On the Inherent Inefficiencies of TLR for Trading Electricity†

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MEET 2000, Stanford, CA
August 17-20, 2000

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PSERC

Acronyms, more acronyms

Progress

- TTC, ATC
- OASIS
- TLR
- MRD
- Multilateral
- Locational pricing:
  - Zonal, Flowgate, Nodal

TTC and ATC

Total Transmission Capability

How much can you send from A to B?

Available Transmission Capacity

How much can you send from A to B and given other trades *and* have "room for reserves"?

OASIS: A rational approach to establish and post ATC to facilitate trade and take into consideration engineering limits

What is wrong with ATC?

- **Economically inefficient**
  - **Costs not considered**
- **Inherent imprecision and uncertainty leads to:**
  - **under-utilized capacity on some lines**
  - **oversold capacity on other lines**

TLR (Transmission Loading Relief)

Administrative rule invoked to curtail trades when congestion occurs

Not based on economics

Arbitrary formula allocates curtailments

$$\text{Curtailed amount}_k = \text{PTDF}_k * \text{Initial Transaction}_k * \frac{\text{Total amount to curtail}}{\sum_i \text{PTDF}_i^2 * \text{Initial Transaction}_i}$$

TLR in theory

- It sounds simple
- It sounds fair
- It seems to work
- It is necessary
  - Something must be done
- It is fast
- It is not centralized
  - (really?)

Inefficiencies in Initial TLR Rules

- **No consideration of economics**
  - Congested transmission capacity not auctioned off to highest bidder
- **Multilateral trades deemed separable bilateral trades**
  - Effect of counter-flow trades not credited against other trades over congested lines

Why Administrative Curtailments are Inefficient (1)

- **Economics 101: In a competitive market, prices are set on the margin**
  - **The price of transmission between two locations is equal to the difference in the locational prices**

Why Administrative Curtailments are Inefficient (2)

Price of transmitting power from A to B = $20/MWh

Transmission provider collects* = 20*100 = $2000 in *congestion rents*

*** Caution: In a network, the congestion rent calculation is slightly different**

Why Administrative Curtailments are Inefficient (3)

- Suppose transmission provider charges $5/MWh to ship power from A to B?
  - Market participants see free money
    - Marginal profit is 20–5 = $15/MWh
    - *Congestion rent* "left on the table" is $1500 (15*100)
  - Market participants try to get it by gaming TLR

Why Administrative Curtailments are Inefficient (4)

- If I can anticipate TLR, I can create positions that will be curtailed "less" by forcing others to be curtailed more
  - Phantom trades can be scheduled
  - Trades that slip under the TLR radar can be put together

It is not optimal to setup counterflow trades to minimize flow over congested lines because this leaves "money on the table."

Why Taking a Strictly Bilateral Viewpoint is Bad

- Silly example:
  - A trader has an A to B trade of 100 MW, and a B to A trade of 100 MW.
    - This combined trade has no effect on flow in the congested line
- TLR rules curtail A to B trade while allowing B to A trade
  - In networks, there are multilateral trades that have no effect on some congested lines
  - NERC TLR rules treat them as undesirable

NERC TLR issues (May 2000)

- How is TLR reallocation and reloading to be accomplished?
- Loading guidelines [illegible] implementation of TLR Levels [illegible] development
- Method under [illegible] elopment to find parallel flo[illegible] ffects of native load and net[illegible] service so that assign[illegible]nt of relief will not double count point-to-point generation

Issues galore remain

Improvements to TLR: Market Redispatch (MRD)

"MRD is a procedure for prearranging market redispatch transactions to provide counterflows on a constrained path to protect transactions that would otherwise be curtailed under transmission loading relief procedures" (NERC, July 2000)

Advantages of MRD

- "Solves" most serious TLR problems
- It is market oriented
- It is reasonable
- It recognizes the importance of nodal (rather than regional) redispatch

Problems with MRD

No incentive to set up counter-flows on inefficiently priced congested lines

Why forsake "free" congestion rents?

For multiple congestion conditions, optimal trades must be multilateral

No congestion	$\Rightarrow$ One marginal unit
One congested line	$\Rightarrow$ Two marginal units
Two congested lines	$\Rightarrow$ Three marginal units

What is the status of MRD?

- FERC approved MRD for summer 1999
- FERC accepted NERC's revised MRD (extended it to December 31, 2000)
  - "The revised MRD represents a best effort to meet its mandate"
  - NERC will file a report summarizing MRD results and recommending whether it should be continued, modified, or discontinued.

Improvements to TLR: Multilateral Trades

- Trader has the option of creating a packaged trade [Wu, Varaiya 1996]
  - Counter-flows are credited against flows
- Curtailment of packaged trade based on a normed optimization problem [Bialek et al 2000]

Advantage of multilaterals

- Packaged multilateral trades more efficient than bilateral trades
  - A trader can maximize power transfers and minimize curtailments
- More than one flowgate constraint can be accommodated

Disadvantage of multilaterals

- No incentive to use multilateral trade prior to TLR curtailment
  - Why forsake “free” congestion rent?
- Curtailment formula is still inefficient
  - If packaged trade is curtailed, counterflows are also curtailed
    - This is silly
  - If only counter-flows are not curtailed, other traders benefit from counterflow trade
- Greater administrative difficulties managing complex trades

Multilateral trades: comments

After one round of TLR curtailments, there is no capacity left to sell

- **"Lucky" participants get 100 MW after first TLR**
- **They sell this 100 MW at prevailing market price and the market *could* reach a competitive equilibrium [Wu and Varaiya 1996]**

Multilateral trades better than plain TLR

- **Gaming incentives prior to first TLR remain**

Multilaterals "great" AFTER first TLR has occurred
Why bother before? No incentive!

Best Solution to TLR dilemma: Price flowgate capacity

- **Directly: Auction capacity on each flowgate separately**
  - **Chao-Peck pricing**
  - **NERC is "looking" at APX**
- **Indirectly: Nodal pricing**

Both approaches are theoretically equivalent; however, nodal pricing is more practical today

Practicality of Indirect Pricing

It is better to buy the entire jigsaw puzzle in one box rather than to buy it a part at the time, from different stores, and maybe with someone hoarding pieces

You are not exposed to “PTDF risk”

If PTDFs change after the rights are purchased, a legal or administrative problem may occur

Direct (flowgate): You buy segments for a trip
Indirect (nodal): You buy a trip from A to B
In both cases you can go from A to B! However, in the direct case, if a segment is canceled, you are out of luck!

Arguments against pricing flowgate capacity

- "Any centralized solution is likely to be met with deep suspicion"
- "Why should traders give private cost-benefit information to an ISO?"
- "Redispatch costs are lower than congestion rents; why shouldn't marketers pay only redispatch costs?"
- "It will increase market power"

These arguments are flawed

"Locational Pricing Methods are too Centralized"

Pop Quiz: Which is fairer? Which is less arbitrary?

- **An arbitrary curtailment scheme by a centralized authority who does not care what you are willing to pay (TLR)?**
- **A centralized authority (ISO) who curtails you only if what you are willing to pay is lower than the market clearing price?**

TLR is no more centralized than Locational Pricing Models; it is just more arbitrary

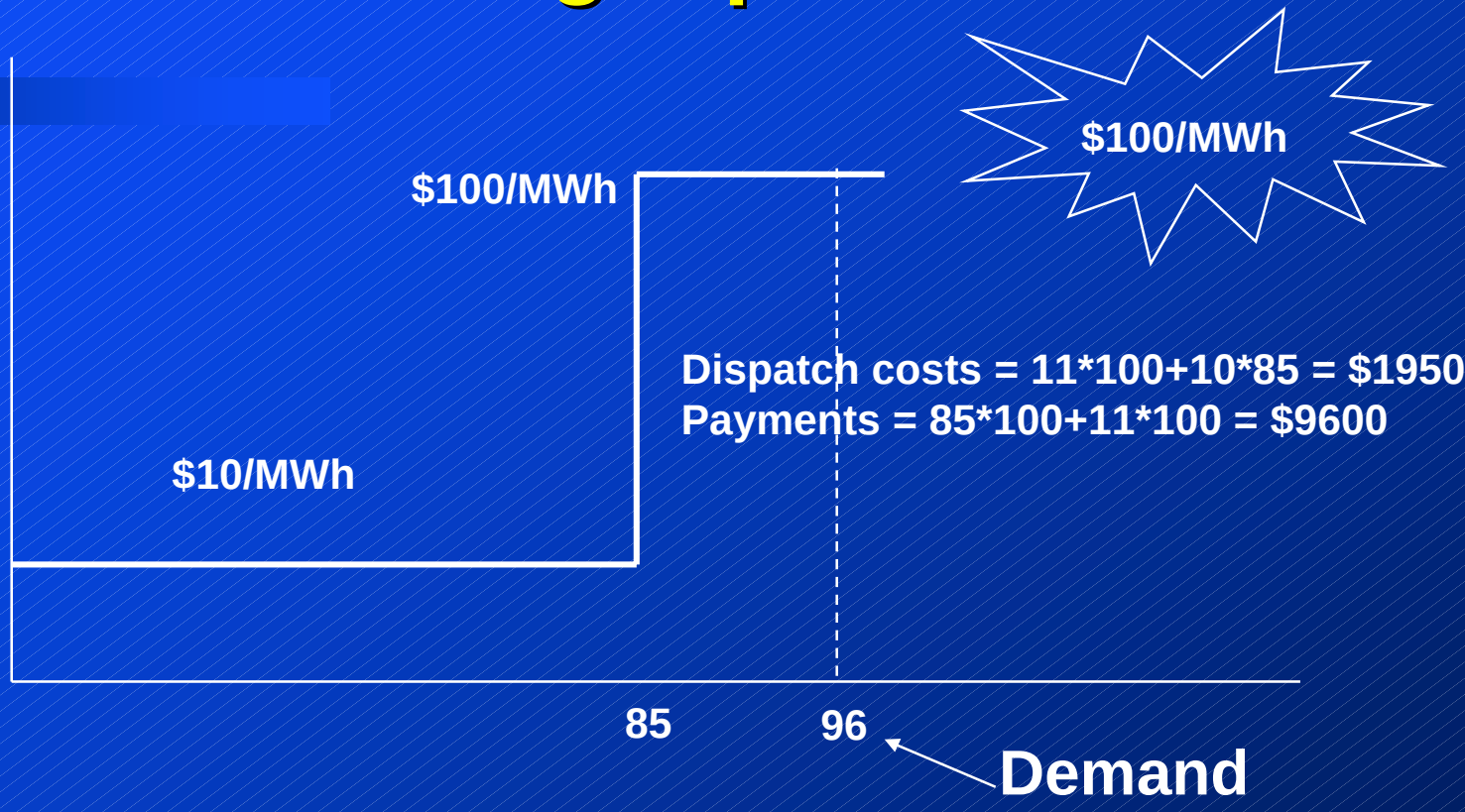
"Why should traders give private cost-benefit information to an ISO?"

- An ISO is a trader of transmission capacity and would like to obtain the best price for this capacity
  - OK, it is a "regulated" trader
- Using bids/offers the ISO solves the least-cost problem for all nodes
  - Since the ISO is regulated, the ISO cannot extract monopoly profits from the sale of capacity on congested flowgates

“Why should traders pay congestion rent rather than redispatch cost?”

- Because transmission is a commodity and must be priced on the margin
- Comparing congestion rent to redispatch cost is analogous to comparing total generator cost to total payments to generators in an unconstrained system
  - All infra-marginal generators get the same market clearing price

What is the right price?

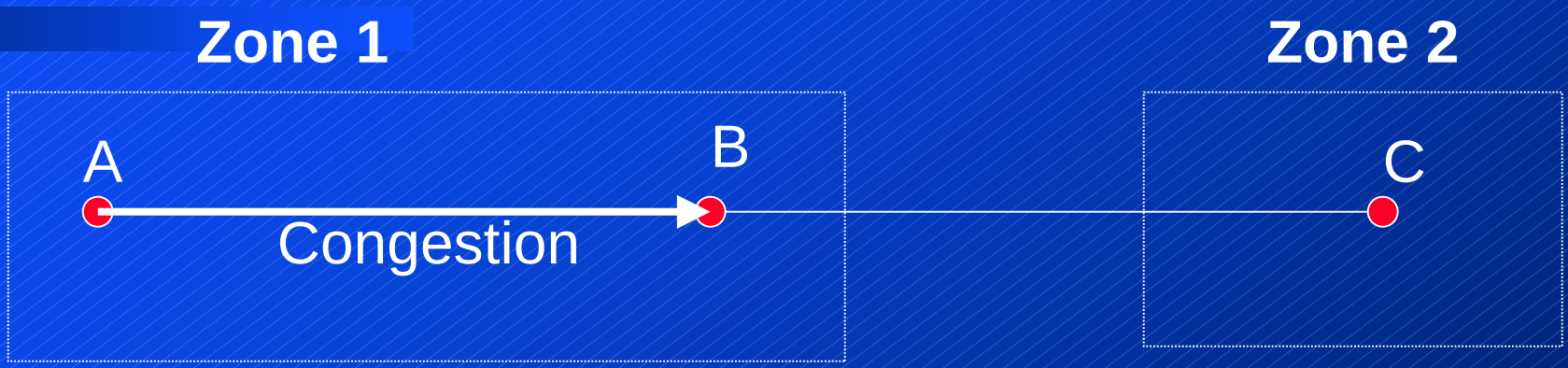


Even without congestion, total dispatch costs are lower than payments

"Proposed method allows marketers to exercise market power"

- There is no evidence that such method exacerbates *existing* market power
  - Examples in the literature often ascribe *existing* market power to nodal pricing!
- On the other hand, there is a theory that suggests that other methods can make market power worse (Hogan 2000)

Illustration



If both the A to C and B to C transactions are treated as transactions from Zone 1 to Zone 2, intra-zonal congestion in Zone 1 limits transactions from B to C, and increases market power in Zone 2

NERC MRD vs. PJM "experiments"

- NERC: none succeeded (tagging problems)
- PJM: many successes

Conclusions

ATC and OASIS have problems

TLR leads to gaming and inefficiencies

MRD is better, but still has problems

Multilateral redispatch is “almost” right

The right methods:

- Flowgate-based direct flowgate pricing
- Indirect flowgate-based (nodal) pricing