Transmission Congestion and Loss Only Virtual Product

Overview

Transmission products differ from Energy Products because they are by definition products designed to converge congestion and provide a mechanism to hedge against congestion differences. FTRs provide a hedge against DA congestion. UTCs could provide a hedge for RT congestion, but are currently only able to provide an imperfect hedge due to the lack of available trading points. By creating flexible transmission products in the market, market participants are better able to manage and hedge the exposure to RT congestion. Using an Inc or Dec to create a synthetic transmission position is inefficient and in many ways has unwanted and unintended effects on commitment and dispatch. A paired Inc/Dec is also only effective if it is offered in a price insensitive manner.

The proposed product, a Transmission Inc/Dec is offered as an alternative to the traditional Inc/Dec product. The goal of the product is to provide flexibility to participants wishing to transact on the value of congestion in RT in a price sensitive manner. It will also allow participants to transact at every currently available node for Incs and Decs. The differentiation between a traditional Inc/Dec is that this product will be offered and cleared based on Congestion and Losses of a node only, thus making it a transmission product. Traditional Inc/Dec clear on the value of Energy, Congestion, and Losses or the total LMP at a node.

The product will provide convergence between DA and RT congestion and overall price convergence. The granularity of the product helps converge locational price differences that can sometimes be masked at the higher zonal level. Transmission constraints can occur in different areas of a zone and small differences in zonal prices between DA and RT does not necessarily equate to small differences at the nodal/bus level. This product will improve convergence at the nodal/bus level and ultimately the zonal level.

Product Design Components

Transmission Inc (TxInc)

Location: offered at any PJM hub, transmission zone, aggregate, or single bus for which PJM calculates an LMP
MW: The offer (TxInc Offer), in MW, for this segment.
Price: The offer (TxInc Offer) price for this segment.
Segments: Up to 10

Transmission Dec (TxDec)

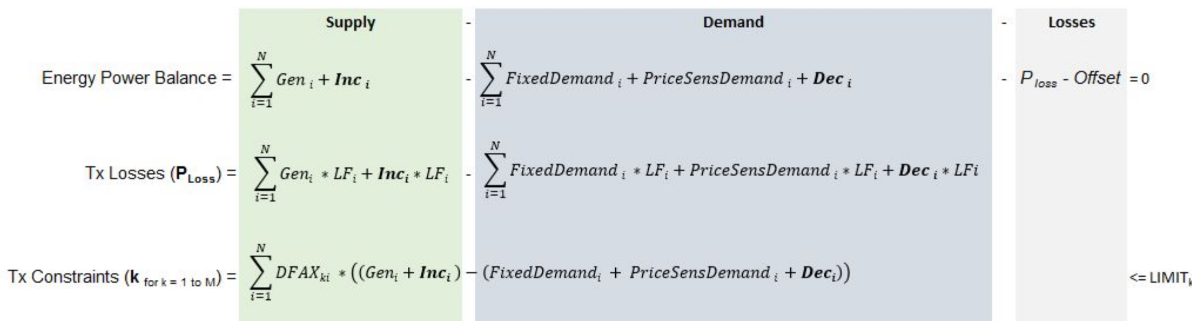
Location: offered at any PJM hub, transmission zone, aggregate, or single bus for which PJM calculates an LMP
MW: The bid (TxDec Bid), in MW, for this segment.
Price: The bid (TxDec Bid) price for this segment.
Segments: Up to 10

Technical Implementation

Implementing this new product into the classic economic dispatch formulation requires understanding of how the traditional Inc/Dec contributes to each constraint in the model and how the proposed TxInc/TxDec would differ in its contributions to the constraints.

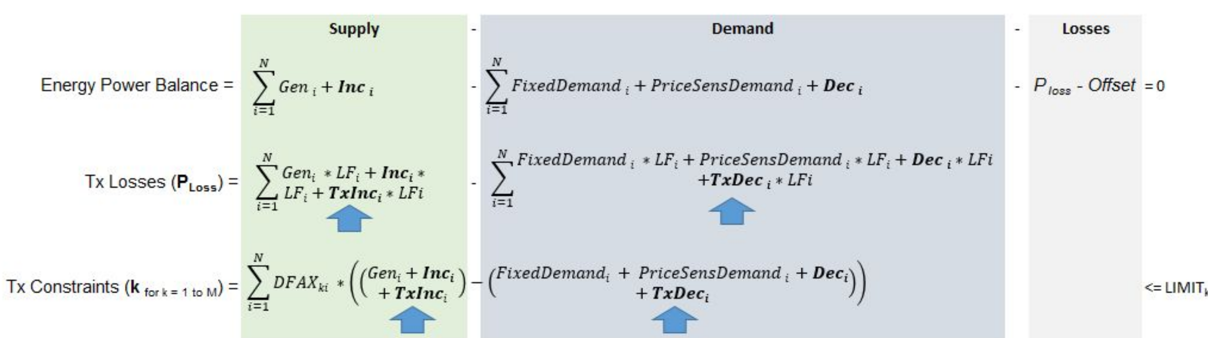
The traditional Inc/Dec is modeled as a virtual injection or a virtual withdrawal that impact the total power balance constraint, which includes total system losses, and transmission constraints. Because the traditional Inc/Dec contributes to energy and transmission constraints, its resulting clearing price reflects the 3 components of LMP: Energy, Congestion, and Losses.

Figure 1 Economic Dispatch constraints with Traditional Inc/Dec



The proposed TxInc/TxDec would contribute to the power balance constraint, but only the total transmission loss portion of the power balance constraint. Because the impact to the energy power balance is confined to system losses, there is no energy component included in the clearing price for this product. Its resulting clearing price will reflect only the remaining two components: Congestion and Losses.

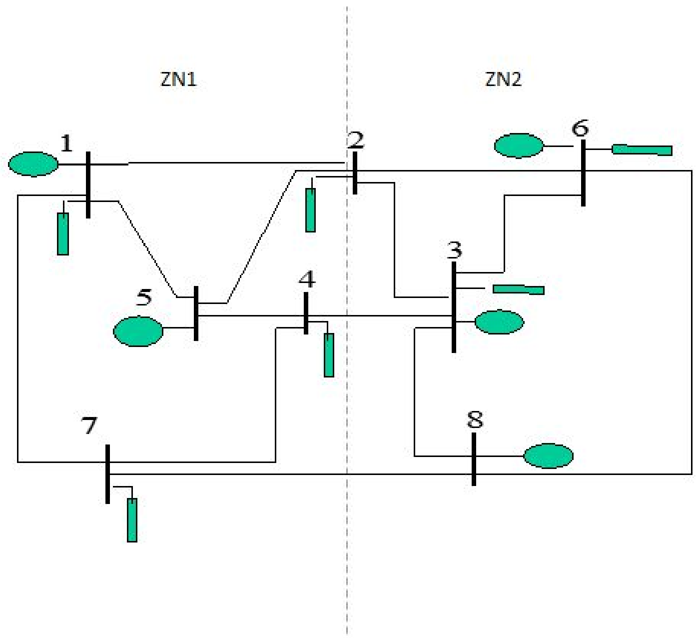
Figure 2 Economic Dispatch constraints with Transmission Inc/Dec



Market Clearing Examples

Using the constraints defined in Figure 1 and Figure 2 it is possible to simulate how these new products would clear using a theoretical eight bus model and excel solver. Transmission Losses and Loss LMP are excluded for simplification.

Figure 3 Theoretical eight bus model with transmission limits



Transmission Line	Limit
1-2	100
1-5	100
1-7	100
2-3	100
2-5	100
2-6	200
3-4	200
3-6	350
3-8	200
4-5	100
4-7	150
6-8	500
7-8	300

Figure 4 shows generation economic max and offer price. These will be held constant for all of the scenarios.

Figure 4 Generation Offer MW and Price for all Scenarios

Generation		
GEN Bus	ECO MAX (MW)	PRICE ($/MW)
UNIT 1	100	$10.00
UNIT 2	0	$0.00
UNIT 3	100	$50.00
UNIT 4	0	$0.00
UNIT 5	300	$50.00
UNIT 6	500	$15.00
UNIT 7	0	$0.00
UNIT 8	600	$25.00

Figure 5 shows three scenarios. Scenario 1 will represent the real-time load and real-time distribution of load at each bus (LDF). Scenario 2 represents day-ahead fixed demand bid at 100% of real-time forecast, but with a slightly different LDF. Scenario 3 represents day-ahead fixed demand bid at 95% of real-time forecast (Underbid Load). The LDF used in Scenario 3 is the same as Scenario 2.

Figure 5 Fixed Demand Bids for Scenarios 1-3 (Without Virtual Transactions)

Fixed Demand							
		Scenario 1 (RT)		Scenario 2 (100%)		Scenario 3 (95%)	
Load Zone	Bus	MW	LDF	MW	LDF	MW	LDF
ZN1	1	-165	0.15	-154	0.14	-146.3	0.14
ZN1	2	-220	0.20	-231	0.21	-219.45	0.21
ZN1	4	-275	0.25	-264	0.24	-250.8	0.24
ZN1	5	-220	0.20	-231	0.21	-219.45	0.21
ZN1	7	0	0.00	0	0.00	0	0.00
ZN2	3	-110	0.10	-132	0.12	-125.4	0.12
ZN2	6	-110	0.10	-88	0.08	-83.6	0.08
ZN2	8	0	0.00	0	0.00	0	0.00
RTO	Total	-1100	1.00	-1100	1.00	-1045	1.00

Figure 6 Generation dispatch and Bus LMP for Scenario 1 through 3

	Bus	1	2	3	4	5	6	7	8	ZN1	ZN2	RTO
Scenario 1	Gen Max	100.0		100.0		300.0	500.0		600.0	400.0	1200.0	1600.0
	Gen Dispatch	100.0		0.0		89.2	500.0		410.8	189.2	910.8	1100.0
	Gen Offer	$10.00		$ 50.00		$ 50.00	$ 15.00		$ 25.00			
	LMP	$52.48	$ 46.14	$ 43.98	$ 52.35	$ 50.00	$ 35.53	$ 65.08	$ 25.00	$52.43	$41.56	$ 48.62
	Energy	$48.62	$ 48.62	$ 48.62	$ 48.62	$ 48.62	$ 48.62	$ 48.62	$ 48.62	$48.62	$48.62	$ 48.62
	MCC	$ 3.85	$ (2.49)	$ (4.65)	$ 3.73	$ 1.38	$(13.10)	$ 16.45	$(23.62)	$ 3.80	$ (7.06)	$ 0.00
	Load	165.0	220.0	275.0	220.0		110.0	110.0		715.0	385.0	1100.0
	LDF	0.15	0.2	0.25	0.2	0	0.1	0.1	0			1
Scenario 2	Gen Max	100.0		100.0		300.0	500.0		600.0	400.0	1200.0	1600.0
	Gen Dispatch	100.0		64.1		15.4	500.0		420.5	115.4	984.6	1100.0
	Gen Offer	$10.00		$ 50.00		$ 50.00	$ 15.00		$ 25.00			
	LMP	$41.44	$ 44.78	$ 50.00	$ 65.08	$ 50.00	$ 36.91	$ 24.44	$ 25.00	$48.17	$45.64	$ 47.26
	Energy	$47.26	$ 47.26	$ 47.26	$ 47.26	$ 47.26	$ 47.26	$ 47.26	$ 47.26	$47.26	$47.26	$ 47.26
	MCC	$(5.82)	$ (2.47)	$ 2.74	$ 17.82	$ 2.74	$(10.35)	$(22.82)	$(22.26)	$ 0.91	$ (1.62)	$ 0.00
	Load	154.0	231.0	264.0	231.0		132.0	88.0		704.0	396.0	1100.0
	LDF	0.14	0.21	0.24	0.21	0	0.12	0.08	0			1
Scenario 3	Gen Max	100.0		100.0		300.0	500.0		600.0	400.0	1200.0	1600.0
	Gen Dispatch	100.0		33.9		0.0	500.0		411.1	100.0	945.0	1045.0
	Gen Offer	$10.00		$ 50.00		$ 50.00	$ 15.00		$ 25.00			
	LMP	$36.31	$ 42.69	$ 50.00	$ 66.13	$ 47.94	$ 36.40	$ 10.58	$ 25.00	$44.97	$45.47	$ 45.15
	Energy	$45.15	$ 45.15	$ 45.15	$ 45.15	$ 45.15	$ 45.15	$ 45.15	$ 45.15	$45.15	$45.15	$ 45.15
	MCC	$(8.84)	$ (2.46)	$ 4.85	$ 20.98	$ 2.79	$ (8.75)	$(34.57)	$(20.15)	$ (0.18)	$ 0.32	$ 0.00
	Load	146.3	219.5	250.8	219.5		125.4	83.6		668.8	376.2	1045.0
	LDF	0.14	0.21	0.24	0.21	0.00	0.12	0.08	0.00			1

Figure 7 Binding transmission constraints and shadow prices for Scenario 1 through 3

	Line	% of Rating	Shadow Price
Scenario 1	2-6	92%	$ -
	4-7	93%	$ -
	7-8	100%	$ 52.48
Scenario 2	2-6	97%	$ -
	4-7	100%	$ 70.80
	7-8	100%	$ 14.25
Scenario 3	2-6	97%	$ -
	4-7	100%	$ 89.19
	7-8	98%	$ -

Figure 6 show the results of the three scenarios. The different load levels and different load distributions both drive different results between all three scenarios. The most obvious difference is the binding constraints, shown in Figure 7, which are the primary driver in dispatch and price differences. In Scenario 1 or real-time, line 7-8 is binding with a shadow price of $52.48. In Scenario 2, representing a day-ahead scenario with the same load level, but different distributions, line 7-8 is binding with a much lower shadow price of $14.25 and an additional line is now binding with a shadow price of $70.80. Finally, in scenario 3 with only 95% of load bid and a different distribution, only line 4-7 is binding with a shadow price of $89.19. While all 3 scenarios are close to binding on the same lines (> 90% of rating), the different shadow prices are a key part of the price formation and price convergence.

These differences in pricing provide incentives for virtual transactions to arbitrage the prices between DA and RT and by doing so drive the prices together. More importantly, allowing transactions to converge congestion without big impacts to overall unit dispatch and commitments will provide greater efficiencies to the market in terms of commitment and price convergence. This is demonstrated in two new scenarios where virtual transactions are now included.

The first scenario, Scenario 4 will focus on traditional virtual transactions and show how a traditional Dec would be used and the impacts to dispatch and prices. The RT minus DA spread we will focus on is the delta between Scenario 1 and Scenario 2, both using the same total load of 1,100 MW. Figure 8 shows the deltas for each zone and each transmission zone and the product that would be used to help provide convergence. For example, Bus 7 has the largest price delta of $40.64 meaning that a DEC is incented to Buy at a lower DA price and Sell back at a higher RT price. Conversely, Bus 4 has a price delta of -$12.73 meaning that an INC is incented to sell at a higher DA price and buy back at a lower RT price.

Figure 8 Scenario 1 and Scenario 2 RT minus DA spreads for each bus and transmission zone

Node	Scenario 1 (RT)	Scenario 2 (DA)	RT-DA DELTA	INC or DEC
1	$ 52.48	$ 41.44	$ 11.04	DEC
2	$ 46.14	$ 44.78	$ 1.36	DEC
3	$ 43.98	$ 50.00	$ (6.02)	INC
4	$ 52.35	$ 65.08	$ (12.73)	INC
5	$ 50.00	$ 50.00	$ -	
6	$ 35.53	$ 36.91	$ (1.38)	INC
7	$ 65.08	$ 24.44	$ 40.64	DEC
8	$ 25.00	$ 25.00	$ -	
ZN1	$ 52.43	$ 48.17	$ 4.26	DEC
ZN2	$ 41.56	$ 45.64	$ (4.08)	INC

Traditional Dec Clearing Example

In Scenario 4, a DEC bid of 35 MW is placed at Node 7 with a bid price of $45. If DA clears at a price equal to or lower than $45, the DEC bid will clear. This is simulated in Scenario 4 using Scenario 2 as the base with a single DEC bid now included in the model.

Figure 9 Generation dispatch and Bus LMP for Scenario 1 and Scenario 4 with Dec Bid

	Bus	1	2	3	4	5	6	7	8	ZN1	ZN2	RTO
Scenario 1	Gen Max	100.0		100.0		300.0	500.0		600.0	400.0	1200.0	1600.0
	Gen Dispatch	100.0		0.0		89.2	500.0		410.8	189.2	910.8	1100.0
	Gen Offer	$10.00		$ 50.00		$ 50.00	$ 15.00		$ 25.00			
	LMP	$52.48	$ 46.14	$ 43.98	$ 52.35	$ 50.00	$ 35.53	$ 65.08	$ 25.00	$52.43	$41.56	$ 48.62
	Energy	$48.62	$ 48.62	$ 48.62	$ 48.62	$ 48.62	$ 48.62	$ 48.62	$ 48.62	$48.62	$48.62	$ 48.62
	MCC	$ 3.85	$ (2.49)	$ (4.65)	$ 3.73	$ 1.38	$(13.10)	$ 16.45	$(23.62)	$ 3.80	$ (7.06)	$ 0.00
	Load	165.0	220.0	275.0	220.0		110.0	110.0		715.0	385.0	1100.0
	LDF	0.15	0.2	0.25	0.2	0	0.1	0.1	0			1
Scenario 4	Gen Max	100.0		100.0		300.0	500.0		600.0	400.0	1200.0	1600.0
	Gen Dispatch	100.0		0.0		79.3	500.0		430.2	179.3	930.2	1109.5
	Gen Offer	$10.00		$ 50.00		$ 50.00	$ 15.00		$ 25.00			
	DEC Bid							$ 45.00				
	DEC MW							35.00		35.00		35.0
	DEC Dispatch							9.50		-		9.5
	LMP	$47.03	$ 45.47	$ 46.95	$ 58.64	$ 50.00	$ 36.21	$ 45.00	$ 25.00	$50.07	$43.37	$ 47.66
	Energy	$47.66	$ 47.66	$ 47.66	$ 47.66	$ 47.66	$ 47.66	$ 47.66	$ 47.66	$47.66	$47.66	$ 47.66
	MCC	$(0.63)	$ (2.19)	$ (0.71)	$ 10.98	$ 2.34	$(11.45)	$ (2.66)	$(22.66)	$ 2.41	$ (4.29)	$ 0.00
	Load	165.0	220.0	275.0	220.0		110.0	110.0		715.0	385.0	1100.0
	LDF	0.15	0.2	0.25	0.2	0	0.1	0.1	0			1

Figure 10 Binding transmission constraints and shadow prices for Scenario 1, 2 and 4

	Line	% of Rating	Shadow Price
Scenario 1	2-6	92%	$ -
	4-7	93%	$ -
	7-8	100%	$ 52.48
Scenario 2	2-6	97%	$ -
	4-7	100%	$ 70.80
	7-8	100%	$ 14.25
Scenario 4	2-6	93%	$ -
	4-7	100%	$ 34.98
	7-8	100%	$ 33.60

Figure 11 Scenario 1 and Scenario 4, RT minus DA spreads for each bus and transmission zone

Node	Scenario 1 (RT)	Scenario 4 (DA)	RT-DA DELTA
1	$ 52.48	$ 47.03	$ 5.45
2	$ 46.14	$ 45.47	$ 0.67
3	$ 43.98	$ 46.95	$ (2.97)
4	$ 52.35	$ 58.64	$ (6.29)
5	$ 50.00	$ 50.00	$ -
6	$ 35.53	$ 36.21	$ (0.68)
7	$ 65.08	$ 45.00	$ 20.08
8	$ 25.00	$ 25.00	$ -
ZN1	$ 52.43	$ 50.07	$ 2.36
ZN2	$ 41.56	$ 43.37	$ (1.81)

Figure 9 shows the results of Scenario 4 and also shows that by using a DEC bid at Node 7, price convergence is improved as is seen in Figure 11. The delta between DA and RT was reduced to $20.08 at node 7, as well as overall price convergence on all of the other nodes and zones. However in this case, an additional 9.5 MW of generation is dispatched in order to meet the additional demand that is created from the DEC bid partially clearing for 9.5 MW. In these two scenarios, the load was the same indicating that the issue wasn't the need for additional load, although the total price deltas indicated that was the case.

Figure 10 shows the binding constraints. The shadow prices are converging closer to RT in Scenario 1 by increasing the shadow price on Line 7-8 and decreasing the shadow price on line 4-7, however two transmission lines are still binding and adding to the divergence between DA and RT in Scenario 2 and Scenario 4.

Transmission Dec (TxDec) Example

In Scenario 4 using a traditional Dec, it was shown that increasing load also impacts power balance and causes additional generation to be dispatched to meet the load. When transmission constraint differences are driving price differences, increasing load or supply in the traditional sense is not necessarily the most efficient solution. The next scenario, Scenario 5, now includes the new product TxDec and will show the benefits over a traditional Dec thru greater price convergence to RT with the same MW and similar risk reward offer.

Figure 12 shows the congestion lmp deltas for each zone and each transmission zone and the transmission product that would be used to help provide convergence. For example, Bus 7 has the largest congestion price delta of $39.27 meaning that a TxDEC is incented to Buy at a lower DA price and Sell back at a higher RT price. Conversely, Bus 4 has a congestion price delta of --$14.10 meaning that a TxINC is incented to sell at a higher DA congestion price and buy back at a lower RT congestion price.

Figure 12 Scenario 1 and Scenario 2 RT minus DA congestion (MCC) spreads for each bus and transmission zone

Node	Scenario 1 (RT)	Scenario 2 (DA)	RT-DA MCC DELTA	TxINC or TxDEC
1	$ 3.85	$ (5.82)	$ 9.67	TxDEC
2	$ (2.49)	$ (2.47)	$ (0.01)	TxINC
3	$ (4.65)	$ 2.74	$ (7.39)	TxINC
4	$ 3.73	$ 17.82	$ (14.10)	TxINC
5	$ 1.38	$ 2.74	$ -	
6	$ (13.10)	$ (10.35)	$ (2.75)	TxINC
7	$ 16.45	$ (22.82)	$ 39.27	TxDEC
8	$ (23.62)	$ (22.26)	$ (1.37)	TxINC
ZN1	$ 3.80	$ 0.91	$ 2.89	TxDEC
ZN2	$ (7.06)	$ (1.62)	$ (5.44)	TxINC

In Scenario 5, a TxDEC bid of 35 MW is placed at Node 7 with a bid price of $11.50. This is a similar risk reward to the Total LMP offer price for Node 7 in Scenario 4. In Scenario 4, RT was valued at $65.08 and the Dec Bid was bid at $45. This is roughly a

30% risk reward ratio. The TxDec is offered in a similar fashion with a 30% risk reward. If DA congestion clears at a price equal to or lower than $11.50, the TxDEC bid will clear. This is simulated in Scenario 5 and is again using Scenario 2 as the base with a single TxDEC bid now included in the model.

Figure 13 Generation dispatch and Bus LMP for Scenario 1 and Scenario 5 with new TxDec Bid

	Bus	1	2	3	4	5	6	7	8	ZN1	ZN2	RTO
Scenario 1	Gen Max	100.0		100.0		300.0	500.0		600.0	400.0	1200.0	1600.0
	Gen Dispatch	100.0		0.0		89.2	500.0		410.8	189.2	910.8	1100.0
	Gen Offer	$10.00		$ 50.00		$ 50.00	$ 15.00		$ 25.00			
	LMP	$52.48	$ 46.14	$ 43.98	$ 52.35	$ 50.00	$ 35.53	$ 65.08	$ 25.00	$52.43	$41.56	$ 48.62
	Energy	$48.62	$ 48.62	$ 48.62	$ 48.62	$ 48.62	$ 48.62	$ 48.62	$ 48.62	$48.62	$48.62	$ 48.62
	MCC	$ 3.85	$ (2.49)	$ (4.65)	$ 3.73	$ 1.38	$(13.10)	$ 16.45	$(23.62)	$ 3.80	$ (7.06)	$ 0.00
	Load	165.0	220.0	275.0	220.0		110.0	110.0		715.0	385.0	1100.0
	LDF	0.15	0.2	0.25	0.2	0	0.1	0.1	0			1
Scenario 5	Gen Max	100.0		100.0		300.0	500.0		600.0	400.0	1200.0	1600.0
	Gen Dispatch	100.0		0.0		70.7	500.0		429.3	170.7	929.3	1100.0
	Gen Offer	$10.00		$ 50.00		$ 50.00	$ 15.00		$ 25.00			
	TxDEC Bid							$ 11.50				
	Tx DEC MW							35.00		35.00		35.0
	TxDEC Dispatch							9.70		-		9.7
	LMP	$50.95	$ 45.95	$ 44.81	$ 54.11	$ 50.00	$ 35.72	$ 59.44	$ 25.00	$51.41	$41.78	$ 47.94
	Energy	$47.94	$ 47.94	$ 47.94	$ 47.94	$ 47.94	$ 47.94	$ 47.94	$ 47.94	$47.94	$47.94	$ 47.94
	MCC	$ 3.01	$ (1.99)	$ (3.13)	$ 6.17	$ 2.06	$(12.22)	$ 11.50	$(22.94)	$ 3.47	$ (6.16)	$ 0.00
	Load	165.0	220.0	275.0	220.0		110.0	110.0		715.0	385.0	1100.0
	LDF	0.15	0.2	0.25	0.2	0	0.1	0.1	0			1

Figure 14 Binding transmission constraints and shadow prices for Scenario 1, 2, 4 and 5

	Line	% of Rating	Shadow Price
Scenario 1	2-6	92%	$ -
	4-7	93%	$ -
	7-8	100%	$ 52.48
Scenario 2	2-6	97%	$ -
	4-7	100%	$ 70.80
	7-8	100%	$ 14.25
Scenario 4	2-6	93%	$ -
	4-7	100%	$ 34.98
	7-8	100%	$ 33.60
Scenario 5	2-6	93%	$ -
	4-7	100%	$ 9.82
	7-8	100%	$ 47.18

Figure 15 Scenario 1 and Scenario 5, RT minus DA spreads for each bus and transmission zone

Node	Scenario 1 (RT)	Scenario 5 (DA)	RT-DA DELTA
1	$ 52.48	$ 50.95	$ 1.53
2	$ 46.14	$ 45.95	$ 0.19
3	$ 43.98	$ 44.81	$ (0.83)
4	$ 52.35	$ 54.11	$ (1.76)
5	$ 50.00	$ 50.00	$ -
6	$ 35.53	$ 35.72	$ (0.19)
7	$ 65.08	$ 59.44	$ 5.64
8	$ 25.00	$ 25.00	$ -
ZN1	$ 52.43	$ 51.41	$ 1.02
ZN2	$ 41.56	$ 41.78	$ (0.22)

Figure 13 shows the results of Scenario 5 and also shows that by using a TxDEC bid at Node 7, price convergence is improved as is seen in Figure 15. Price convergence is improved even greater than in Scenario 4 using a traditional Dec. The delta between DA and RT was reduced to $5.64 in Scenario 5 versus $20.08 in Scenario 4. This improved convergence was due to the nature of the transmission products and their impact on transmission flows, without the impact on power balance. No additional generation was dispatched in this scenario and the total generation was equal to that needed in RT to meet load. This should result in lower production cost and lower uplift charges.

The main driver of the price convergence was the convergence in shadow prices shown in Figure 14. Line 4-7 was greatly reduced and line 7-8 is nearly identical to the RT shadow price.

These examples help understand how the different types of products clear in a simple, but fundamentally sound eight bus model. The advantage of using a transmission product to help improve convergence in congestion is clearly shown in the 5 scenarios illustrated here. Similar examples could be shown on how an Inc and TxInc are cleared, and the TxInc would be shown to be the superior product. Additionally, a UTC or Spread Bid can achieve the same or better results as a single TxInc or TxDec. Further examples can be constructed to show the benefits of transmission products over energy products, but for the sake of brevity these will not be shown here.

Settlement Examples

Settlement of the TxDec or TxInc would be very similar to the traditional Inc or Dec except there would be no Net Energy Bill. The congestion and loss net bill would be the same and made up of Implicit Congestion and Implicit Loss Charges/Credits.

Figure 16 Net Bill (Energy + Implicit Congestion) Settlement for Dec

Day-Ahead						
	Node	INJECTION	WITHDRAWAL	NET POSITION	DA Energy	DA Energy Net Bill
DEC	7	0	9.5	9.5	$ 47.66	$ 452.77
Real-Time Balancing						
	Node	INJECTION	WITHDRAWAL	NET POSITION	RT Energy	Bal Net Energy Bill
DEC	7	0	-9.5	-9.5	$ 48.62	$ (461.89)
					Total Energy Bill	$ (9.12)
Day-Ahead						
	Node	INJECTION	WITHDRAWAL	NET POSITION	DA MCC	DA Net Congestion Bill
DEC	7	0	9.5	9.5	$ (2.66)	$ (25.27)
Real-Time Balancing						
	Node	INJECTION	WITHDRAWAL	NET POSITION	RT MCC	Bal Net Congestion Bill
DEC	7	0	-9.5	-9.5	$ 16.45	$ (156.28)
					Total Congestion Bill	$ (181.55)
					Total Net Bill	$ (190.67)
					Provided Convergene = Net Credit	

Figure 16 uses the RT prices from Scenario 1 and the DA prices from Scenario 4 to show how a Dec would settle.

Figure 17 Net Congestion Bill (Implicit Congestion) Settlement for TxDec

Day-Ahead							
	Node	INJECTION	WITHDRAWAL	NET POSITION	DA MCC	DA Net Congestion Bill	
TxDec	7	0	9.7	9.7	$ 11.50	$	111.55
Real-Time Balancing							
	Node	INJECTION	WITHDRAWAL	NET POSITION	RT MCC	Bal Net Congestion Bill	
TxDec	7	0	-9.7	-9.7	$ 16.45	$	(159.57)
					Total Congestion Bill	$	(48.02)
					Provided Convergene = Net Credit		

Figure 17 uses the RT prices from Scenario 1 and the DA prices from Scenario 5 to show how a TxDec would settle.

As shown in Figure 16 and Figure 17, the settlement for a TxDec is very similar to a Dec and would occur in the implicit congestion (implicit loss) category only. No energy settlement would occur resulting in lower payment strictly from congestion and losses.

Product Benefits and additional comments

As shown in this paper, the proposed products have the ability to provide greater price convergence over the traditional Inc or Dec.

These new products give participants greater flexibly to transact on the value of congestion and losses.

Removes unintended impacts on unit commitment and power balance that can occur when a paired Inc/Dec does not clear together or a single Inc or Dec is used.

Opens up all the available points Incs and Decs are allowed without the suggested increase in DA solve time.

PJM proposal to limit UTC transactions to only sourcing at Gen and Sinking at Load Zone, Residual Zone, Interface, or Hub creates more combinations than this product would, so the intuition says this will decrease DA solve time. Limiting one side of each transaction to the reference bus, creates roughly 20,000 combinations given PJM current nodes.

Further, there are possible short cuts that can be used when implementing this product that would not require the modeling of a UTC with source or sink at the reference bus. For example, the reference bus is a distributed load reference and is implied in the calculation of DFAX and Loss factors. Whether you assume there is an implicit injection or withdrawal by use of DFAX and LF or explicitly create injections and withdrawals at each load bus by modeling as a UTC, the end result will be the same. The eight bus model used in this description, did not model the product as a UTC, but rather relied on the equations defined in Figure 1 and Figure 2.