1. INTRODUCTION

In a recent note Larry Ruff\(^1\) attempts to refute assertions made by Chao et al. (CPOW)\(^2\) with regard to the advantages of Flowgate rights (FGR) over point to point Firm Transmission Rights (FTR). The disputed claim is that unlike point-to-point FTRs that are defined as two way obligations, FGRs can be defined as one way options without reducing their ability to cover the full capacity of the grid so that all possible transactions can be hedged. Ruff correctly concludes that "if this were true it would indeed be a powerful argument in favor of a flowgate/FGR system over an LMP/FTR system".

Unfortunately his attempt to disprove the above claim throws darkness on the subject and obscures the debate with gratuitous cynicisms. The true colors of Ruff's arguments come out in his concluding remarks where he states "Decentralized bilateral trading may be able to create something roughly equivalent to transmission hedges independent of the RTO, but this would be difficult and inefficient. And anything along these lines that can be done in a flowgate/FGR regime could be done at least as well in an LMP/FTR regime."

So we are back to the old debate of centralized vs. decentralized markets. As the father of the POOLCO concept\(^3\) it is not surprising that Ruff's anti FGR thesis amounts to nothing more than reiteration of his disbelief in the potential of decentralized electricity markets.

The remainder of this note will attempt to clarify and justify the assertions made in the CPOW and shed light on misconceptions that underlie Ruff's arguments.

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1 Larry E. Ruff, "Flowgates vs. FTRs, and Options vs. Obligations", (August 26, 2000)
3 Larry E. Ruff, "Stop wheeling and start dealing: resolving the transmission dilemma" Electricity Journal, v.7, no.5, pp.24-43
2. AGREEMENTS AND DISAGREEMENTS

The basic thesis in Ruff’s note is that full exploitation of the grids capacity may require counterflows that involve generation at a marginal price exceeding the sale price at the demand node. The economic rationale for such a "losing" transaction is that the counterflow produced by the expansive generator enables more production by a less expansive generator whose production is constrained by the grid capacity. Ruff concludes that in such a situation, in order for the cheap generator to be able to hedge the congestion costs for its full production it is necessary for the expansive generator to take on the obligation to produce the counterflow. He proceeds to conclude that the above refutes the assertion by CPOW that unlike point to point FTRs, FGRs defined as options can provide full hedge coverage for any possible transaction within the capability of the grid. This conclusion is summarized by the statement "FGRs defined as options will not allow traders to get enough of most critical FGRs to schedule/hedge the most efficient set of transactions when counterflows are required to implement those transactions." The arguments supporting that conclusion are cast in the framework of the following three node example introduced in CPOW which uses a lossless DC model with equal line admittance and thermal capacity as denoted in Figure 1. Figure 2 shows the area of feasible injections that can be accommodated by the transmission lines (Flowgates) and the limiting line corresponding to each boundary of that feasible region.

Both the CPOW paper and Ruff’s note agree that real time congestion relief and settlements will be based on LMP. In other words bilateral contracts will be charges for congestion or compensated for counterflow based on locational price differences. Accordingly, point to point FTRs will be settled based on the same locational price differences whereas FGRs issued by the RTO will be settled based on the corresponding flowgate shadow prices. Hence any efficient transaction in the feasible area defined by the flow constrains is achievable.
The domain of controversy concerns the forward market and the desirable form of property rights to the grid capacity that will allow hedging of congestion costs by energy traders. Following are some basic desiderata associated with transmission rights that underlie much of the FGR vs. point-to-point FTR debate.

1. Define rights as options rather than two way obligations

2. Rights should enable hedging of all feasible transactions
3. Congestion rents should cover or exceed the settlement of rights issued by the RTO
4. Define rights that can be easily traded and reconfigured without central coordination

While Ruff agrees that being able to meet the first two criteria above would be an advantage the main thrust of his note is to prove that that is impossible. He further argues that there is nothing wrong with two sided rights that may have negative value and that such rights are consistent with economic efficiency. It is surprising to hear such a claim from a seasoned practitioner. Issuing a property right that has a negative expected value amounts to selling an obligation for a volatile payout in exchange for an upfront lump sum payment. In a risk neutral world such a transaction makes perfect economic sense. However, in the real world, risk averse traders will avoid such a deal or will demand a high risk premium to undertake it. It is not surprising that even systems that embraced the LMP/FTR approach tend to shy away from such contracts. It is exactly the same reasons that motivate traders to hedge congestion cost by entering into forward contracts that will prevent them from accepting an upfront lump sum payment for underwriting the cost of counterflow produced by out of merit generation. The classic argument advocating the commercial feasibility of such contracts is that their holder would be covered typically by generation capacity that can produce the counterflow and the out of merit generation revenues will offset the FTR obligation. Even in such a situation, however, FTRs that carry a financial liability may be considered risky since they compound the risk associated with a generator being down. When that happens the FTR holder bears the financial responsibility for the counterflow that would have to be produced by a more expansive generator than his own. Consequently, bids for negative valued FTR are likely to be inflated by a high-risk premium which would reduce the allocative efficiency of the property rights.

There is little disagreement on the third criteria but there is fundamental disagreement with regard to the importance and efficacy of decentralized trading in supporting an efficient forward market for energy and transmission service. Nevertheless, even strong proponents of the LMP/FTR approach concede that FGR's are more amenable to decentralized trading and do not require as intense central coordination as point to point FTRs since they do not require a simultaneous feasibility test. Furthermore, once issued
FGRs can traded on secondary markets and reconfigured in any desired combination to meet short term hedging needs whereas reconfiguration of FTRs requires central coordination.

3. HEDGE SHORTAGES

The key question on the table is whether FGRs defined as options have an advantage over point to point FTRs defined as options in term of enabling hedging of all possible transactions. In order to understand the difference between alternative forms of transmission rights with respect to their hedging capability we need to differentiate the possible causes for a shortage of hedges. There are three possible reasons why a transaction cannot be hedged against congestion cost. Those are described below and illustrated in terms of the three node example introduced above:

1. *The forward market is incomplete.*

This condition refers to the case when available hedging instruments cannot cover the full range of possible transactions. To illustrate such a situation considers the example illustrated in Figure 2. With FTRs defined as rights and obligation it is possible to issue a combination of point-to-point FTRs 1→3 and point-to-point FTRs 2→3 that will provide a full hedge for any feasible transaction. Note that in order to provide a full hedge for a transaction represented by point Z 100MW of FTR 1→3 must be defined as an obligation. The payment that will be received by the holder of the FTR 1→3 will cover the negative congestion rent paid in real time to the generator at node 1 for producing counterflow. In the absence of the FTR 1→3 obligation the RTO would run a deficit. If point to point FTRs are defined as options then the light shaded region in Figure 2 describes the set of all possible FTR combinations that will guarantee revenue adequacy for the RTO, i.e., the set of FTRs for which real time congestion revenues will cover the FTR settlements. This set of FTRs is incomplete in the sense that it cannot provide full congestion hedges for transaction that fall in the dark gray shaded area (outside the light shaded area). This doesn't mean that such transactions cannot be executed in real time, however, part of the transactions will be unhedged exposing the traders to congestion risk.
2. **Real time mismatch between mix of hedges and operating conditions**

Even if the available instrument types have the potential of hedging all possible transactions there is no guarantee that in real time all possible transactions can be fully hedged unless the available hedges can be continuously reconfigured to match the real time dispatch. For example, if the RTO sold FTRs corresponding to point X in Figure 2 these FTRs cannot provide a full hedge for a real time transaction described by point Y. Suppose for example if Generator 2 buys all the FTRs 2→3 corresponding to point X while Generator 1 buys all the FTRs 1→3 available at that point. If the real time efficient dispatch happens to be at point Y (for example due to a glut of run of river energy at node 1) then Generator 2 will be overhedged whereas Generator 1 will be underhedged. As noted by Hogan in his seminal article, the congestion revenues at point Y are guaranteed by duality theory of Linear Programming to exceed the FTR settlements based on point X. However, what is excess revenue for the RTO amounts to unhedged congestion payments by the traders. Since the RTO has a monopoly over reconfiguration of FTRs there is no way for a secondary market to reconfigure the FTRs so as to allow trader to better hedge their transactions. The RTO would have to increase the frequency of the reconfiguration auctions to weekly or even daily auctions if it were to allow traders to keep their transmission hedges up to date. *Hurray!!! More power to the RTO.*

FGRs on the other hand enable decentralized reconfiguration of point to point hedges enabling traders to reconfigure their hedges so as to track changing conditions that will shift the operating point. All the RTO needs to do in the FGR setup is to sell off the FGRs corresponding to the different flowgates and publish the PTDFs periodically. In our example, both points X and Y correspond to a binding flowgate 1→3 all other flowgate constraints are not binding and hence have no trading value. Both Generator 1 and Generator 2 can easily adjust their hedge to reflect the shift

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from point X to Y through a bilateral transaction in which Generator 2 sells its excess flowgate rights to Generator 2 with no intervention by the RTO.

3. Failure to trade

The efficiency of any centralized or decentralized markets depends on the voluntary exercise of profitable trade opportunity by market participants. However, while efficient markets theory tells us that all profitable trades will be exhausted, in practice it is possible to find $20 bills on the ground. Both FTRs and FGRs or any other form of property rights are susceptible to failure of their holders to trade them. In our three-node example, there is no guarantee that Generator 2 will sell its excess FGRs to Generator 1 so that they can both be fully hedged when moving from point X to Y. It is possible that Generator 2 will stay overhedged and have a positive balance after paying congestion rents and receiving the FGR settlement from the RTO while Generator 1 will stay underhedged and incur a net congestion expense. While the result of such failure to trade may be no different then the outcome of an incomplete forward market or the impossibility of secondary markets due to complex coordination requirements, there is hope that inefficiencies due to failure to trade can be removed with the advances in trading technology and proliferation of electronic commerce.

4. HEDGING WITH OPTIONS

As discussed above defining FTRs as options creates an incomplete set of hedging instruments that leaves part of the feasible transactions uncovered so that traders engaged in such transactions will not be able to hedge all their congestion risk. The unhedgable transactions with FTR options are those that are enabled by counterflow. However, such counterflows must be covered by a financial obligation before the RTO can provide a congestion hedge on the enabled transaction without undertaking financial risk. This difficulty is inherent in the point-to-point FTRs that combine transmission capacity enabled by the physical grid with capacity that is enabled by counterflows. FGRs on the other hand provide a natural means to differentiate between property rights to the physical network and rights to flowgate capacity resulting from counterflow. All FGRs
whether those based on property rights to the physical capacity of a flowgate or those resulting from counterflow are defined as financial options. In other words such rights entitle their holder to receive the real time shadow price corresponding to the directional flowgate but entails no obligation. Flowgate rights also entitle their holders to scheduling priority on the corresponding directional flowgates but do not obligate them to exercise that priority. Unclaimed scheduling priority (but not the financial right) reverts to the RTO who can use the unclaimed capacity for unhedged transactions.

In the FGR system the RTO only issues and settles (property) rights that are backed by physical capacity of the flowgates. FGRs resulting from scheduled counterflow are automatically endowed (at no cost) to the counterflow producer. Hence, the set of all FGRs including those issued by the RTO and those endowed to the counterflow producers provides a complete set of hedging instruments that can cover the entire set of feasible transactions (unlike FTR options). However, it is up to secondary trading to get these rights into the right hands and reconfigure them into desirable hedges that will mirror the real time transactions. A major advantage of this approach that has been discounted in Ruffs note is that the RTO only deals with the physically based FGRs that are issued as options and compensated according to the flowgate shadow prices whereas FGRs that are based on counterflow are traded and settled bilaterally or through secondary markets with no financial implication for the RTO. Of course any private trading results in an obligation on part of the seller so in this case a seller of an FGR that is basically a forward entitlement to counterflow rent is liable to the buyer for that rent. However, the RTO that is a public entity and acts as custodian of the transmission system can offer property rights defined as FGR options and doesn't bear any risk associated with enforcing forward financial obligations. Congestion rents collected by the RTO in real time are used for settlement of the physically based FTRs and for payment of negative congestion rent to the counterflow producers. Revenue adequacy of this scheme (for the RTO) is guaranteed by LP duality theory.

Counterflow producers who are endowed the default FGR options corresponding to the counterflow they produce have several alternatives for what to do with them.
a. They can keep them and collect the real time negative congestion rent resulting from their produced counterflow. In that case they have no scheduling obligation. However, if the counterflow is produced the RTO will treat the scheduling priority associated with the associated FGRs as unclaimed and will release it to unhedged transactions.

b. Sell the financial entitlement of the FGR undertaking the liability for the negative congestion rent associated with the counterflow but not taking on the obligation to schedule the counterflow. Here again the RTO will treat the scheduling priority associated with these FGRs as unclaimed and will release it to unhedged transactions.

c. Sell the financial entitlement and undertake a scheduling obligation for the counterflow, which will allow the buyer to obtain scheduling priority. This can be implemented without direct intervention of the RTO by simply consolidating the schedules.

Ruff is correct in his observation that in order to fully hedge transactions that are enabled by counterflow the counterflow producer must sell its FGR options to the counterflow user and this amounts to a bilateral obligation. So indeed the assertions in CPOW should be qualified to state that FGR options allow full hedging of all feasible transactions without requiring that the RTO handle obligations. With obligations left to private markets, there is the possibility of failure to trade, which will limit the hedging possibilities. Failure to trade results in the "wrong" people holding hedging instruments thus preventing full hedging of transaction. This situation is not different from under or over hedging due to a mismatch between point-to-point FTR holdings and real time transactions. On the other hand the fact that FGR options provide a complete set of hedging instruments (unlike the point to point FTR options) and can be easily reconfigured through decentralized trading give hope that the "failure to trade" will diminish with proliferation of electronic trading.

To further clarify the difference between FGR options and point to point FTR options let us consider the example used by Ruff where a counterflow obligation is needed in order
to fully hedge an operating point where Generator 1 produces 350 MW and Generator 2 generates 50 MW. Ruff makes the following correct observations:

"A transmission rights regime based purely on options, whether FGRs or FTRs, provides no mechanism within that regime itself for committing to counterflows in advance, so the issue is whether and how a (say) day-ahead or real-time market can find and enforce the required counterflows. In a flowgate/FGR market, the generators at node 1 who want to schedule 350 MW of 1→3 transactions need (for a complete hedge) $2/3 \times 350 \text{ MW} = 233 \text{ MW}$ of 1→3 FGRs and $1/3 \times 350 \text{ MW} = 117 \text{ MW}$ of both 1→2 and 2→3 FGRs. ……. The only binding constraint is on the 1→2 flowgate, so this is the only one that will have any value in the day-ahead market – or, if this situation is expected to be “normal,” in the FGR auction that takes place seasonally or annually."

The issue here is that the RTO can only issue 100 MW of 1→2 FGRs so even if Generator 1 buys all of them he will be 17 MW short from having a full hedge. However, Generator 2 is automatically endowed 17 MW of 1→2 FGRs for the 50 MW it will produce. And these FGRs will entail in real time a negative congestion rent paid by the RTO. Whether, Generator 2 chooses to sell its 17 MW 1→2 FGRs to Generator 1 which will enable Generator 1 to fully hedge its congestion cost and perhaps obtain scheduling priority is a private matter that does not involve the RTO. The beauty of the FGR approach is that it provides a simple mechanism in which private FGRs that are backed by counterflow complement the RTO issued FGR options that entail property rights to the physical capacity of the flowgates so as to produce a complete forward market. Furthermore, since, financially, counterflow FGRs and RTO issued FGR are equivalent, the RTO FTR auction provides the price discovery function that facilitates trading of the counterflow FGRs bilaterally or in secondary markets.

Ruff’s claim that "...anything along these lines that can be done in a flowgate/FGR regime could be done at least as well in an LMP/FTR regime." However, he has not shown us what type of private contracts that require no RTO intervention would complement point-to-point FTR options to enable full hedging capability. Chances are that such contracts would be much more complex and less liquid than counterflow based FGRs.
5. CONCLUSIONS

Flowgate rights provide a natural way to separate between property rights associated with the physical capacity of the transmission system and rights to enhanced capacity on the flowgates due to counterflow produced by out of merit generation. This separation enables the definition of FGRs as options so that all possible transactions can be hedged without exposing the RTO to risks associated with selling and settling of obligations. While it is necessary that some congestion hedges be backed by counterflow obligations, all such obligations can be relegated to a decentralized secondary market or bilateral agreements. Such separation is not possible with point-to-point FTRs that require central coordination. Furthermore, unlike point to point FTR options that create an incomplete forward market, the set of FGR options corresponding to the physical capacity of the network augmented by the set of FGRs endowed to counterflow producers constitute a complete set of forward instruments that can be traded to fully hedge any feasible transaction.

In practice it is likely that only a small set of commercially significant flowgate rights will be actively traded and most transactions will only be partially hedged. However, in spite of claims by the LMP/FTR proponents, centrally coordinated point-to-point FTRs defined as two-way contracts do not provide full hedging capability either. The myth that point-to-point FTRs enable traders full hedging of congestion cost could only be realized with continuous reconfiguration of these FTRs to track the changing operating point. With FTR auctions occurring once a month like in PJM and the RTO having a monopoly over reconfiguration, (which is the cornerstone of the LMP/FTR paradigm) traders are not able to fully hedge their trades even when all FTR obligations are underwritten. The RTO's congestion revenue surplus (after settling the FTRs), which is guaranteed by the LMP/FTR theory, is a direct measurement of the unhedged congestion risk that must be born by the traders under that approach.

So, when it comes to false rumors, proponents of the LMP/FTR approach should stop spreading the myth that in practice point to point FTRs enable full hedging of all efficient transactions whereas FGRs will leave many such transactions unhedged. At least with FGRs secondary markets have a chance to achieve the full hedging goal.