VRR curve to the higher of Gross CONE and 1.75x Net CONE, as the former provides all potential entrants a cost recovery "floor" when reserve margins are tight, regardless of one's chosen E&AS outlook.*

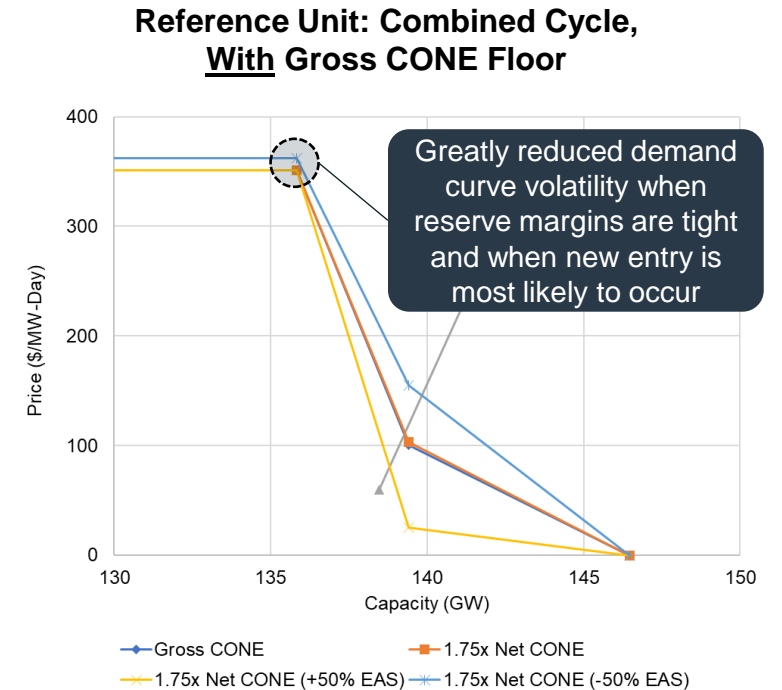
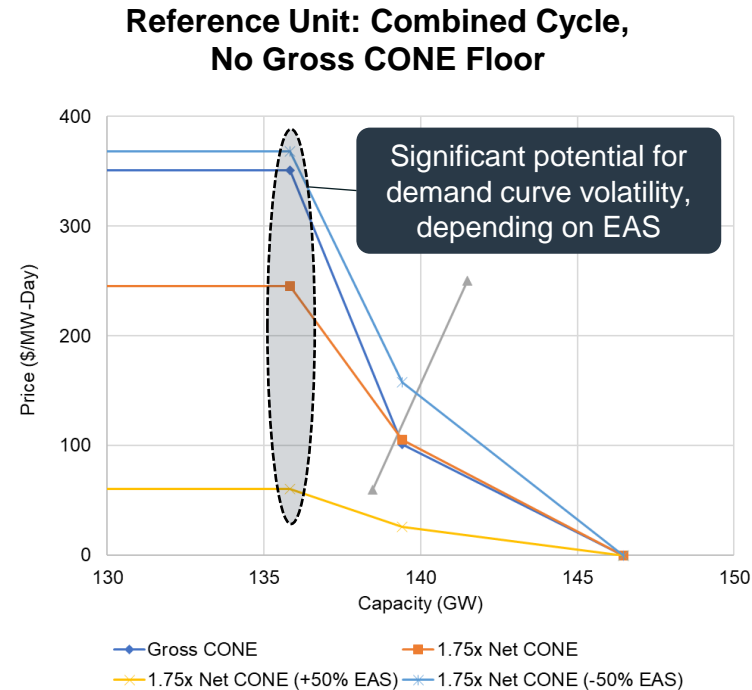
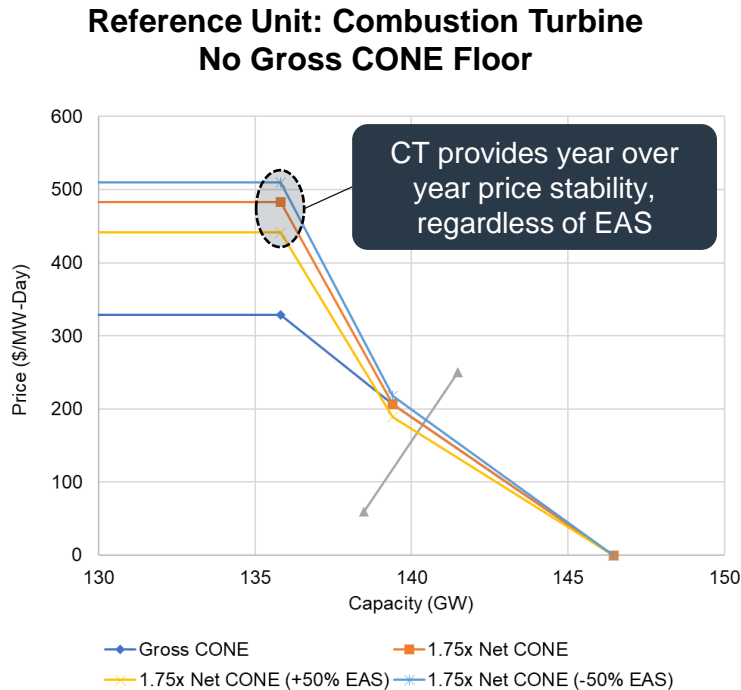
"As an example, consider a stress test scenario in which the "True" Net CONE needed to attract supply into the market is $1.4 \times$ the administrative Net CONE used to set the demand curve. There would then be an insufficient small "buffer" of only $0.1 \times$ Net CONE between the price cap and the long-run average price needed to attract entry.

The only way to produce average prices near the long-run cost of supply would be to clear at the price cap (i.e., in shortfall) approximately half of the time. This would be an unsustainable outcome and would result in administrative intervention, though we acknowledge that the scenario assumes a large error in Net CONE."

- **Brattle, describing value of 1.75x Net CONE vs 1.5x (5th VRR Study, pg. 16)**

VRR: Gross CONE vs Net CONE Multiplier

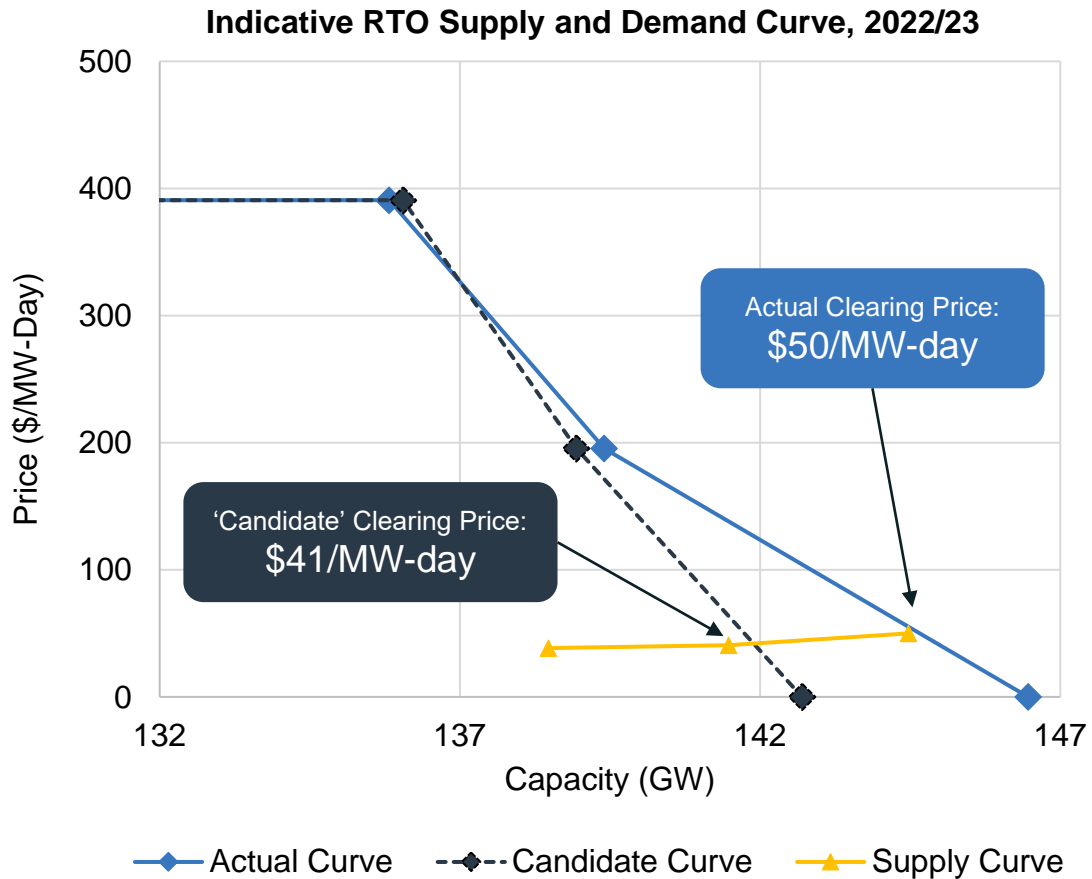
The example below shows that EAS uncertainty has far greater implications on the demand curve if a CC rather than CT is the reference unit – but that this can be greatly mitigated by keeping the Gross CONE floor for Point A



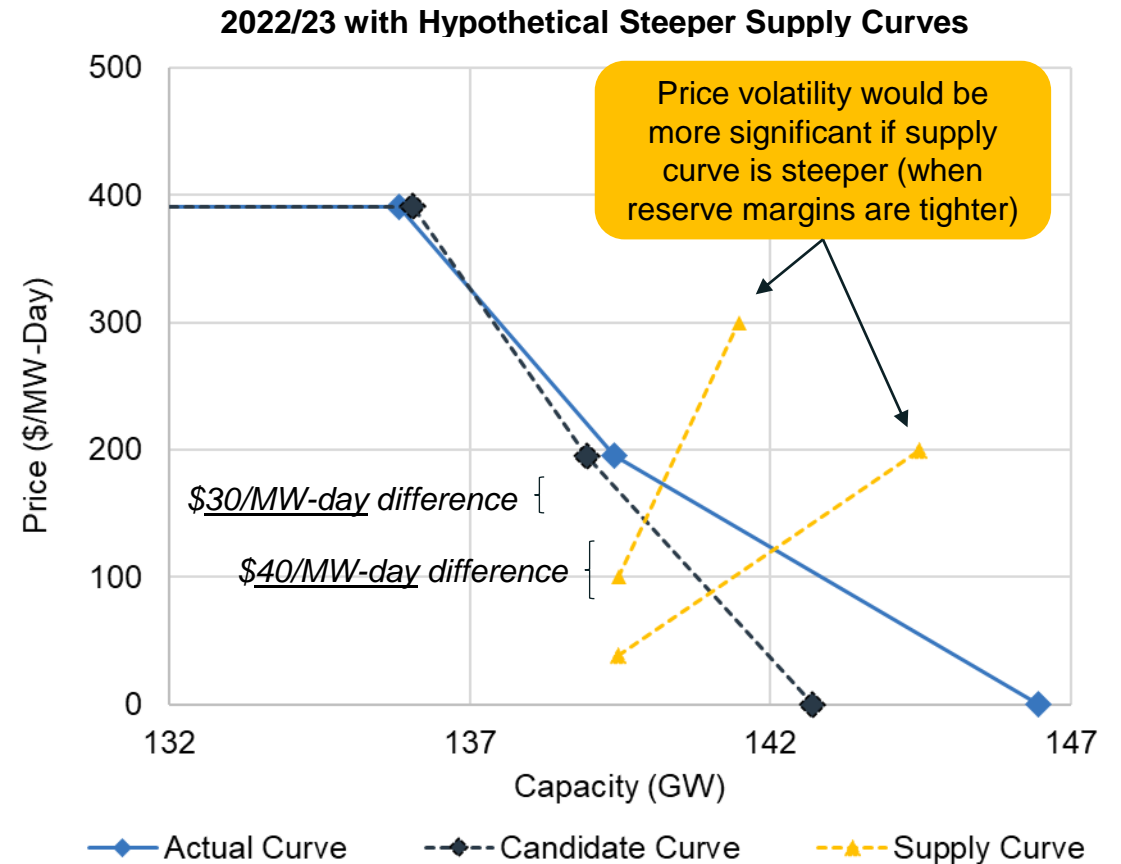
- Since a CT does not earn significant amounts of energy margins, 1.75x Net CONE is much closer to being sufficient to ensure full cost recovery for any new entrant, whereas 1.5x falls short.
- A demand curve pegged to CC and without Gross CONE backstop may not result in desired new entry if market participant view of Gross CONE is higher than PJM view and/or market participant view of EAS is lower than PJM view
- ***PA Recommendation: Keeping the Gross CONE floor to Point A significantly reduces the potential for demand curve volatility, particularly during delivery years with tight reserve margins, when predictability is key***

VRR: Overview of Candidate Curve

Future load uncertainty warrants a wider Point C than what is currently contemplated in the Candidate Curve



At current reserve margins, a change to the VRR curve does not have a significant impact on RTO clearing prices...



... but as reserve margins tighten in PJM, potential for price volatility with a steeper supply curve will increase significantly.

VRR: Lessons from CAISO and MISO

Other ISOs are recognizing the need to plan for greater uncertainty as the grid transitions.

CAISO

- CAISO does not feature a capacity market clearing mechanism, but the CPUC does have a resource adequacy construct.
- CAISO has recently increased its reserve margin from 15% to 17.5% to 20.7% to account for greater uncertainty to supply and demand.

“most notably the increasing prominence of variable and dispatch-limited resources on the grid ... especially in light of the challenges experienced in 2020 and upcoming resource retirements.”

- ALJ Ruling, identifying rationale for wider reserve margin

MISO

- Tight reserve margins in MISO have been warned for years, and most recently cleared short of its Planning Reserve Margin Requirement.
- MISO’s Planning Resource Auction has a vertical demand curve, which the Independent Market Monitor says does not provide predictable price signals for new entrants.
- MISO is pursuing a wider demand curve beginning in 2022.

“[A sloped demand curve] would ensure existing resources that were needed to maintain reliability would remain in operation”

– David Patton, MISO IMM

A wider foot (point C) to the VRR curve would reduce price volatility and allow for more predictable response from new capacity entrants

VRR: Future reserve margin uncertainty in PJM

PJM may face reliability concerns sooner than is currently anticipated

Although PJM currently enjoys strong installed reserve margins, the future looks significantly more uncertain than the past:

- **Demand** – Increasing potential for weather-driven summer and winter storms;
- **Demand** – EV charging and electrification demand may be understated by load forecasts;
- **Supply** – Greater amount of supply from renewables and duration-limited resources;
- **Supply** – New generation development uncertainty (supply chain issues, inflation, PJM interconnection queue reform); and
- **Supply** – Pace of coal retirements, which are driven by economics, corporate ESG concerns, accelerating state policy preferences as well as EPA action.

This may occur far sooner than current capacity prices reflect and can easily occur by the end of the decade (last year of fifth VRR review).

Recommendation: We recommend PJM keep its VRR curve definitions at least as wide as in the current DCR to account for increasing load and demand uncertainty in PJM over the 2026/27 to 2029/30 period.

“We are increasingly seeing reliability-related concerns on the horizon...”

“[R]isk of pressures for further coal retirements driven by currently high Eastern coal prices, elevated carbon prices, and proposed NOx emissions standards.”

“Eastern states such as MD, DE, and NJ continue to push for decarbonization”

- Julien Dumoulin-Smith, 6/23 BAML Research Note



About PA.

We believe in the power of ingenuity to build a positive human future in a technology-driven world.

As strategies, technologies and innovation collide, we create opportunity from complexity.

Our diverse teams of experts combine innovative thinking and breakthrough use of technologies to progress further, faster. Our clients adapt and transform, and together we achieve enduring results.

An innovation and transformation consultancy, we are 3,300 specialists in consumer and manufacturing, defense and security, energy and utilities, financial services, government and public services, health and life sciences, and transport. Our people are strategists, innovators, designers, consultants, digital experts, scientists, engineers and technologists. We operate globally from offices across the UK, US, Netherlands and Nordics.

PA. Bringing Ingenuity to Life.

Discover more at paconsulting.com and connect with PA on [LinkedIn](#) and [Twitter](#)

Denver Office
PA Consulting Group Inc.
1700 Lincoln Street; Suite 3550
Denver, CO 80203
+1 720 566 9920

paconsulting.com

This report has been prepared by PA Consulting Group on the basis of information supplied by the client, third parties (if appropriate) and that which is available in the public domain. No representation or warranty is given as to the achievability or reasonableness of future projections or the assumptions underlying them, targets, valuations, opinions, prospects or returns, if any, which have not been independently verified. Except where otherwise indicated, the report speaks as at the date indicated within the report.

All rights reserved
© PA Knowledge Limited 2022

This report is confidential to the organisation named herein and may not be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical or otherwise, without the prior written permission of PA Consulting Group. In the event that you receive this document in error, you should return it to PA Consulting Group, PA Consulting Group Inc., Suite 3550, 1700 Lincoln Street, Denver, CO 80203, USA. PA Consulting Group accepts no liability whatsoever should an unauthorised recipient of this report act on its contents.