



# Notional and Offset Revenue Calculation Shadow Settlement

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# Agenda

- Calculation of Notional Revenue
- Calculation of Offset Revenue

# Notional Revenue Calculation

For option CRRs:

$$\begin{aligned} & CRRNotionalMW_{c,k,m,t} \\ &= CRRQuantity_c \times (SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) \end{aligned}$$

For obligation CRR portfolios:

$$\begin{aligned} & CRRNotionalMW_{p,k,m,t} \\ &= \sum_{c \in S_p^{(obl)}} [CRRQuantity_c \times (SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink})] \end{aligned}$$

# Notional Revenue Calculation (continued)

- Example: portfolio calculation for the following constraint:
  - Hour: 12/17/2019 HE 7
  - Flowgate: 22192\_DOUBLTTP\_138\_22300\_FRIARS \_138\_BR\_1 \_1
  - Constraint Case: SD2 SX-PQ + PQ-OT 230
- Step 1, get shadow price (use later)
  - Shadow price from OASIS: \$38.3766

Date From: 12/17/2019 To: 12/17/2019 Market/Process: DAM Nomogram/Branch ID: All item(s) Apply Reset

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### Nomogram/Branch Shadow Prices

Market	Opr Date	Opr Interval	Nomogram ID	Constraint Cause	HE01	HE02	HE03	HE04	HE05	HE06	HE07	HE
DAM	12/17/2019	1	22192_DOUBLTTP_138_22300_FRIARS_138_BR_1_1	SD2 SX-PQ + PQ-OT 230							38.37660	14
DAM	12/17/2019	0	22644_PENSQTOS_69.0_22164_DELMARTP_69.0_BR_1_1	Base Case								

# Notional Revenue Calculation (continued)

- Step 2, get CRRs for your portfolio
  - Example below, from OASIS
  - For each CRR, need source node, sink node, award MW, Time of Use, and CRR Option (Option/Obligation)
  - If validating Offset Revenue calculation, will need data for all CRRs. Need Owner Name in addition to source node, sink node, and award MW.

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Date From: 12/17/2019 To: 12/17/2019 Market Name: ALLOC\_AN\_2019\_S04\_T3 Term of Market: [ALL] Time of Use: [ALL] Apply Reset

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### CRR Inventory

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Market Name	Market Term	Time of Use	Source AP Node ID	Sink AP Node ID	Inventory Date	Start Date	End Date	CRR ID	MW Amount	Owner Name	NSR Index Segment	CRR Type	CRR Category	CRR Option
ALLOC_AN_2019_S04_T3	Seasonal	OFF_PEAK	COACHELV_2_N101	SLAP_SCHD-APND	12/31/2019	10/01/2019	12/31/2019 23:59:59	45222025	1.54800	ANHM	1	LSE	PTP	OBLIGATION
ALLOC_AN_2019_S04_T3	Seasonal	OFF_PEAK	MALIN_5_N101	SLAP_SCEN-APND	12/31/2019	10/01/2019	12/31/2019 23:59:59	45222022	0.61300	ANHM	1	LSE	PTP	OBLIGATION

# Notional Revenue Calculation (continued)

- Step 3, get shift factors for each source and sink
  - Example below, CSV download from Market Modeling Data
  - From the CSV download, column A, we also know this is a flowgate constraint (keep in mind for later)

	A	B	C	D	E	F	G	H	I	J
1	Constraint Class	GMT Interval	Constraint Name	Constraint Direction	Constr	Constraint Cause	Curve I	Segment	Node Name	Shift Factor
160041	FLOWGATE	12/17/2019 14:00	22192_DOUBLTTP_138_22300_FRIARS_138_BR_1_1	FROM-FRIARS-138		SD2 SX-PQ + PQ-OT 230			COACHELV_2_N101	-0.68
160042	FLOWGATE	12/17/2019 14:00	22192_DOUBLTTP_138_22300_FRIARS_138_BR_1_1	FROM-FRIARS-138		SD2 SX-PQ + PQ-OT 230			SLAP_SCHD-APND	0.25

\*Non-public data has been altered for purposes of public presentation

## Notional Revenue Calculation (continued)

- Step 4, get MW flow for the CRR

$$\begin{aligned} MW \text{ flow} &= CRRQuantity_c \times (SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) \\ &= 1.548 \times ((-0.68) - 0.25) = 1.440 \end{aligned}$$

- Step 5, repeat steps 2-4 for all CRRs in your portfolio.
  - If a shift factor exists for a source but not a sink, use zero for the sink shift factor. Same if a shift factor exists for a sink but not a source.
  - If shift factor does not exist for neither source nor sink, the MW flow is zero for that CRR.

## Notional Revenue Calculation (continued)

- Step 6, total the MW flow for all CRRs

$$CRRNotionalMW_{p,k,m,t} = \sum_{c \in S_p^{(obl)}} MW \text{ flows}$$

Lets suppose the total is 10.50

- Step 7, calculate the notional revenue
  - Shadow price is \$38.3766 (Step 1)
  - For all constraint types other than flowgates, multiply the result by  $-1$  due to shift factor convention
    - Because this is a flowgate constraint (Step 3),  $-1$  multiplier is not applicable.

$$\begin{aligned} IntervalCRRNotionalRevenue_{p,k,m,t} &= CRRNotionalMW_{p,k,m,t} * \mu_{k,m,t} \\ &= 10.50 \times \$38.3766 = \$402.9543 \end{aligned}$$



# Offset Revenue Calculation - CFD

$$\begin{aligned}CFD_{k,m,t} &= IFMMW_{k,m,t} \\ &- \sum_{c=0}^C CFD\_FLAG_{c,k,m,t} * [(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c] \\ &- CRRClawback_{k,m,t} - CRRCircularSchedules_{k,m,t}\end{aligned}$$

where

If hedge\_type = 'Obligation'

$$CFD\_Flag_{c,k,m,t} = 1$$

If hedge\_type = 'Option' and

$(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c * DirectionalIndicator_{k,m,t} > 0$   
then  $CFD\_Flag_{c,k,m,t} = 1$

If hedge\_type = 'Option' and

$(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c * DirectionalIndicator_{k,m,t} < 0$   
then  $CFD\_Flag_{c,k,m,t} = 0$

# Offset Revenue Calculation–CFD (continued)

- Continue the previous example: portfolio calculation for the following constraint:
  - Hour: 12/17/2019 HE 7
  - Flowgate: 22192\_DOUBLTTP\_138\_22300\_FRIARS \_138\_BR\_1 \_1
  - Constraint Case: SD2 SX-PQ + PQ-OT 230
- Step 1, get shadow price (use later)
  - Shadow price from OASIS: \$38.3766

Date From: 12/17/2019 To: 12/17/2019 Market/Process: DAM Nomogram/Branch ID: All item(s) Apply Reset

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### Nomogram/Branch Shadow Prices

Market	Opr Date	Opr Interval	Nomogram ID	Constraint Cause	HE01	HE02	HE03	HE04	HE05	HE06	HE07	HE
DAM	12/17/2019	1	22192_DOUBLTTP_138_22300_FRIARS_138_BR_1_1	SD2 SX-PQ + PQ-OT 230							38.37660	14
DAM	12/17/2019	0	22644_PENSQTOS_69.0_22164_DELMARTP_69.0_BR_1_1	Base Case								

## Offset Revenue Calculation–CFD (continued)

- Step 2, get all active CRRs
  - See step 2 from Notional Revenue Calculation for example
- Step 3, get shift factors for all source / sink locations associated with an active CRR.
  - See step 3 from Notional Revenue Calculation for example

# Offset Revenue Calculation–CFD (continued)

- Step 4, get the following from OASIS
  - Total IFM MW
  - Total Clawback MW
  - Total Circular Scheduling MW
  - Directional Indicator

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Date From: 02/01/2020 To: 02/28/2020 Transmission Constraint ID: [ALL] Apply Reset

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### CRR Aggregated Revenue Adjustment Data

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Start Date	End Date	Transmission Constraint ID	Constraint Case	Notional Revenue (\$)	Offset Revenue (\$)	Clawback Revenue (\$)	Circular Scheduling Revenue (\$)	Directional Indicator	IFM Net Flow [MW]
02/10/2020 08:00:00	02/10/2020 09:00:00	NOB_ITC	Base Case	4,205.89718	667.54780	0.00000	0.00000		
02/10/2020 08:00:00	02/10/2020 09:00:00	NOB_ITC	Base Case	4,205.89716	1,203.74454	0.00000	0.00000	1	1,622.00000
02/10/2020 08:00:00	02/10/2020 09:00:00	NdGrp: 22196_DUNHILL_69.0_B1	Base Case	0.91767	-0.30351	0.00000	0.00000	-1	20.00000
02/10/2020 08:00:00	02/10/2020 09:00:00	NdGrp: 32177_SHILOH2_34.5_B1	Base Case	834.33468	26,794.48532	0.00000	0.00000	1	165.00214
02/10/2020 08:00:00	02/10/2020 09:00:00	NdGrp: 32177_SHILOH2_34.5_B1	Base Case	834.33454	865.24993	0.00000	0.00000		
02/10/2020 08:00:00	02/10/2020 09:00:00	NdGrp: 98378_RTP3ANZA_92.0_B1	Base Case	-0.03341	0.00000	0.00000	0.00000	1	10.00000

\*Test environment data provided for presentation purposes

## Offset Revenue Calculation–CFD (continued)

- Step 5, get MW flow for each CRR
  - For obligation CRRs, CFD flag is always 1, MW flow is same equation as used in Notional Revenue Calculation (Step 4)
  - For option CRRs, determine CFD flag first
    - If CFD flag = 0, MW flow is 0 for that CRR
    - If CFD flag = 1, MW flow is same equation as used in Notional Revenue Calculation (Step 4)

*Example: Assume the CRR used in the notional calculation example is an option CRR. Is*

$$\begin{aligned} & CRRQuantity_c \times (SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) \times Directional Indicator_{k,m,t} > 0? \\ & = 1.548 \times ((-0.68) - 0.25) \times -1 = -1.440 \end{aligned}$$

*In this case, the MW flow for this CRR is not considered.*

## Offset Revenue Calculation–CFD (continued)

- Step 6, total the MW flow for all CRRs
  - Where the CFD flag is 1

$$\sum_{c=0}^C CFD\_FLAG_{c,k,m,t} * [(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c]$$
$$= \sum_{c \in S_p^{(obl)}} MW \text{ flows}$$

Lets suppose the total is 23.2

# Offset Revenue Calculation–CFD (continued)

- Step 7, calculate the CFD
  - Total IFM MW = 35 (Step 4)
  - Total Clawback MW = 1.35 (Step 4)
  - Total Circular Scheduling MW = 0 (Step 4)
  - Total MW flow = 23.2 (Step 6)

$$\begin{aligned} CFD_{k,m,t} &= IFMMW_{k,m,t} \\ &\quad - \sum_{c=0}^C CFD\_FLAG_{c,k,m,t} * [(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c] \\ &\quad - CRRClawback_{k,m,t} - CRRCircularSchedules_{k,m,t} \\ &= 35 - 23.2 - 1.35 - 0 = 10.45 \end{aligned}$$

# Offset Revenue Calculation – Alpha

- For option CRR portfolios:

$$\alpha_{c,k,m,t}^{(opt)} = \frac{\eta_{c,k,m,t}^{(opt)} * \left( \frac{(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c - CRRClawbackMW_{c,k,m,t} - CRRCircularSchedulingMW_{c,k,m,t}}{CRRCircularSchedulingMW_{c,k,m,t}} \right)}{\left( \frac{\sum_{p=1}^P \sum_{c \in S_p^{(opt)}} \eta_{c,k,m,t}^{(opt)} * [(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c] + \sum_{p=1}^P \eta_{p,k,m,t}^{(obl)} \sum_{c \in S_p^{(obl)}} [(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c]}{\sum_{p=1}^P \eta_{p,k,m,t}^{(obl)} \sum_{c \in S_p^{(obl)}} [(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c]} \right) - CRRClawback_{k,m,t} - CRRCircularSchedules_{k,m,t}}$$

- For obligation CRR portfolios:

$$\alpha_{p,k,m,t}^{(obl)} = \frac{\eta_{p,k,m,t}^{(obl)} \sum_{c \in S_p^{(obl)}} \left( \frac{(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c - CRRClawbackMW_{c,k,m,t} - CRRCircularSchedulingMW_{c,k,m,t}}{CRRCircularSchedulingMW_{c,k,m,t}} \right)}{\left( \frac{\sum_{p=1}^P \sum_{c \in S_p^{(opt)}} \eta_{c,k,m,t}^{(opt)} * [(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c] + \sum_{p=1}^P \eta_{c,k,m,t}^{(obl)} \sum_{c \in S_p^{(obl)}} [(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c]}{\sum_{p=1}^P \eta_{c,k,m,t}^{(obl)} \sum_{c \in S_p^{(obl)}} [(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c]} \right) - CRRClawback_{k,m,t} - CRRCircularSchedules_{k,m,t}}$$



# Offset Revenue Calculation – Alpha

- Step 8, calculate the numerator for your portfolio
  - Get the MW flow for each CRR in your portfolio (Notional step 4)
  - For obligation CRRs, total the MW flows for your portfolio (Notional step 6)
  - Multiply the MW flow (total MW flow for obligations) by the Directional Indicator (from Offset Step 4)
    - If value is negative, numerator becomes zero, offset is zero
    - If value is positive, numerator is the total MW flow, less any clawback and circular scheduling revenue for the portfolio.

# Offset Revenue Calculation – Alpha (continued)

- Step 8, continued
  - Get the following from CMRI:
    - Total Clawback MW per CRR
    - Total Circular Scheduling MW per CRR
    - These values can be totaled to get Clawback and Circular Scheduling MW per portfolio

Date From: 12/17/2019 To: 12/17/2019 Entity: Transmission Constraint ID: 22192\_DOUBLTTP\_138\_22300\_FRIARS\_138\_BR\_1\_1 Apply Reset

**CRR Revenue Adjustments Details**

Start Date	End Date	SC ID	Transmission Constraint ID	Constraint Case	CRR ID	Hedge Type	CRR Type	Notional Revenue (\$)	Offset Revenue (\$)	CRR Clawback Revenue (\$)	Circular Scheduling Revenue (\$)	Derate Factor	CRR Award MW
12/17/2019 06:00:00	12/17/2019 07:00:00		22192_DOUBLTTP_138_22300_FRIARS_138_BR_1_1	SD2 SX-PQ + PQ-OT 230		OBLIGATIONS	LSE	1.44	-412.12	0.00	0.00	1.00000	9.39800
12/17/2019 06:00:00	12/17/2019 07:00:00		22192_DOUBLTTP_138_22300_FRIARS_138_BR_1_1	SD2 SX-PQ + PQ-OT 230		OBLIGATIONS	LSE	-14.43	-412.12	0.00	0.00	1.00000	37.59200
12/17/2019 06:00:00	12/17/2019 07:00:00		22192_DOUBLTTP_138_22300_FRIARS_138_BR_1_1	SD2 SX-PQ + PQ-OT 230		OBLIGATIONS	LSE	-705.15	-412.12	0.00	0.00	1.00000	574.20200

\*Non-public data has been altered for purposes of public presentation

- Let's assume the clawback and circular scheduling MW values are zero.

# Offset Revenue Calculation – Alpha (continued)

- Step 8, continued

*Example: Assume the total MW flow in a portfolio of Obligation CRRs for SC XYZ is -20. Is*

$$\sum_{c \in S_p^{(obl)}} [(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c] * Directional Indicator_{k,m,t} > 0?$$

$$= -(20) * 1 = -20$$

*Since the value is positive,  $\eta_{p,k,m,t}^{(obl)}$  is 1. Numerator is:*

$$\eta_{p,k,m,t}^{(obl)} \sum_{c \in S_p^{(obl)}} \left( \begin{array}{l} (SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c - \\ CRRClawbackMW_{c,k,m,t} - \\ CRRCircularSchedulingMW_{c,k,m,t} \end{array} \right)$$

$$= 1 * -(20) = -(20)$$

# Offset Revenue Calculation – Alpha (continued)

- Step 9, calculate the denominator
  - Apply this to everyone's CRRs, not just yours
  - Get the MW flow for each active CRR (Notional step 4)
  - For obligation CRRs, group the MW flows by SC portfolio (Notional step 6)
  - Multiply the MW flow (total MW flow for obligations) by the Directional Indicator (from Offset Step 4)
    - If value is negative, it does not contribute to the denominator
    - If value is positive, it contributes to the denominator.
  - Total the MW flows which contribute to the denominator
  - Subtract off the total Clawback and Circular Scheduling values (from Offset Step 4)

## Offset Revenue Calculation – Alpha (continued)

- Step 10, calculate the alpha value.
  - Numerator/Denominator
  - Assume from the previous step the Denominator was -199.04
  - Should be a value equal to or greater than zero, and less than one

$$= -20 / -199.04 = 0.10048$$

- Step 11, calculate the offset MW value
  - Alpha \* CFD

$$\begin{aligned} \text{OffsetMW}_{c,k,m,t} &= \alpha_{c,k,m,t}^{(opt)} * \text{CFD}_{k,m,t} \\ &= 0.10048 \times 10.45 = 1.05 \end{aligned}$$

# Offset Revenue Calculation – Final Calculations

- Step 12, calculate offset revenue
  - Shadow price is \$38.3766 (Step 1)
  - For all constraint types other than flowgates, multiply the result by –1 due to shift factor convention
    - Because this is a flowgate constraint (Step 3), -(1) multiplier is not applicable.

$$\begin{aligned} \text{OffsetRev}_{p,k,m,t} &= \text{OffsetMW}_{p,k,m,t} * \mu_{k,m,t} \\ &= 1.05 \times \$38.3766 = \$40.29543 \end{aligned}$$