

Flow-Based Congestion Management: An Intellectual & Practical Dead-End

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Agenda

Historical and Logical Overview

Initial Claims and Hard Realities

The Search for a “Hybrid”

Current Status and Likely Outcome



Definitions and Abbreviations

FG = Flowgate (Flow-Limited Network Element)

CSF = Commercially Significant Flowgate

FGR = (Physical?) Flow Gate Right

PTDF= Power Transfer Distribution Factor

LMP = Locational (Nodal) Marginal Price

FTR = Financial Transmission Right with LMPs

RT(M)= Real-Time (Market)

RTO = Regional Trans. Org, ISO, or similar entity



Historical and Logical Overview

Initial electricity trading used “contract paths”

- Power flow is “scheduled” on a single path
- Traders must buy rights on this single path
- BUT: Totally inconsistent with physical reality

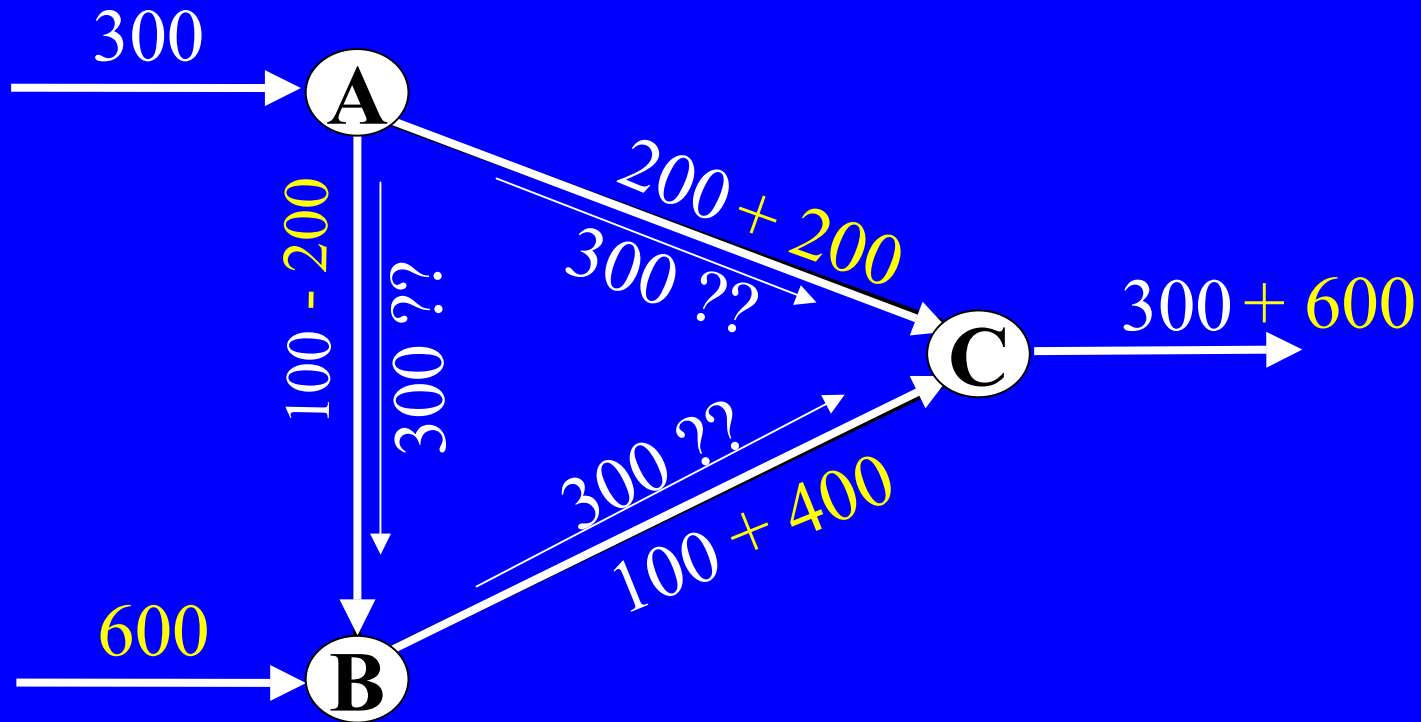
LMP/FTR approach ignores flows for trading

- Power “ins/outs” are sold/bought at points
- Traders buy point-to-point FTRs
- RTO worries about network complexities

Flow-based trading returns to contract paths, but with traders responsible for flows on many paths



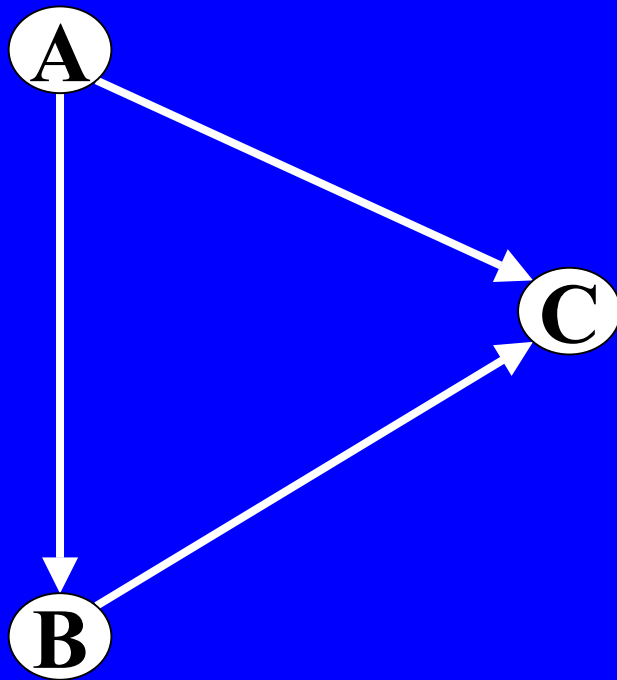
The Simple Idea Behind Flowgates



NOTE: All Lines Have the Same Impedance



Power Transfer Distribution Factors



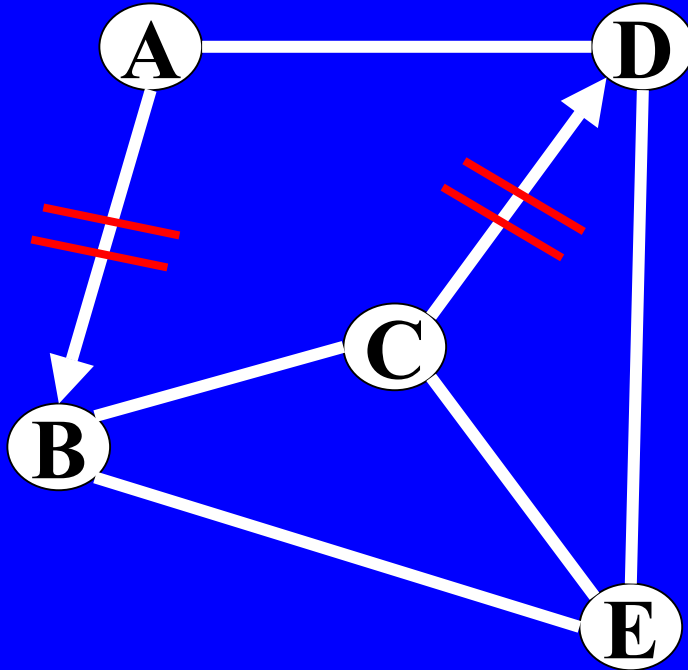
PTDFs (Hub = C)

	Line (CSF?)		
Node	A-C	A-B	B-C
A	2/3	1/3	1/3
B	1/3	- 1/3	2/3

NOTE: All Lines Have the Same Impedance



The Simple Idea Extended



PTDFs (Hub = E)

Node	CSF	
	A→B	C→D
A	+ 0.52	- 0.12
B	- 0.31	+ 0.03
C	+ 0.07	+ 0.43
D	+ 0.02	- 0.62

100 A-C Needs: (52-7) A→B and (-12-43) C→D FGRs

100 B-D Needs: (-31-2) A→B and (3+62) C→D FGRs



The Initial Claims for Flowgates

There are only a “few” CSFs/FGRs that:

- Capture all “significant” congestion
- Are easy to identify and physically intuitive
- Have constant PTDFs and CSF capacities
- Can be 1-way options, not 2-way obligations
- Can be physical, not financial, rights

If this were true, flow-gate trading might be easy, liquid, transparent, with no need for LMPs/FTRs.

Unfortunately, it just ain't so!



Reality: There Are Very Many CSFs

System operations are constrained by:

- Hundreds/Thousands of physical constraints
- Many non-flow (e.g., voltage) constraints
- Many contingency constraints

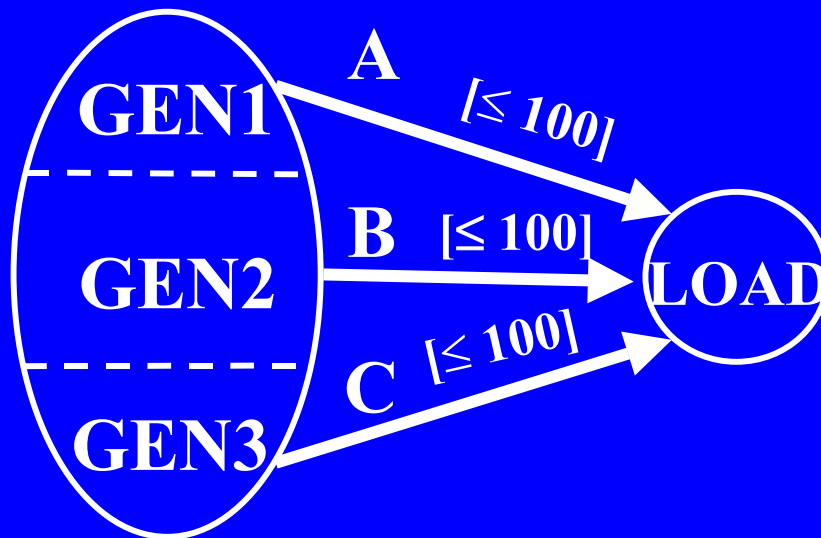
The “fact” that current congestion costs are “small” does not mean they can be ignored

Socializing even “small” congestion costs leads to:

- Distorted operational and location incentives
- Destructive gaming (the “dec” game)
- Large congestion costs eventually



Are CSFs/FGRs Few and Intuitive?

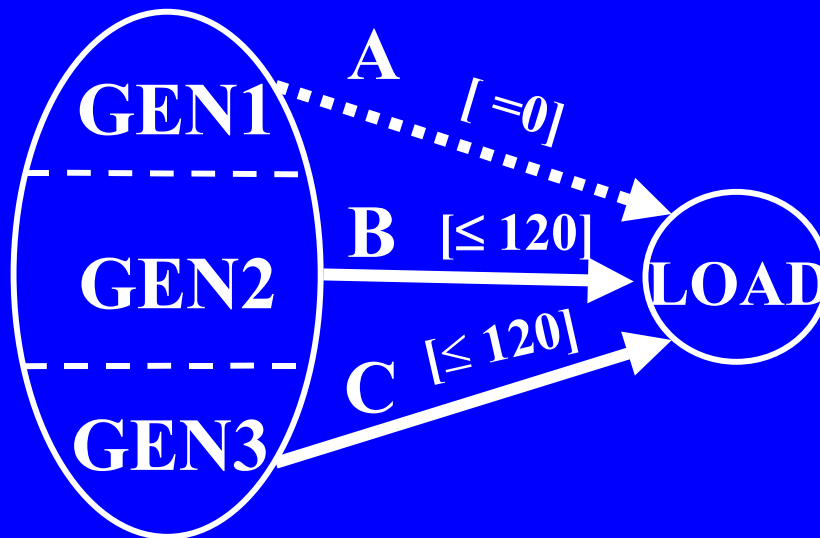


To LOAD from	PTDF for Line		
	A	B	C
GEN1	0.5	0.3	0.2
GEN2	0.25	0.5	0.25
GEN3	0.2	0.3	0.5
FGRs	100	100	100

3 potentially constrained lines “obviously” imply “only” 3 CSFs/FGRs & 9 (6 independent) PTDFs

Unfortunately, it just ain't so!

There Are Many Contingencies



To LOAD from	PTDF for Line		
	A	B	C
GEN1	0.0	0.7	0.3
GEN2	0.0	0.6	0.4
GEN3	0.0	0.3	0.7
FGRs	0	120	120

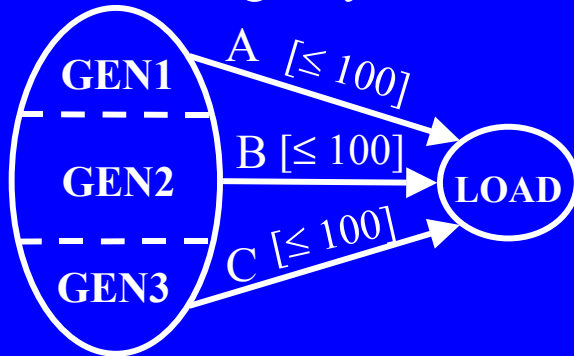
(Assumes surge limits = 120% of steady-state limits)

***Contingencies constrain operations
even when they do not occur***

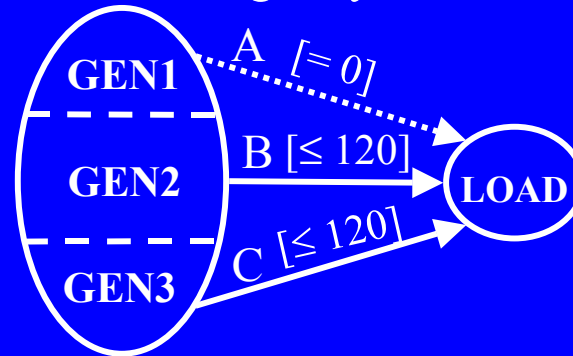


Contingency Constrained Dispatch

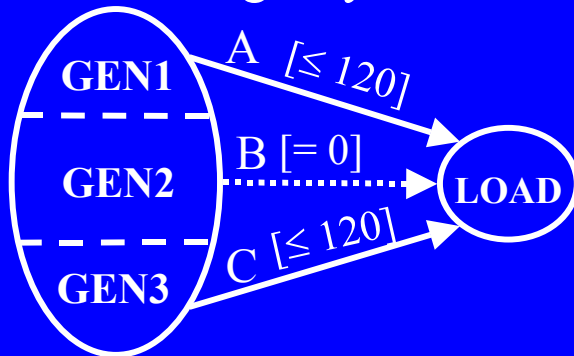
Contingency "0"



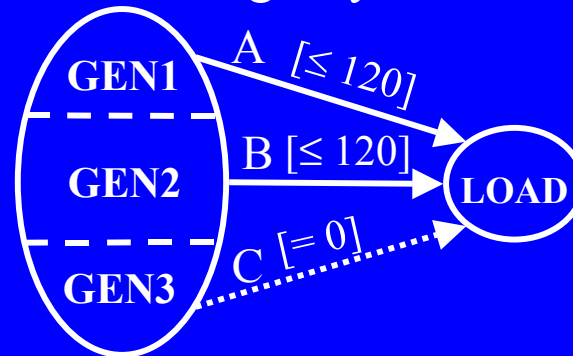
Contingency A



Contingency B



Contingency C



3 Lines with 4 Contingencies Imply Up To 12 Flow Constraints and 36 (24 Ind.) PTDFs



Reality: CSFs/FGRs Are Many and Abstract

All contingency constraints are the same in dispatch

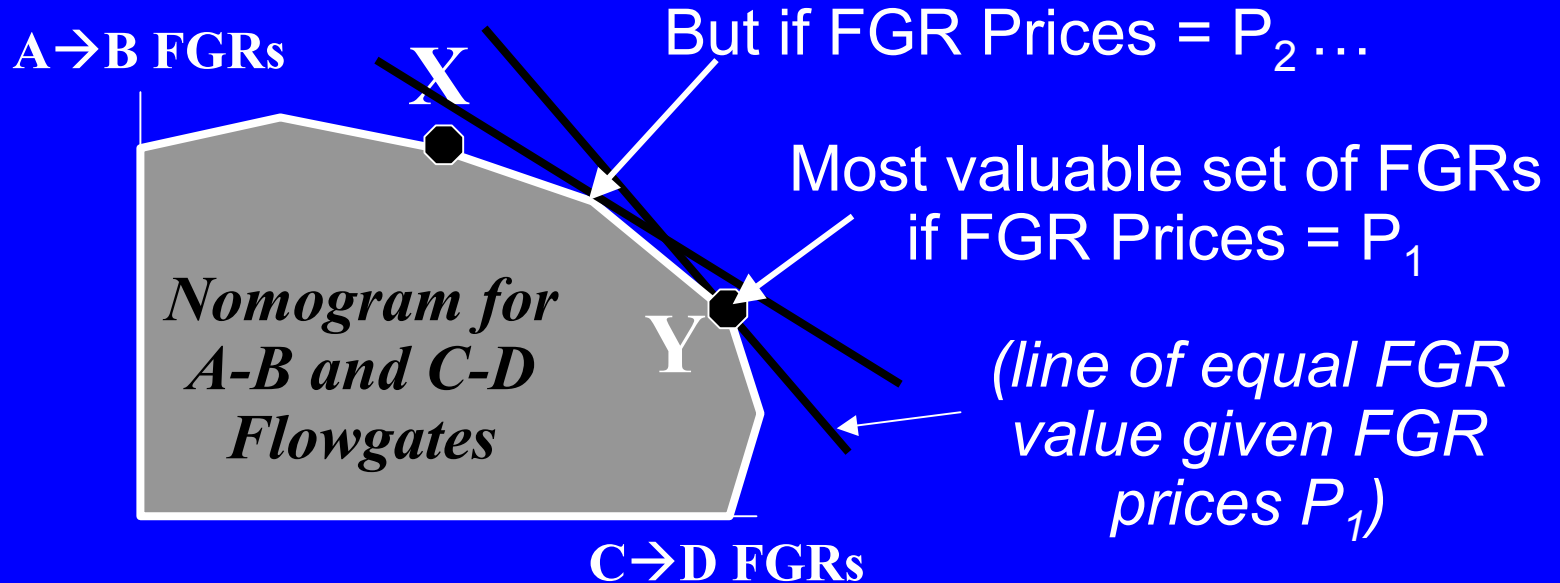
- “100 MW on Line A when all lines are in”
- “120 MW on Line B when Line A is out”
- Even highly unlikely contingencies can affect dispatch and pricing in any/all hours

CSFs and FGRs must be defined accordingly

- They will NOT be “intuitive” physical things/places
- **EPRI has had ~100 contingent CSFs, with more/different ones appearing all the time**



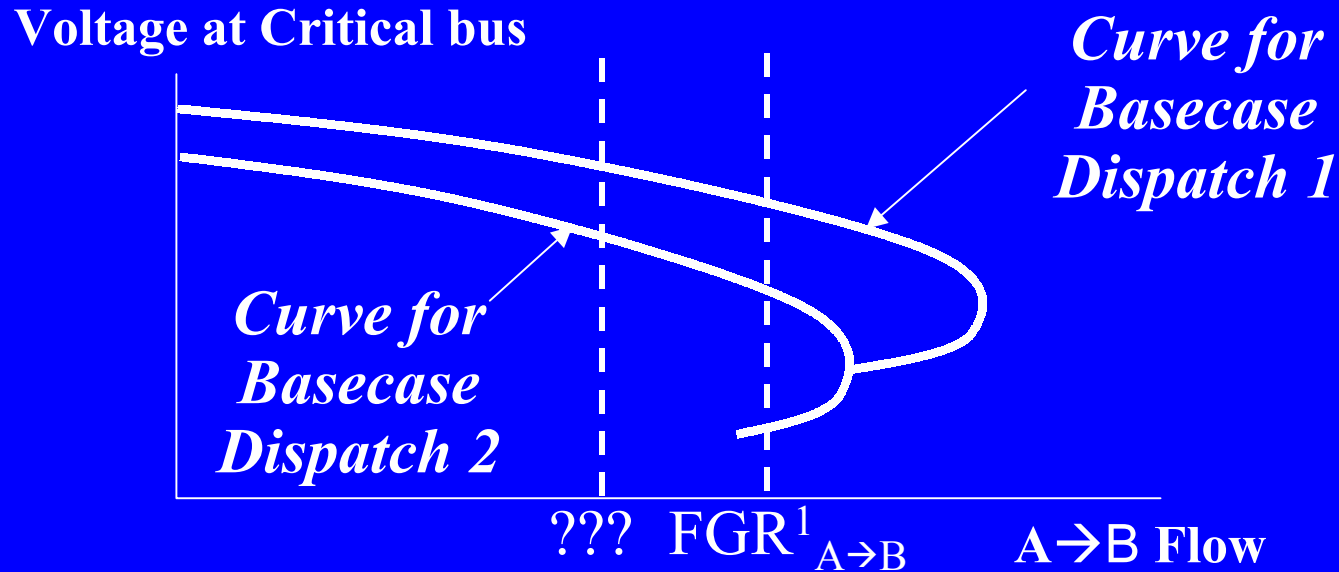
The Problem of Nomograms



Which combination of FGRs does “the market” want?

The RTO must know the market outcome before setting the market parameters!

The Problem of Non-Flow Constraints



***Flow limits depend on the entire dispatch/
market outcome, which is not known even
hours, much less days/months, in advance***



The Problem of Controllable Lines

Controllable lines (phase shifters/DC lines):

- Are becoming more economical and common
- Have no purpose EXCEPT to change PTDFs

Flow-based “theory”:

- Has no way to deal with controllable flows
- Essentially ignores/denies them

In an LMP/FTR system, controllable lines are dispatched and affect prices like anything else; dispatch is efficient and FTRs are good hedges.



The Problem of “Physical” Rights

FGRs were initially regarded as “physical” rights

- Needed to schedule physical transactions
- “Use-or-lose,” w. penalties for exceeding FGRs
- Physical operations determined by FGRs

FGR proposals have now given up on most of this.

- FGRs not needed to schedule or operate
- Physical operations determined in RTM w. LMPs
- FGRs purely financial (w. TLR priority, use/lose?)

FGR “theory” is now scrambling for a “hybrid”



The Problem of Options vs. Obligations

Supposedly, FGRs (but not FTRs) are options that:

- Pay the holder if congestion is in expected direction
- Do not obligate the holder to provide “counterflow”

This is simply not true, logical or an FGR “advantage”

- FTRs can be options just as well as FGR can
- Counterflow obligations can be operationally useful and commercially valuable

Either there is no difference here, or FGRs are clearly inferior to FTRs



The Search for a “Hybrid” Model

A pure FGR market is now seen to be impossible.

- FGRs cannot capture complexities of a grid
- FGR trading will not be fast or efficient enough

So the search is on for a hybrid market in which:

- Forward trading would be based on CSFs/FTRs
- Real-time operations and pricing would use LMPs
- The RTO would socialize some/all of the costs of closing the gap between the two markets

Even the hybrid will eventually prove impractical.



Some of the Issues in a Hybrid Market

Who defines the CSFs/FGRs/PTDFs, and how, when:

- There are far too many CSFs (>100 in Alliance?)
- Capacities (FGRs) and PTDFs change constantly

Do LMPs in RTM reflect all actual constraints/PTDFs?

- If so, how is RTM congestion hedged, how are FGRs settled – and what good are they?
- If not, how is real-time congestion managed and its costs allocated?

Such issues are still unresolved, even unaddressed.



Example: Settling FGRs at LMPs

Suppose I buy FGRs that “almost” hedge a transaction

- Based on the preannounced CSFs and PTDFs
- But RT LMPs reflect different constraints/PTDFs

What am I charged/paid for congestion in the RTM?

1. The RT value of my FGRs less RT LMP charges?
2. Some “small” amount because I was “almost” fully hedged in the forward market, and if so, what?

***Answer 1 is OK, but → FGRs are poor hedges;
Ans. 2 → Logical problems, last costs socialized***



Example: Grandfathering Existing Rights

Existing long-term transmission rights are:

- Either point-to-point or “network” rights
- Relatively easy to convert to point-to-point FTRs

Converting existing rights to equivalent FGRs requires:

- A new set of FGRs whenever CSFs/PTDFs change, i.e., every month, day or hour
- Somebody (RTO?) to pay for each reconfiguration

This is a complex, inefficient, risky way to do what FTRs do easily and automatically!



(How) Will FGR Trading Really Work?

The claim that FTR trading will be easy, liquid, etc.

- Has no basis beyond repeated assertion
- Is implausible on its face, given that there are millions of potentially interesting FGR portfolios

Competitive selling of individual FGRs is unlikely

- Traders will want point-to-point bundles of FGRs
- Centralized, “monopoly” exchanges will be needed

Even then, FGR trading will require the RTO to guarantee an artificially simplified market



The Real Issue: Socialization of Costs

A flow-based market that reflects reality would have:

- Hundreds of abstract, contingent potential CSFs
- Ever-shifting CSF capacities (FGRs) and PTDFs
- No way to hedge more than a few hours in advance

Commercially useful FGR trading requires the RTO to:

- Select a few CSFs with fixed FGRs/PTDFs
- Somehow manage physical reality in real time
- Protect FGR holders from the real-time costs.

FGRs “work” only if the RTO socializes large costs.



Summary and Conclusions

“Everybody” now accepts the need for:

- Financial, not physical FGRs (ex. TLRs, use/lose?)
- LMP-based real-time operations and pricing

FGR/Hybrid advocates are still searching for ways to:

- Define stable CSFs, FGRs, PTDFs
- Settle FGRs against real-time LMPs
- Convince others to pick up large, socialized costs

A flow-based market is a logical/practical dead-end – which is not to say that nobody will try it, of course!

