Operating-Reserves, Price Spikes & Generation Investment

Steven E. Stoft
www.Stoft.com

Top 4 Market Flaws

- **No pricing policy for operating reserves when they are in short supply.**

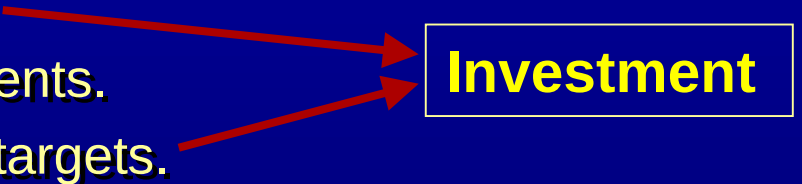
2. **Two Demand-Side Flaws: Almost no demand elasticity + no physical control over bilateral trades in real time.**
3. **Barriers to trade between markets: the seams problem.**
3. **The use of pools instead of exchanges. Pools:**
   1. Cause policy errors due to complexity.
   2. Find the wrong long-term prices for investment.
   3. Find the wrong demand-side prices.
   4. Solve the wrong unit-commitment problem in the presence of non-pool trading. (20% of the data used in PJM's DA Pool is wrong.)
   5. See Part 3, *Power System Economics.*

What's the Policy Point?

- **NERC & FERC together control:**
  - Price spikes, ➔
  - Market (in)stability, risk premiums & installed capacity
  - ➔ Reliability.
- **They don't understand this, so control is haphazard.**
  - NERC controls price-spike duration (and should control height).
  - FERC controls height.
- **Resulting U.S. policy:**
  - May cause 5-8% over investment.
  - Causes far more price volatility than necessary.
  - Causes boom-bust investment fluctuations.
  - Makes market power easier to exercise.
  - Increases risk premiums–especially for investment.

What's the Engineering Point?

- **Engineers control Operating Reserve (OpRes) policy.**
  - They set OpRes requirements.
  - They interpret OpRes requirements.
  - They set ICap requirements or targets.



- **The current engineering interpretation of OpRes requirements is completely vague except when it's impossible.**
  - Just do it. Pay whatever it takes. But not THAT much.
- **Engineers should:**
  - Specify how much to pay—a demand function for OpRes.
  - From this function, compute the long-run equilibrium ICap.
  - Adjust P(*OpRes*) to get the right ICap.
  - Suggest various possible P(.) functions to allow market designers to trade-off Height vs. Duration of price spikes.

Can OpRes Pricing Really Matter so Much ?

1. $P > MC_{peaker}$ only when OpRes is in short supply.
2. Only then do peakers recover their fixed costs.
3. That's about $5/MWh (every hour all year)
4. Every generator gets this—all run when peakers run (~).
   - But most generators don't sell in the spot market ???
   - Forward prices are determined by spot prices !!!
5. OpRes pricing determines $5/MWh of short-run profits all the time for all generators. That's roughly 50% of short-run profits!
6. This easily controls the ICap equilibrium.

Shouldn't "the Market" Control Price & ICap ?

- **It should, but currently, it cannot.**

  Why not?

- **Because demand-side flaws prevent a long-run equilibrium. There is no ICap level at which:**
  1. Price is high enough to support that ICap.
  2. Price is finite all the time. (supply sometimes ≠ demand)

- **If there were an equilibrium,**
  - It might still have prices above VOLL, the value of power to consumers. This would be inefficient.
  - It would mean giving up OpRes requirements and relying during a near blackout on high market-clearing prices to induce voluntary OpRes. (Someday this will work.)

How To Convince NERC / FERC

- **How should we convince NERC & FERC they control**
  - price spikes, ➔
  - market (in)stability, risk premiums & installed capacity
  - ➔ Reliability. **???**

1. **Explain the theory (Part 2 of *Power System Economics*)**
   - In policy circles, theory does not convince.
2. **Take a few example functions, P(OpRes), and compute:**
   - Price spikes,
   - Installed capacity, and
   - Reliability (load shedding).

A Closer Look at the Price Mechanism

1. **Model:**
   1. Supply, demand,
   2. Load shedding,
   3. OpResR, Pcap,
   4. ICap.

LRR(policy)

2. **Show (OpResR, Pcap) ➔ (ICap, Reliability)**
3. **Although the model is simple, a more complex model would only make the function LRR(., .) more complicated. The qualitative conclusion would hold.**

LRR(policy) is the long-run reliability function.

The Simple Model of Reliability

- L = "Load" = Economic demand.
- K = installed capacity (ICap).
- g = generation out of service.
- Load shedding occurs when L + g > K.
- OR^R = Operating Reserve Requirement.
- Price spike occurs when L + g + OR^R > K. P = Pcap
- L(s) = Demand curve with shift factor.
  - s is a random variable with a known distribution.
- Q(P) = Supply curve.

Needs high-tech analysis.

❖ Entire model is well defined except: Pcap ??? .

The NERC / FERC Ambiguity (FERC)

- **What is the OpRes requirement?**
- **What happens if OpRes < OR^R? P goes to what?**
- **FERC has declared the proper answer is Pcap =**
  1. $1,000 for PJM
  2. $10,000 for NYISO
  3. $1,000 for PJM, NYISO, and ISO-NE
  4. Infinity (X-Chairman Hebert)
  5. $100 for California, but only for 18 months. (Pat Wood's explanation: If there's a fire in the kitchen you don't look to see what's in the slop bucket, you just throw it on.)
- **Other "right" answers:**
  1. $25,000 AU (estimated).
  2. $15,000 AU (implemented). (But $100, if too much at $15k.)
  3. $56,000 realized price in England.

The NERC / FERC Ambiguity (NERC)

- **NERC says in effect "pay whatever it takes."**
- **What if you are just a few MW short?**
  1. still pay $15,000?
  2. don't bother (that's what ISOs really do).
- **What if you are just about to shed load?**
- **What if load has been shed?**
- **What does NERC really mean by a "requirement" ?**
  1. Before the market, it was clear.
  2. Now, they must name a price but can't bring themselves to reduce engineering to mere economics.

The NERC / FERC Ambiguity (how serious?)

- **FERC's answers span a 100-fold range (ruling out infinite price caps).**
- **NERC provides no answer at all.**
- **Half of short-run profits, are determined by these wildly haphazard policies. For peakers, all of short-run profits.**

- **Could this cause serious problems?**
  1. In California, prices tanked for 2 years then went sky high.
  2. In the East, there were small bankruptcies and some close calls on larger ones from 1-day spikes.
  3. Over-building of generation in several eastern markets.
  4. Enron collapses. Western generators (Calpine, etc.) retrench.

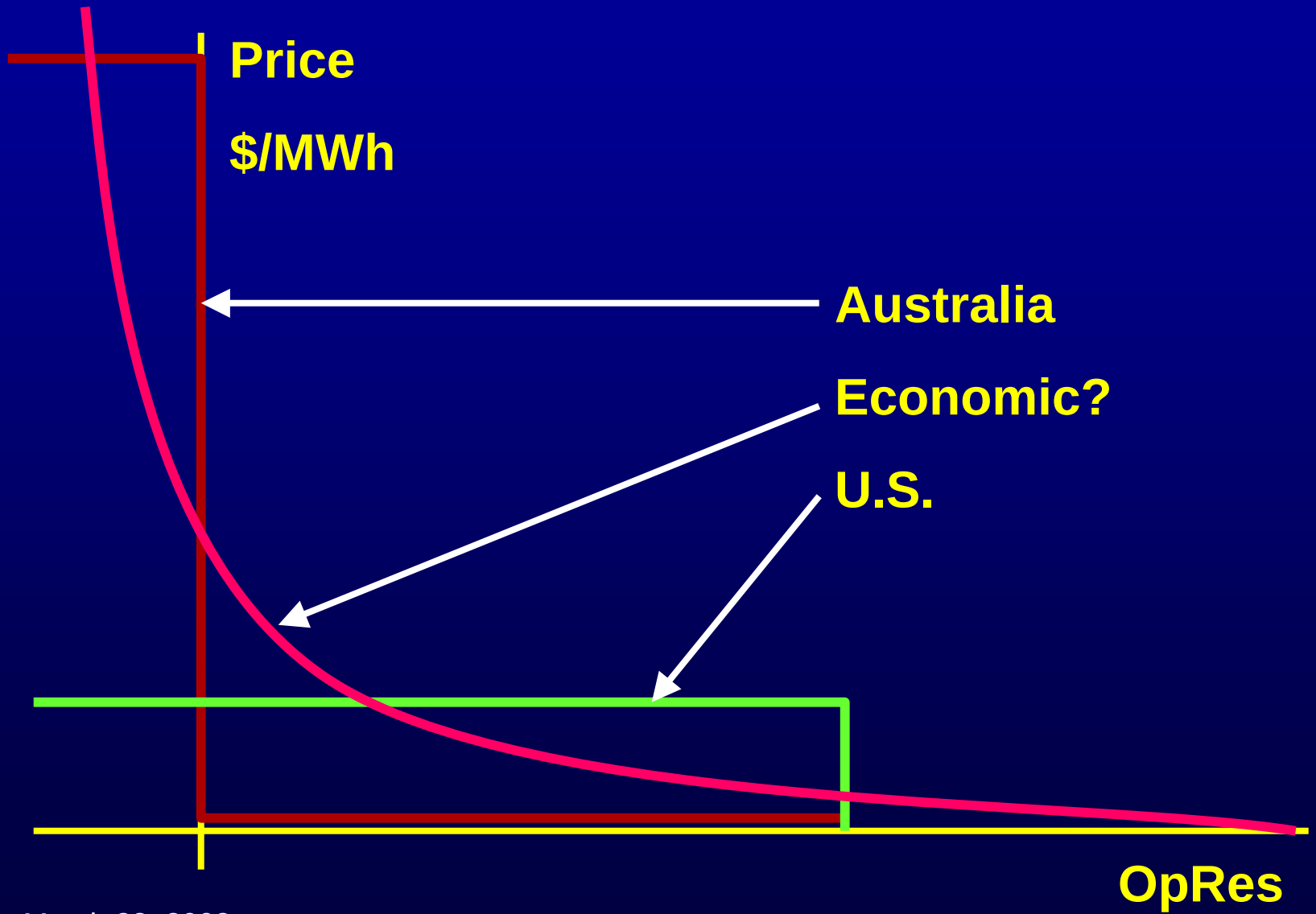
The OpRes Demand Function

1. **P(OpRes) states the system operator's willingness to pay.**
2. **That's a demand function, and it should slope downward.**
3. **This demand function plays two roles:**
    1. Short-run: it buys reserves.
    2. Long-run: it raises the price of E and induces investment.

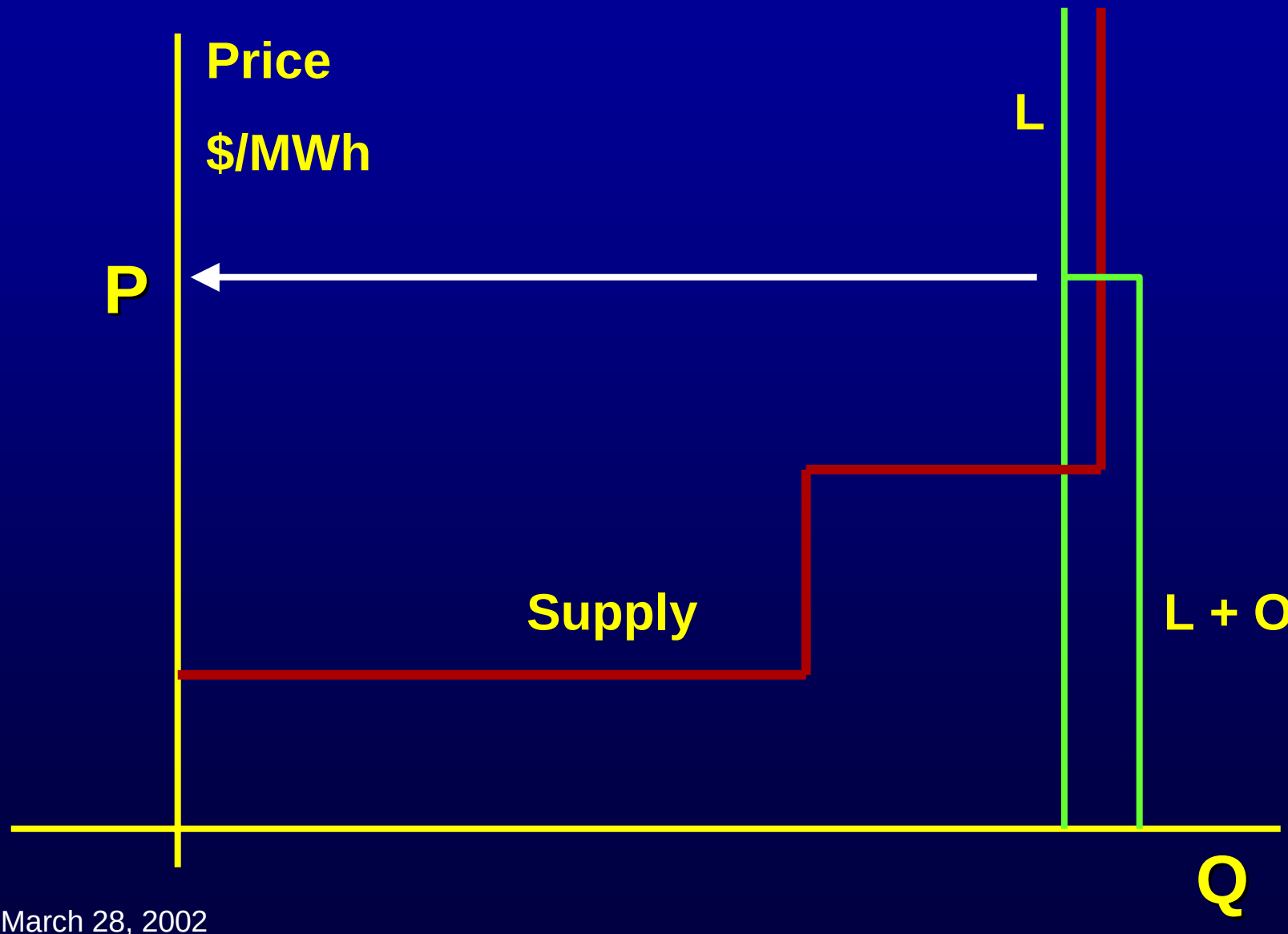
- **The short-run is tangled in inter-SO competition.**
    1. A uniform OpRes Policy would put an end to this.

1. **We will explore the long run.**

Possible Answers to: How High Is Pcap?



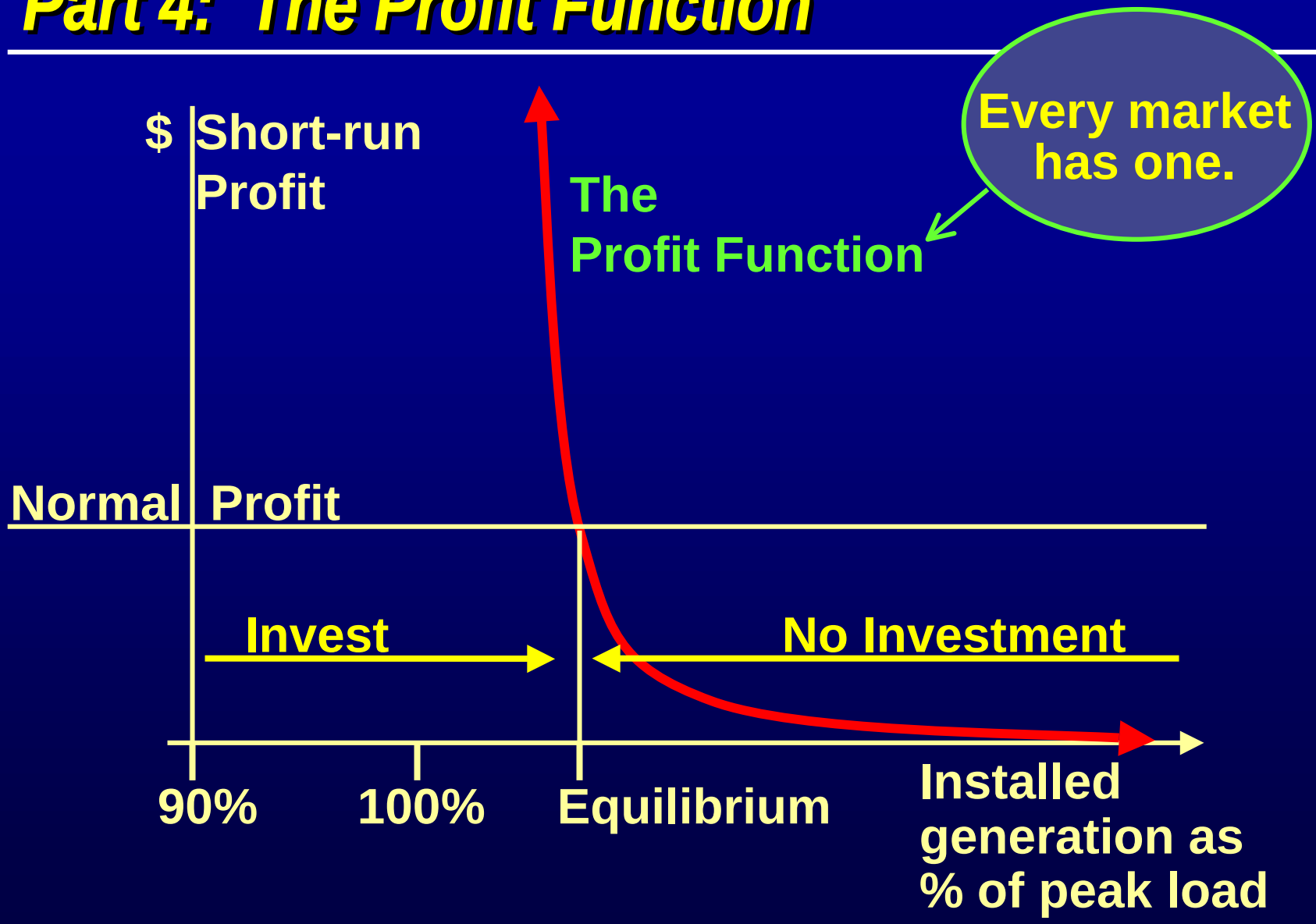
Assume P(OpRes) Is Given



The Price Duration Curve ➔ Investment

1. **Given**
   1. the load duration curve.
   2. the distribution of generation outages.
   3. it's correlation with load.
   4. the supply of generation.
2. **The calculation of the price-duration curve is mechanical.**
3. **Given FC and VC for the generators,**
   - Their profit is determined.
4. **Positive (economic) profits induce investment.**
5. **➔ An equilibrium mix of technologies ➔ ICap.**
6. **➔ The expected amount of load shedding.**

Part 4: The Profit Function



Many P(OpRes) ➔ The Same Investment

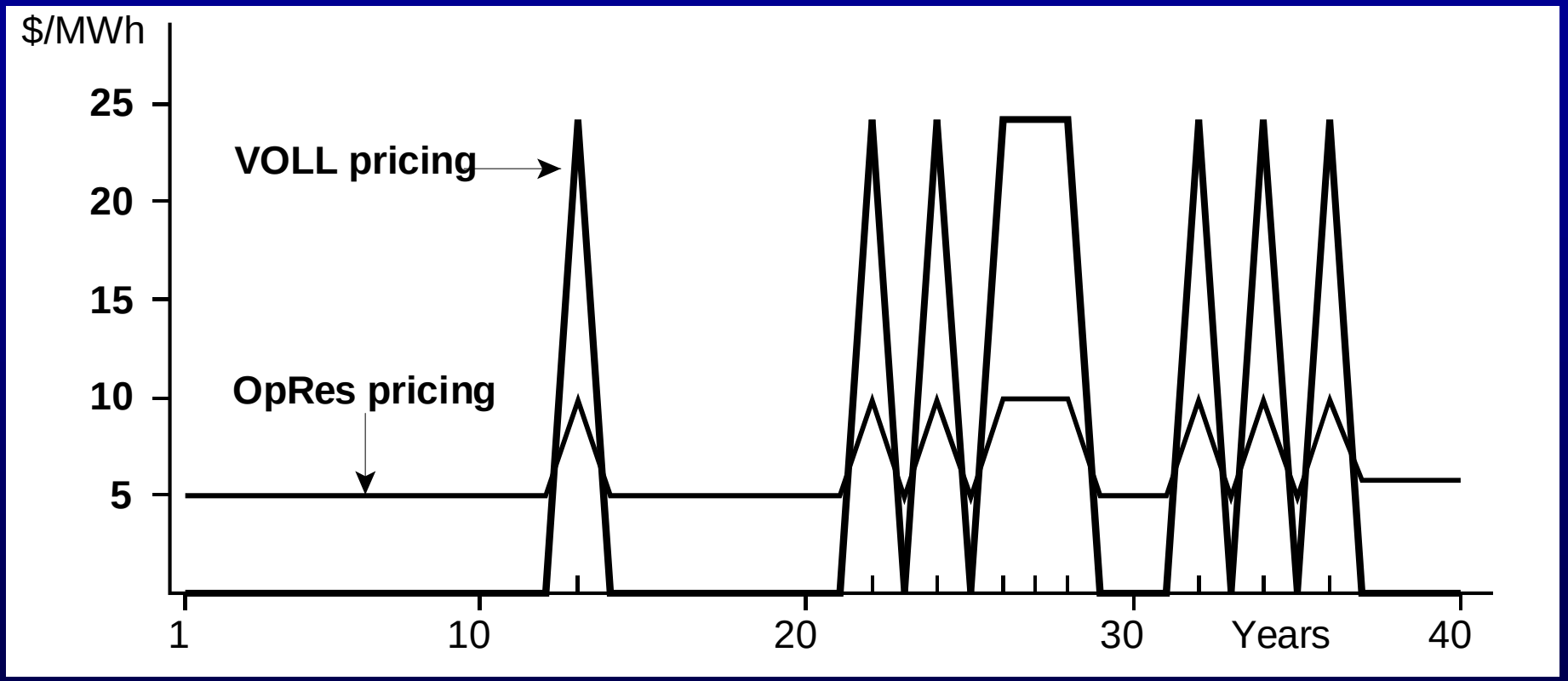
1. Equilibrium ICap is the value at which a peaker breaks even.
2. This is determined by (1) the duration of P > MCpeaker.

   which is determined by the width of P(OpRes).
3. And (2) by the height of P(OpRes).
4. There are infinitely many P(OpRes) that determine the same total ICap.

With Many "Optimal" P(OpRes) Functions, Which is Best?

1. **Engineers need not answer this.**
2. **They should present a set of choices, all of which induce optimal investment.**
3. **They should point out that FERC has a choice.**
   - Either $500 price spikes or $50,000 price spikes can induce optimal investment. (With the right OR^R.)
4. **Move the discussion out of the realm of ideology and into the realm of policy trade-offs.**

The Riskiness of High Price Spikes



The "Price-Cap" Trap

- **Price caps, according to FERC Chairmen, most politicians, and some economists, are something out of the kitchen slop bucket, and probably communistic.**
- **"Price cap" is a dangerous term. Try "price limit."**
- **Nixon's, price controls set the price of hamburger and about 70,000 other things. The controls were binding most of the time. They capped the price the grocery store could charge.**
- **Price-cap regulation is a respected modern form of "incentive" regulation.**
- **But, is P(OpRes) really a "price cap" ???**

P(OpRes) is a Purchase-Price Limit

- P(OpRes) does not tell any generator what it can charge in the private market.
- P(.) just tells the SO not to pay too much when it goes shopping. This is not communistic or anti-economic.
- P(.) does effectively cap the price in every market including all forward markets.
- This effect operates through the 2nd Demand Side Flaw: Anyone can shop in the spot market and the SO will sell at cost to those who do.

❖ The OpRes Pricing Policy IS The Price-Cap Policy.

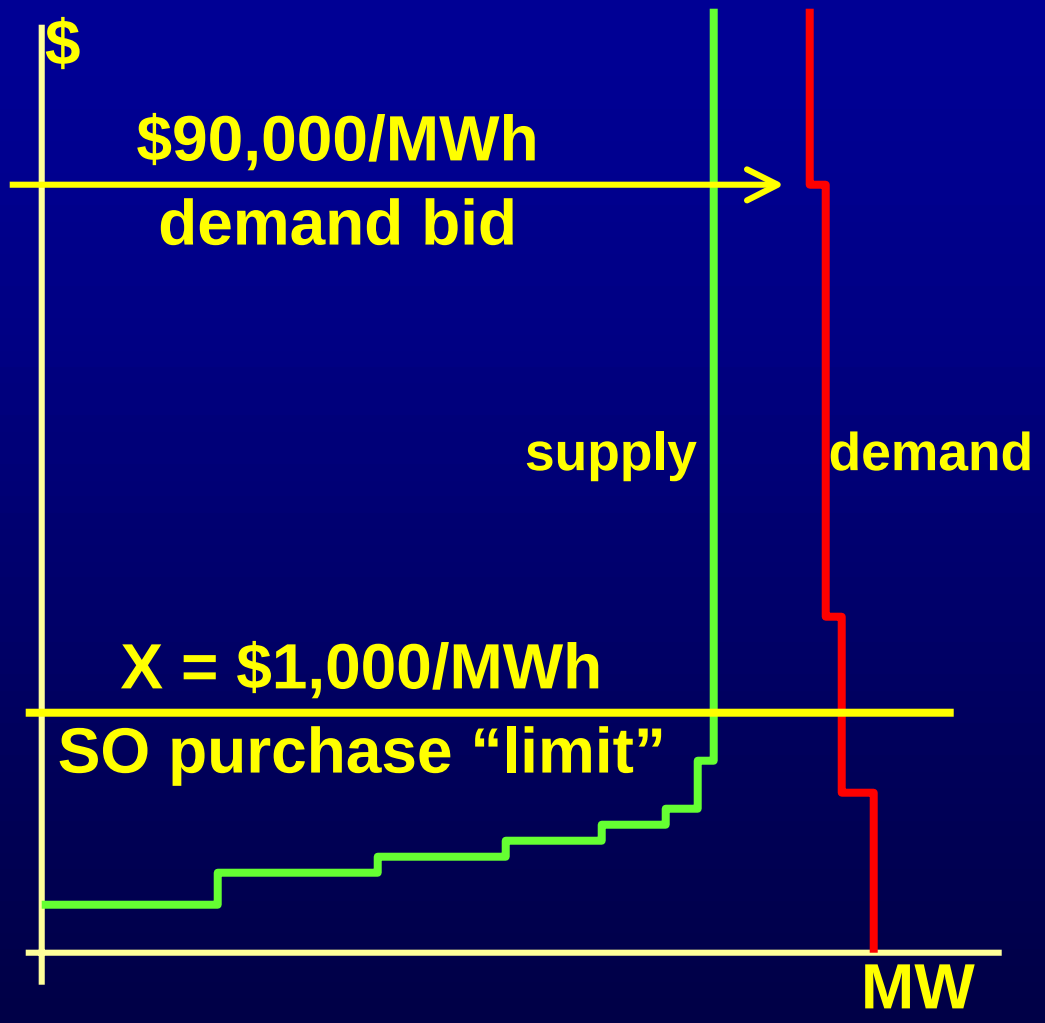
What Can We Do?

- **Send the message to NERC (then through to FERC).**
- **This group is the only one capable of convincing NERC.**
- **Could NSF fund papers and a conference?**
  - Papers should be mainly high level.
  - Some must include rough calculations.
  - A few should be “high tech.”
  - Conference should be high profile and policy oriented.

The End

News Flash: End Run Around SO Limits ???

- A New Approach:
- Real-time prices capped by the maximum of X or the highest demand bid.
- No economic justification.
- The demand side is still broken, and one or two high demand bids will not fix it!
- Texas & FERC



How to Choose A Pricing Policy for OpRes?

1. High price spikes cause very uneven profit.
2. A very few years give huge profits, and most years give negative profits.
3. This is a very risky environment.
4. If investors are not very far sighted, this will cause a boom-bust investment cycle. (inefficient).
5. A steep (inelastic) P(OpRes) increases market power.
6. High prices (above $500/MWh) are needed to induce the last 1% of output. Without them you need to build 1% more capacity.
7. High prices are need to induce demand response. But you don't need high supply-side prices for this.

What About Price Caps

1. **If the SO will pay no more than P(OpRes), and if all competing SO's pay the same, this demand function caps the spot market and all future markets.**

   Power-market price caps need not, and should not, be normal price caps. They do not limit what private suppliers charge. They limit what SO's will pay.

Why Does this Matter?

1. California had two years of low prices and no incentive to invest, then 1 year of supper high prices. Both situations were aggravated by the P(OpRes) functions in use throughout the west.
2. PJM had a few hot days two and a half years ago, and this push profits high enough that they generation is being overbuilt. This is wasteful.
3. Once the East has been overbuilt for 6 years and profits have been negative investment will dry up, when we will have a few super-good years for generation, perhaps in small regions. Then, overbuilding.

Why Does this Matter?

1. If you look at the profits of major generation companies, they are extremely volatile.
2. Consumers pay for all this risk !
3. This market could be less efficient at building generation than the old regulated regime.
4. The idea the now stockholders pay for the mistakes is wrong on average.

A power-market with a functioning demand side would not produce the price-spikes we have designed the broken market to produce.

Why not design it work like a well-functioning market?

VOLL Defined

1. Assume there is a cost to shed load: C(S(t)). Where S is the amount shed and the pattern of shedding.
2. Assume that for any ICap, K, the is a distribution of possible load shedding histories S(t).
3. Then associated with every K is an expected cost, C(K), determined by the expectation of C over the distribution of S(t) determined by K.
4. dC(K)/dK = marginal VOLL.
5. Very hard to compute, but conceptually well defined.

The VOLL Result

1. It pays to build peakers up to the point where marginal VOLL equals the cost of another peaker.
2. dC(K)/dK = VOLL = rental cost of a peaker.
3. Setting P(OpRes) = VOLL for OpRes < 0
   = 0 for OpRes > 0

   Induces optimal investment in peakers, optimal ICap.

   So do infinitely many other P(OpRes) functions.