Evaluation of the Dynamic Performance of Demand Curves for Annual Resources Using the Hobbs Simulation Model: Critique

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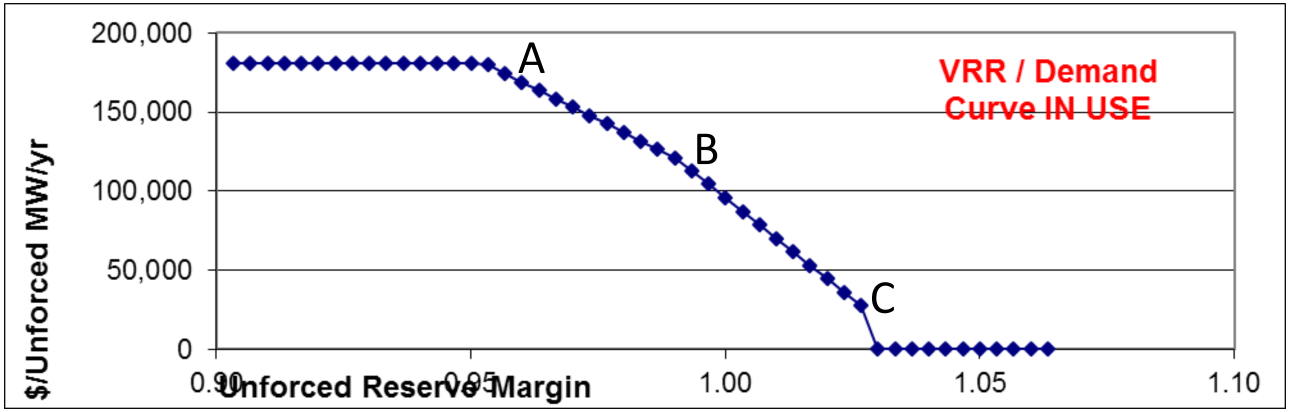
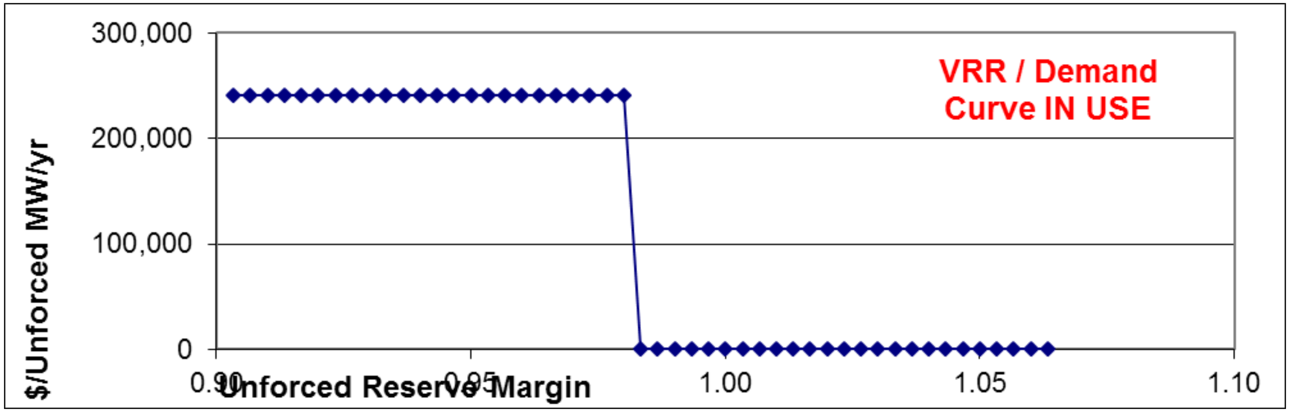
Background

- PJM has used the Hobbs model to simulate RPM dynamic performance for sloped or vertical VRR curves (September 9 CSTF)
  - PJM is concerned that the Minimum Annual Resource Requirement (MARR) is essentially a vertical demand curve for Annual resources
- The PJM analysis suggests that the sloped VRR curve performs much better than the vertical VRR curve for selected the assumptions and two performance measures:
  - frequency of meeting reserve margin
  - consumer cost
- Implication: changes needed so MARR is not a vertical demand curve

Comparing Sloped and Vertical Demand Curves

(demand curve graphs from Hobbs model spreadsheet posted for the Sept. 9 CSTF)





Hobbs Dynamic Simulation: Structure and Assumptions

The Hobbs model has many simplifying assumptions compared to real world RPM:

1. All new entry is CT (RPM: CTs are 6% of incremental capacity)
2. Quantity of CT entry is based on a complex formula using past E&AS earnings, risk aversion, other assumptions
3. All resource, old and new, offered at zero price; vertical supply curve
4. Functional relationship between reserve margin and E&AS cost
5. No additional resources are available less than three 3 years to delivery year
6. No incremental auctions
7. … … …

Today I will focus only on #3, the **vertical supply curve assumption**.

Preliminary Question: How Much Slope Is Needed?

(according to the Hobbs simulation and selected performance measures)

I explored results for the two performance measures (frequency of meeting reserve margin; consumer cost) as I varied demand curve slope:

1. From Point A to Point B – cleared quantities below target
2. From Point B to Point C – excess capacity situations

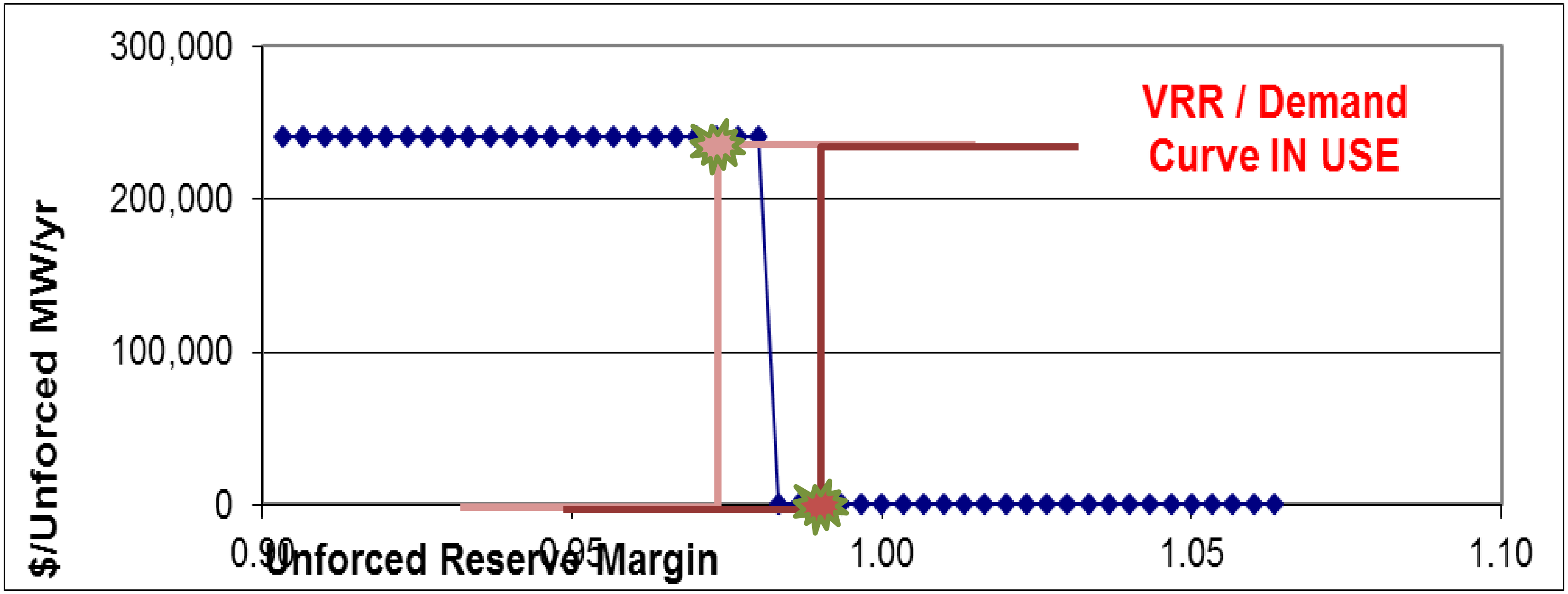
Conclusions (**details in Appendix to presentation**):

- The Hobbs model really, really doesn't like a vertical demand curve!
- Only a little slope to *left* of Point B is good; more harms reliability
- Only a little slope to *right* of Point B is needed; more doesn't matter

Hobbs model says: Vertical is Bad, but Only a Little Slope is Needed

Key Question: Why Does the Hobbs Model Hate the Vertical Demand Curve So Much?

Answer: Because it models a vertical *supply* curve; so capacity price is always either zero or maximum (see sheet DynamicCap column AJ); volatile prices create risk and boom-bust cycles



Hobbs Model Assumptions that Make the Vertical Demand Curve Look Bad

- Vertical supply curve – so under vertical demand curve, prices are always zero or maximum, no other outcome is possible
- All entry decisions are based not on long-run forecasts, but on energy and ancillary services outcomes in historical years up to the DY (years during which a new CT would not yet be operating)
- No diversity in investor costs or market expectations; no inertia in entry decisions; no entry based on bilateral contracts
- Investors are risk averse to annual (not multi-year) outcomes
- No additional resources are available after the base residual auction (the model has this feature but PJM is not using it)

The Good News: RPM Annual Resource Supply Curves Are Sloped!

- Annual resource supply curves contain offers from existing power plants, Annual Demand Response, and other resources at a range of prices – resulting in sloped supply curves

- So prices are much, much less volatile than the Hobbs model represents, and new plants offering into RPM see a sloped *residual* demand curve for annual resources

- In fact, the annual supply curves are much more gently sloped than the VRR curve; we already have more slope and price moderation than needed for Hobbs model best performance (Appendix shows how much slope needed)

PJM Recognizes The Importance of Reflecting the Increasing Elasticity of Supply Curves In RPM Analysis

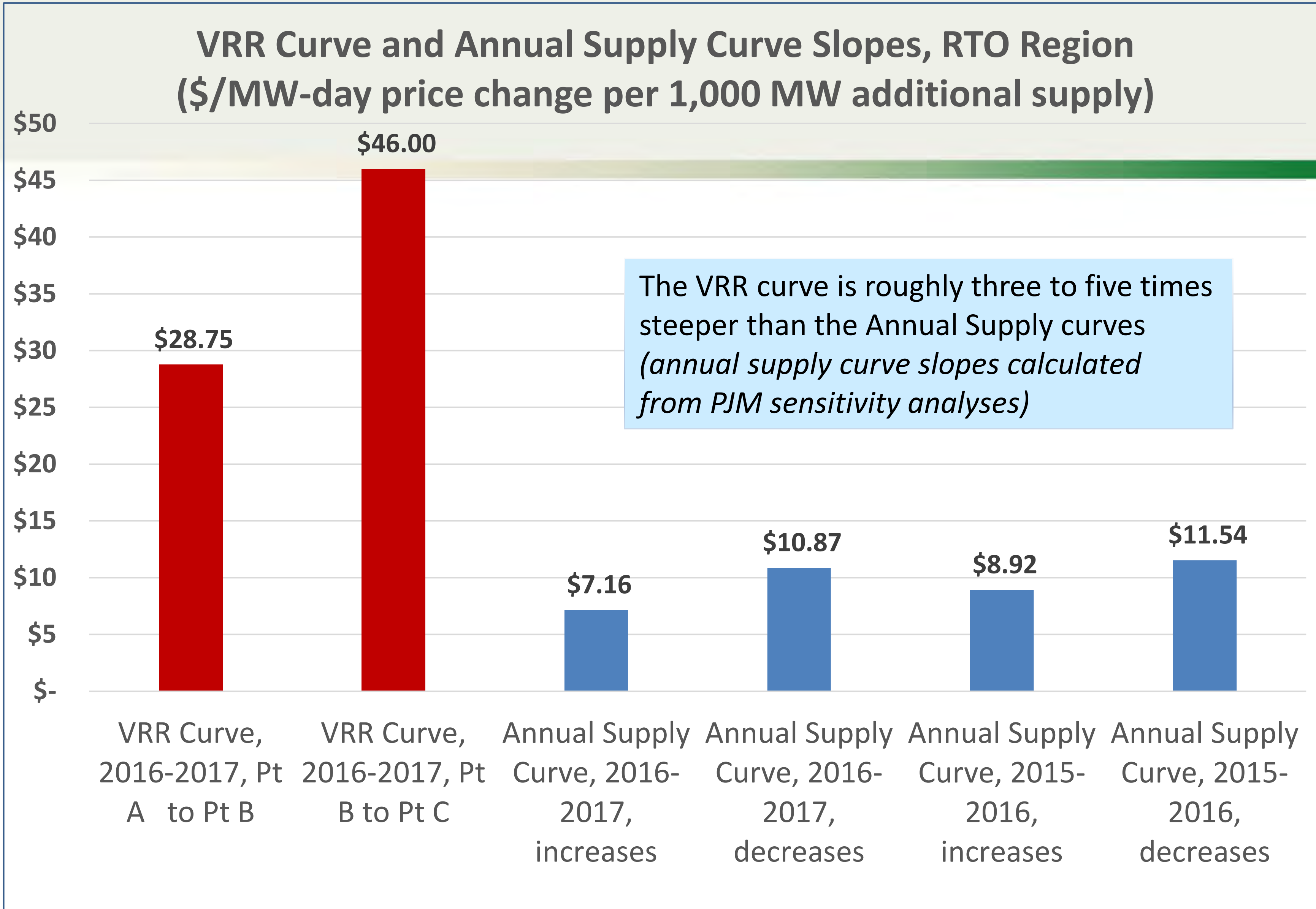
Affidavit of Andrew L. Ott on Behalf of PJM Interconnection, L.L.C., March 4, 2013 in ER13-535 (MOPR Compliance): **[emphasis added]**

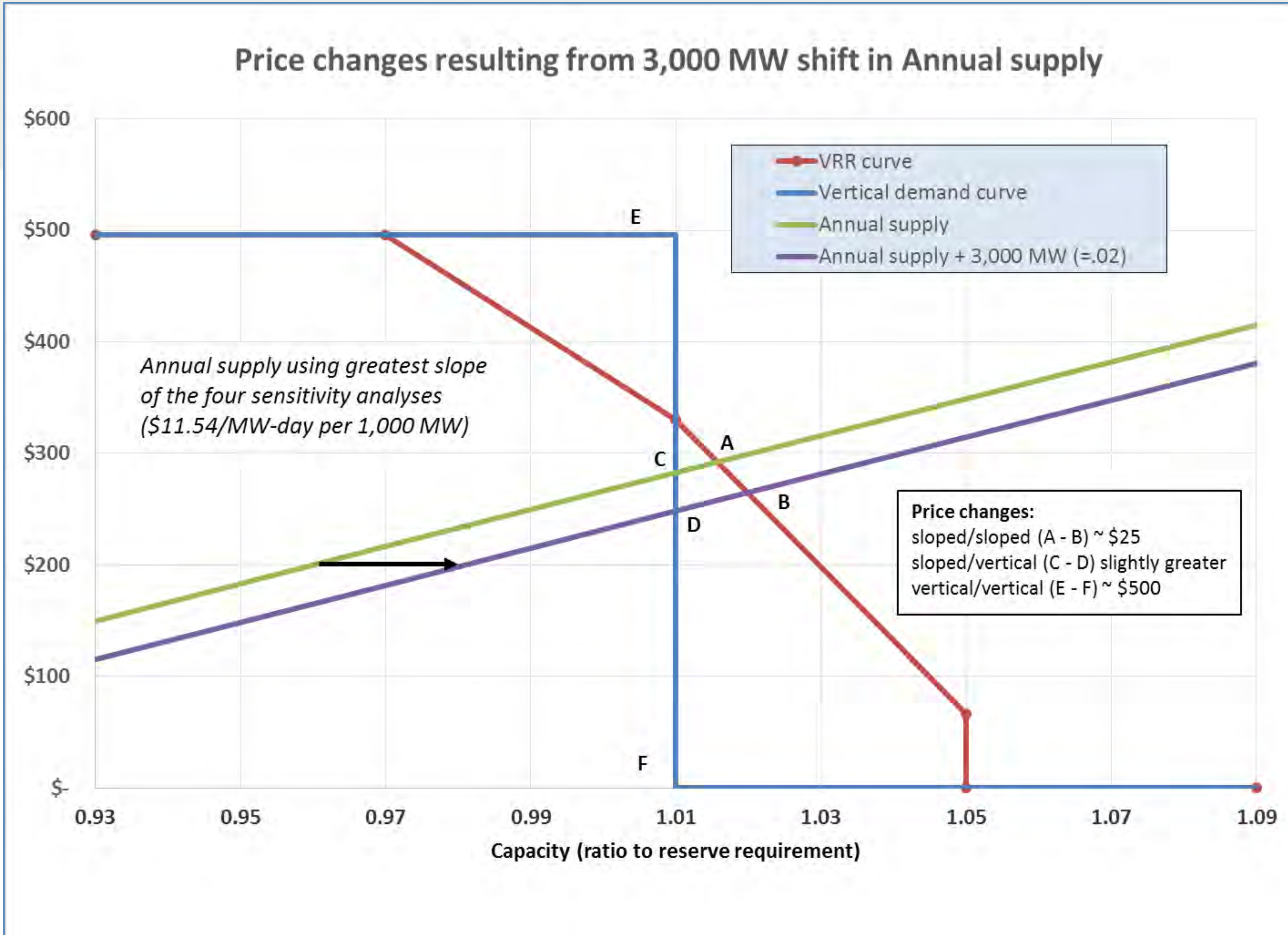
"In short, since interactions of the VRR Curve with the supply curve, and the shape of the supply curve used in the analysis, **can have a dramatic effect on the results** of any analysis of the clearing-price reduction effects of new entry, **it is important to use a realistic supply curve** when attempting to determine the benefits to a Self-Supply LSE of an uneconomic new entry offer." p. 12

"As shown in detail below, those analyses generally show that the **supply curve has become more elastic, i.e., more gradual**, in the last three years." [and noting evidence of more gradual supply curves in MAAC, EMAAC, SWMAAC] p. 12

"Similarly, the relevant portions of the VRR Curve for the PS and PEPCo LDAs reduce price by 56 and 69 cents, respectively, per MW, in contrast to the **reductions of only about 10 cents per 24 MW when the actual supply curves are taken into account**. p. 17

"Based on my experience overseeing administration of the RPM markets, **several trends**, which are unlikely to dramatically reverse themselves, **appear to contribute to this increased supply curve elasticity.**" [and noting increasing demand response, DR offers at a range of prices, DR linked bids, offers from existing capacity requiring investment, other factors] p. 12


VRR Curve and Annual Supply Curve Slopes, RTO Region
($/MW-day price change per 1,000 MW additional supply)
$50
$45
$40
$35
$30
$25
$20
$15
$10
$5
$-
$28.75
$46.00
$7.16
$10.87
$8.92
$11.54
The VRR curve is roughly three to five times steeper than the Annual Supply curves
(annual supply curve slopes calculated from PJM sensitivity analyses)
VRR Curve, 2016-2017, Pt A to Pt B
VRR Curve, 2016-2017, Pt B to Pt C
Annual Supply Curve, 2016-2017, increases
Annual Supply Curve, 2016-2017, decreases
Annual Supply Curve, 2015-2016, increases
Annual Supply Curve, 2015-2016, decreases


Price changes resulting from 3,000 MW shift in Annual supply
VRR curve
Vertical demand curve
Annual supply
Annual supply + 3,000 MW (=.02)
E
A
C
B
D
F
Annual supply using greatest slope
of the four sensitivity analyses
($11.54/MW-day per 1,000 MW)
Price changes:
sloped/sloped (A - B) ~ $25
sloped/vertical (C - D) slightly greater
vertical/vertical (E - F) ~ $500
$600
$500
$400
$300
$200
$100
$-
0.93
0.95
0.97
0.99
1.01
1.03
1.05
1.07
1.09
Capacity (ratio to reserve requirement)

Price changes resulting from 3,000 MW shift in Annual supply:
Less elastic supply
$600
$500
$400
$300
$200
$100
$-
0.93
0.95
0.97
0.99
1.01
1.03
1.05
1.07
1.09
.09
Capacity (ratio to reserve requirement)
E
C
A
B
D
F
Annual supply using slope =$40/MW-day per 1,000 MW, more than three times value from sensitivity analysis)
VRR curve
Vertical demand curve
Annual supply
Annual supply + 3,000 MW (=.02)

Summary and Conclusion

- Hobbs model says "Vertical supply meeting vertical demand is bad"
  - Results in volatile capacity pricing (zero or maximum)
  - Leads to risk, boom-bust, poor performance in both reserves and cost
- Hobbs model says "Only a little slope is needed" for good performance
- But RPM does not have that "vertical meets vertical" situation
  - Considerable slope in supply curves, as indicated in PJM sensitivity analyses; various resources offered at a range of prices
- Enhancing the Hobbs model to represent sloped supply would show that recognizing sloped supply, vertical & sloped curves perform similarly
  - Vertical might outperform sloped – Hobbs model says "too much slope is bad"

Conclusion: No case here for a problem requiring changes to RPM

Postscript: A Few Other Realistic Assumptions that Eliminate The Preference for Sloped Demand Curve

1. Assume supply equal to 5% of peak is available after the BRA

   (cells I8, J8 = $200,000, .05)

   – Sloped demand curve: Meet IRM 95.7%, consumer cost $140.7
   – Vertical demand curve: Meet IRM 97.8%, consumer cost $139.0 ←

2. Supply = 3% of peak is available after the BRA, load growth 1%

   (cells I8, J8 = $200,000, .03; cell DynamicCap/F12 = 1.0)

   – Sloped demand curve: Meet IRM 94.6%, consumer cost $140.4
   – Vertical demand curve: Meet IRM 98.2%, consumer cost $135.8 ←

3. Less risk averse (cell AD8 = .52)

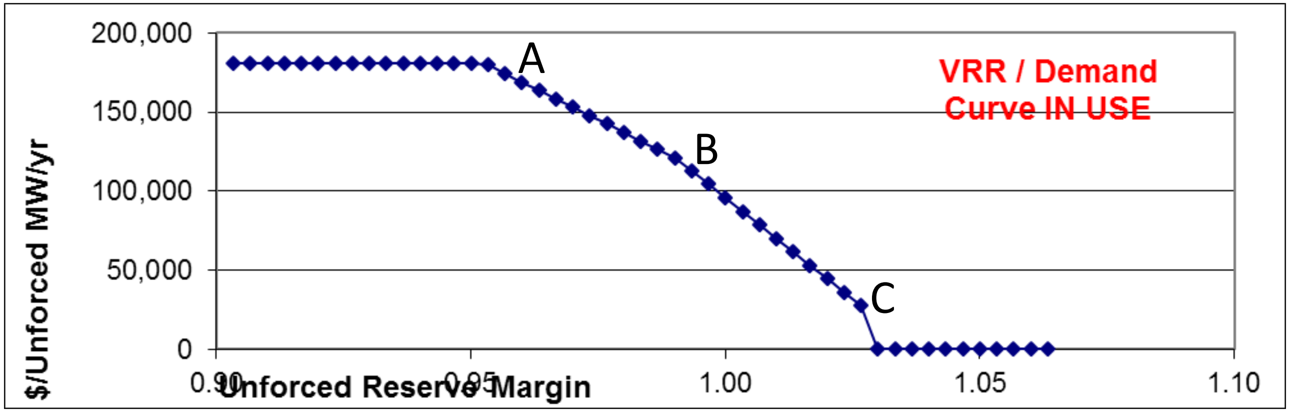
   – Sloped demand curve: Meet IRM 91.3%, consumer cost $139.4
   – Vertical demand curve: Meet IRM 85.0%, consumer cost $132.6

Appendix: Analysis of Performance of Demand Curve Varying the Slopes to Right and to Left of Point B

Varying Point A

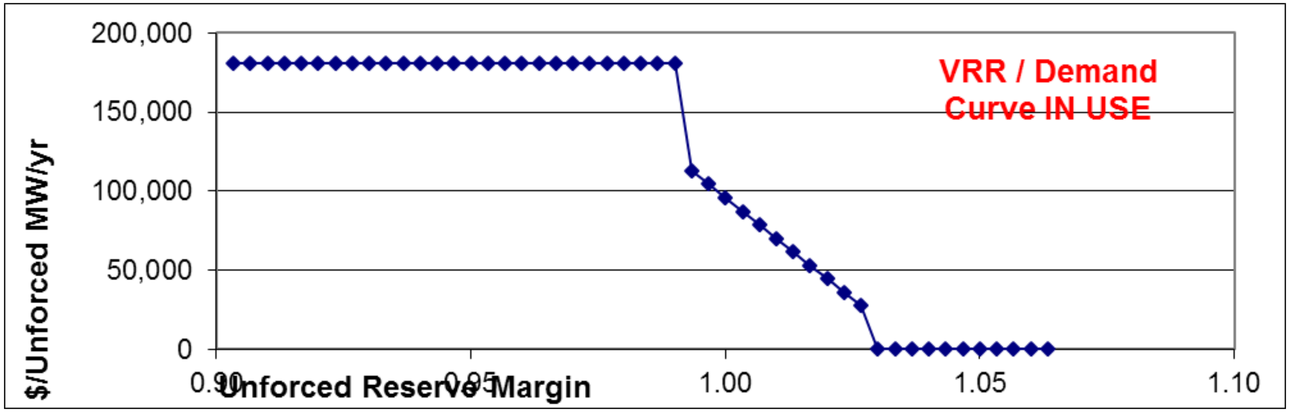
Point A =

.953 (base)

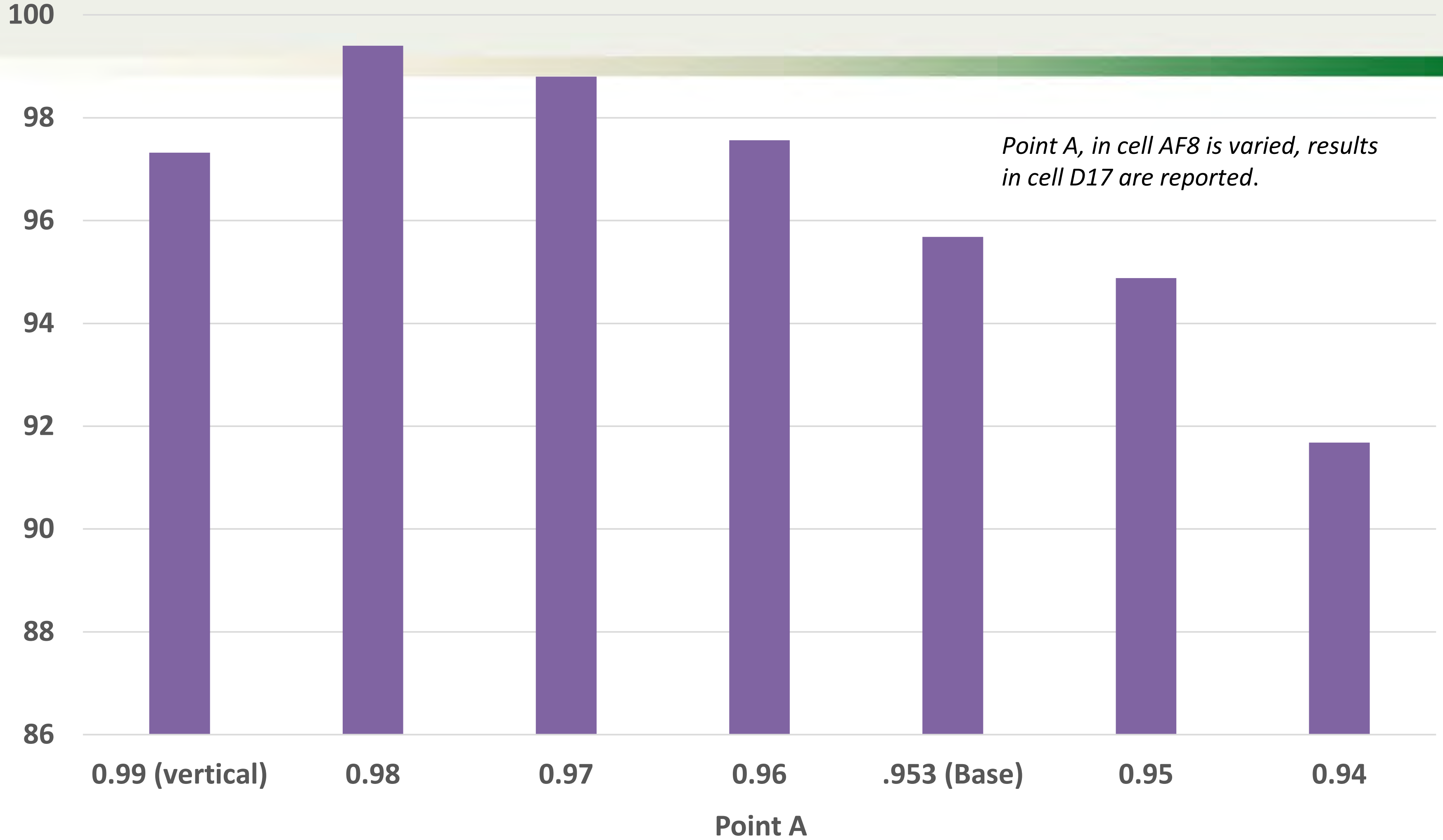


Point A =

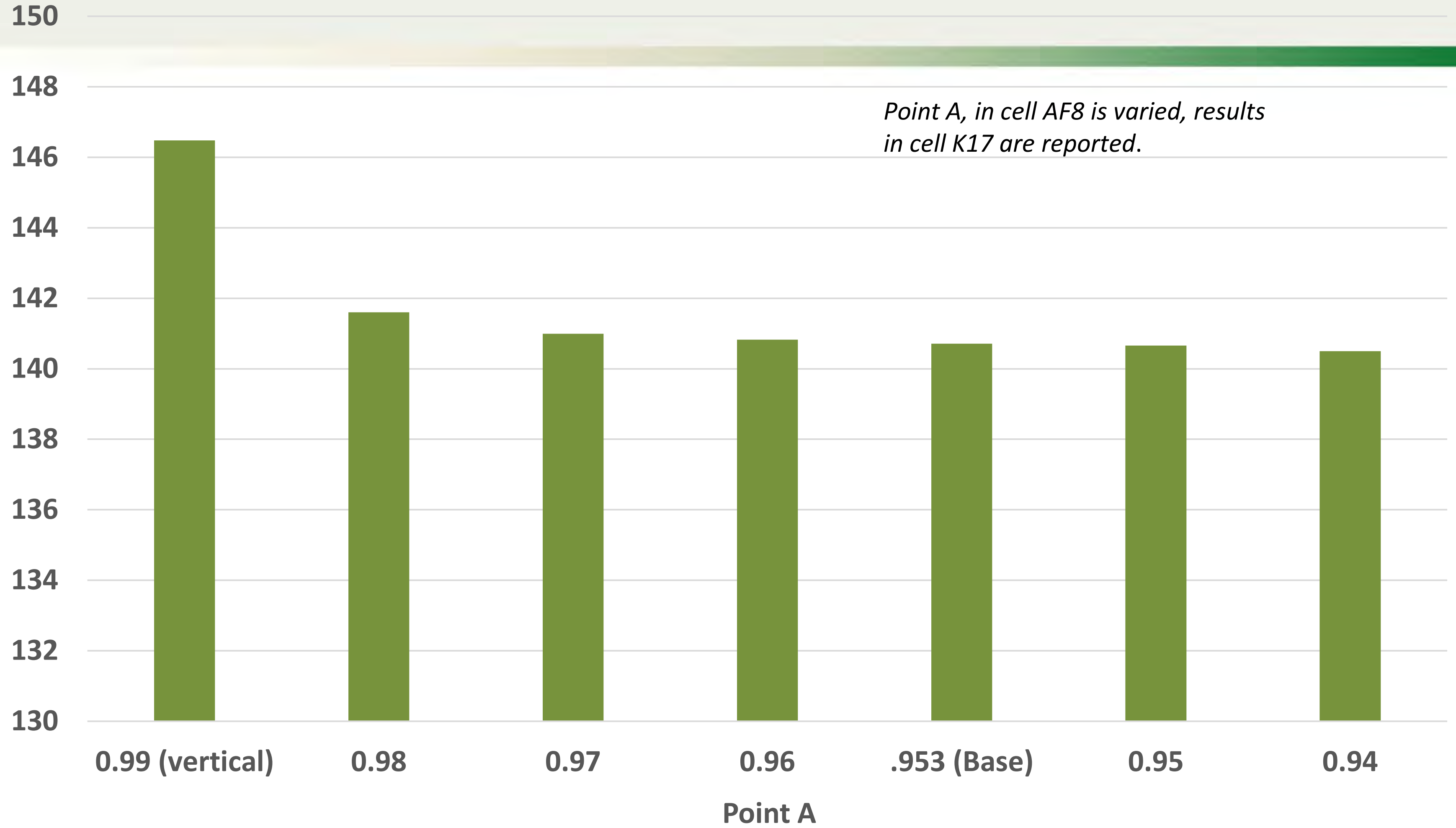
.99



Frequency of meeting reserve margin as Point A of sloped demand curve is varied



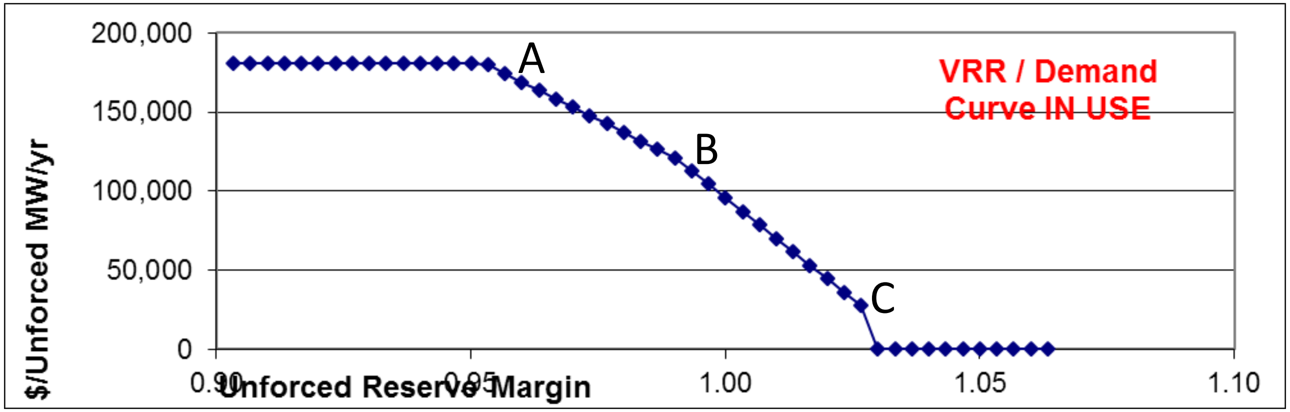
Consumer Cost
as Point A of sloped demand curve is varied



Varying Point C

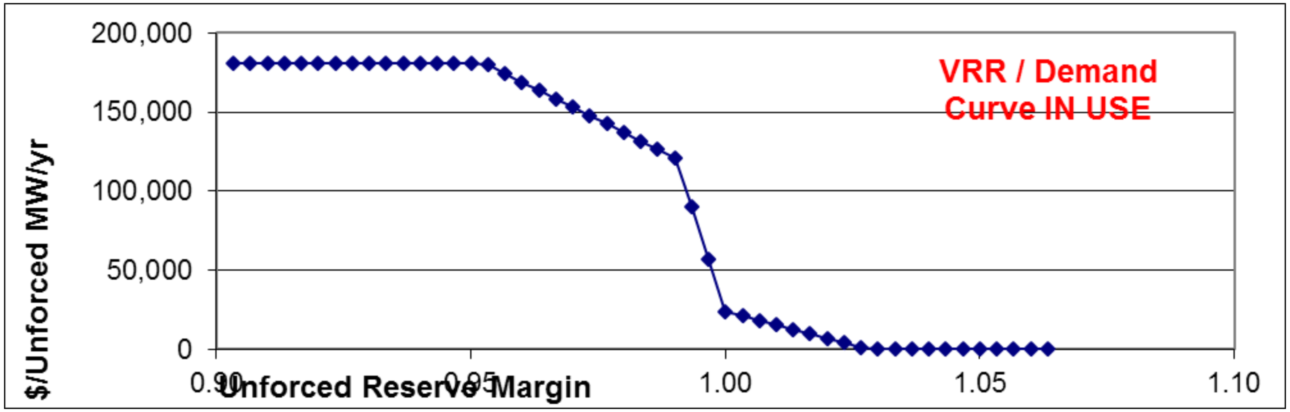
Point C =

1.028 (base)

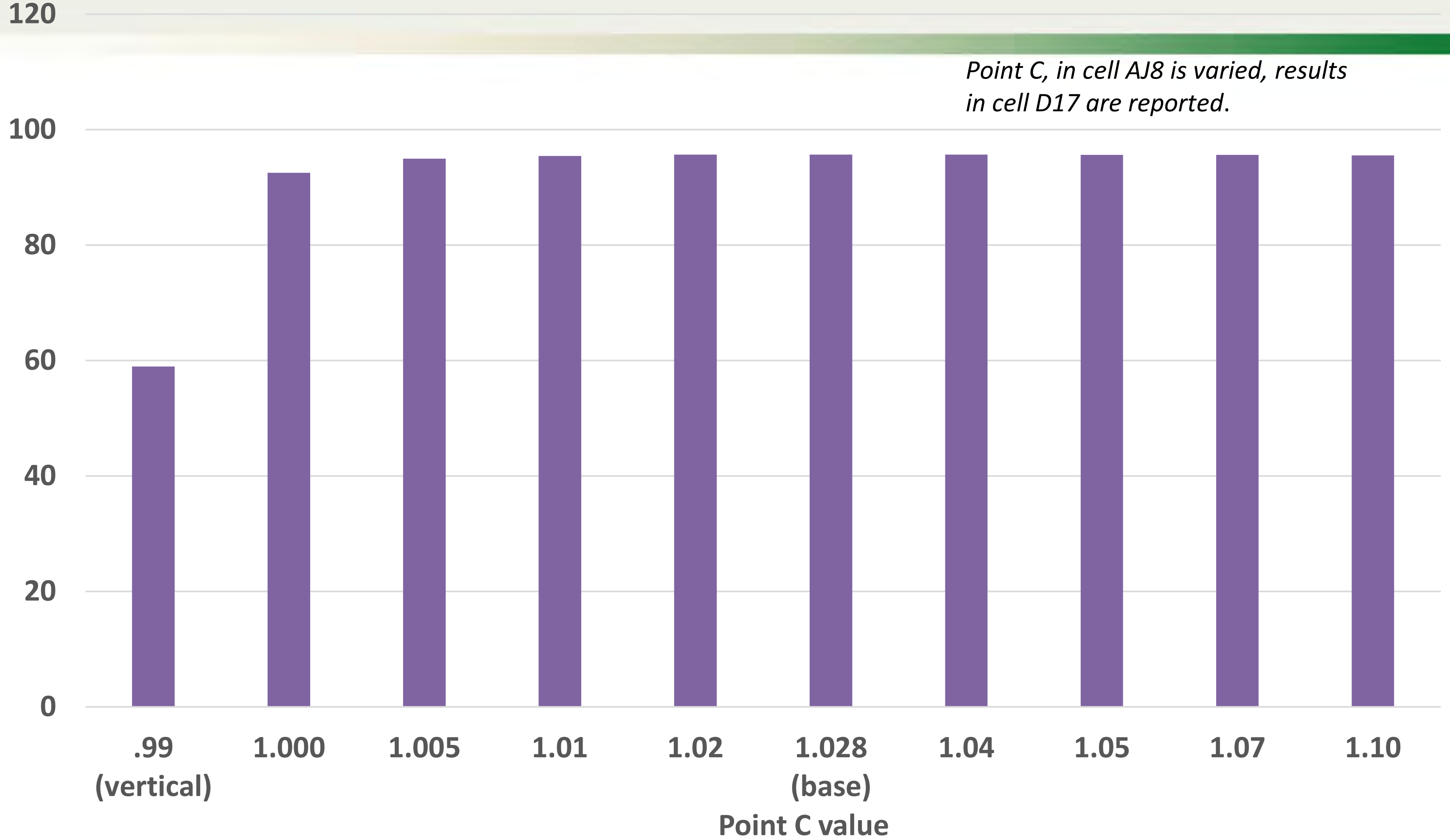


Point C =

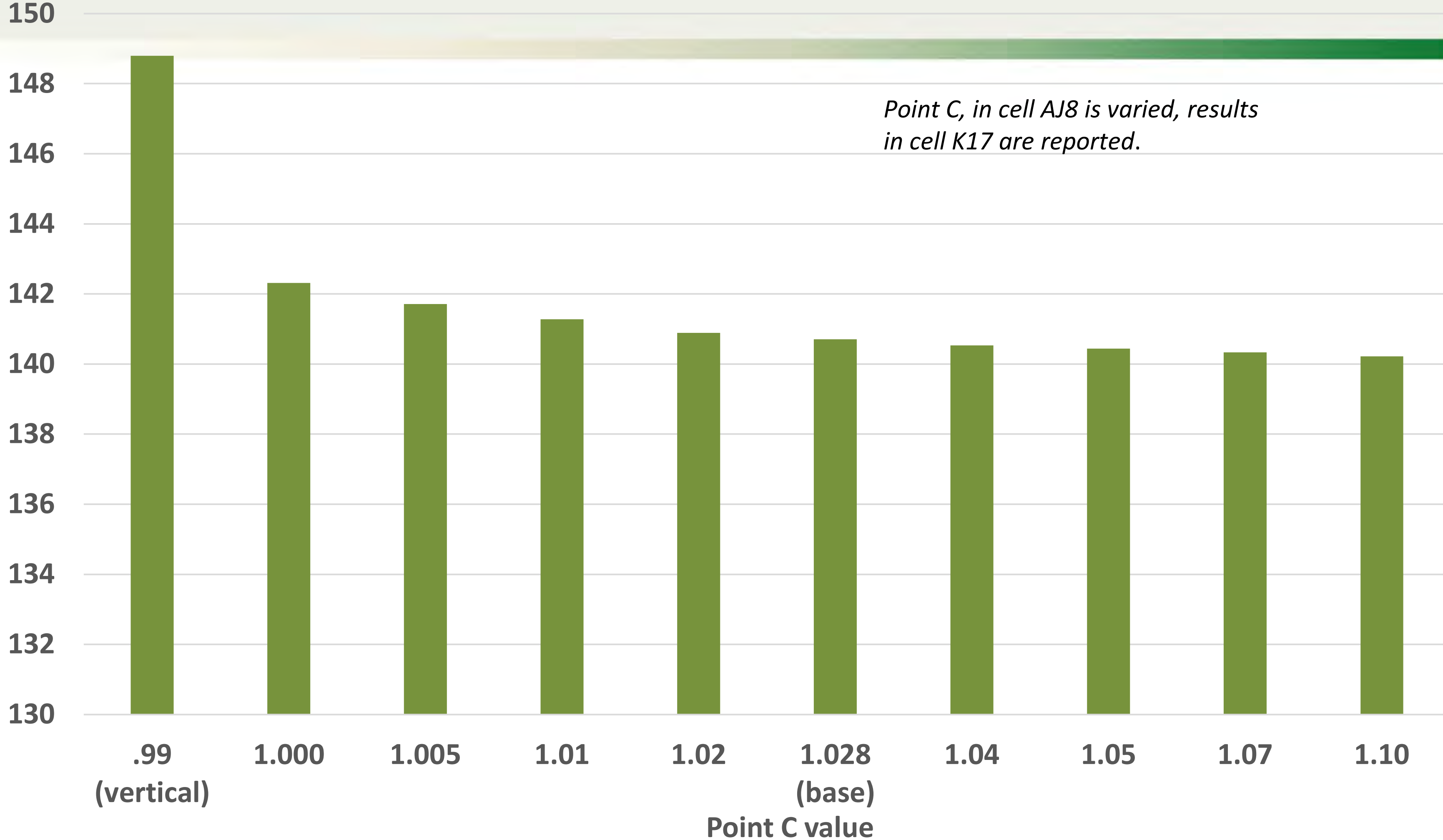
1.0



Frequency of meeting reserve margin as Point C of sloped demand curve is varied



Consumer Cost as Point C of sloped demand curve is varied



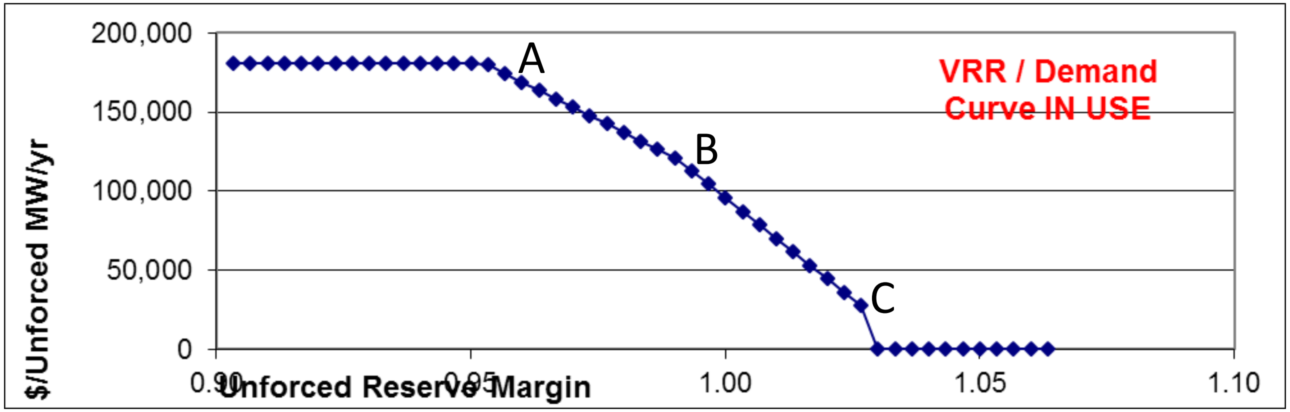
Summary – How Much Slope Is Needed?
(according to the Hobbs simulation and the selected measures)

1. To the left of Point B, Point A at .96 to .98 is best (base= .953):
   - Point A needs to be .98 or lower (poor performance if higher)
   - But below about .97 frequency of meeting reserve declines while consumer cost is about the same
2. To the right of Point B, any value 1.0 or higher is about the same (base = 1.028):
   - Point C needs to be at least 1.0
   - Taking Point C beyond 1.01 has little additional impact on either performance measure (base is 1.028)

Hobbs model says: Vertical is Bad, but Only a Little Slope is Needed

Comparison of Base Case and Somewhat Steeper Scenario

Base Case
Pt A = .953
Pt C = 1.028
Meets IRM 95.7%
Cons. Cost $140.7



Scenario:
Pt A = .97
Pt C = 1.02
Meets IRM 98.7%
Cons. Cost $141.3