# Notional and Offset Revenue Calculation Shadow Settlement

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3/5/2020

# Agenda

- Calculation of Notional Revenue
- Calculation of Offset Revenue

# Notional Revenue Calculation

For option CRRs:

$$CRRNotionalMW_{c,k,m,t}$$
$$= CRRQuantity_c \times \left( SF^{source}_{c,k,m,t} - SF^{sink}_{c,k,m,t} \right)$$

For obligation CRR portfolios:

$$CRRNotionalMW_{p,k,m,t}$$

$$= \sum_{c \epsilon S^{(obl)}_p} \left[ CRRQuantity_c \times \left( SF^{source}_{c,k,m,t} - SF^{sink}_{c,k,m,t} \right) \right]$$

# 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

# 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.

# 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 | Constra | Constraint Cause | Curve I | Segme | Node Name | Shift Fa or |
| 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

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# Notional Revenue Calculation (continued)

- Step 4, get MW flow for the CRR

$$MW\ flow = CRRQuantity_c \times \left(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}\right)$$

$$= 1.548 \text{ x } ((-0.68) - 0.25) = 1.440$$

- 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

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

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.

$$IntervalCRRNotionalRevenue_{p,k,m,t} = CRRNotionalMW_{p,k,m,t} * \mu_{k,m,t}$$
$$= 10.50 \text{ x } \$38.3766 = \$402.9543$$

# Offset Revenue Calculation - CFD

$$CFD_{k,m,t} = IFMMW_{k,m,t}$$

$$-\sum_{c=0}^{C} CFD\_FLAG_{c,k,m,t} * \left[ (SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c \right]$$

$$-CRRClawback_{k,m,t} - CRRCircularSchedules_{k,m,t}$$

$where$
If hedge_type = 'Obligation'

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

If hedge_type = 'Option' and
$(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c \quad * Directional\ Indicator_{k,m,t} > 0$
$then\ CFD\_Flag_{c,k,m,t} = 1$

If hedge_type = 'Option' and
$(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c * Directional\ Indicator_{k,m,t} < 0$
$then\ CFD\_Flag_{c,k,m,t} = 0$

# 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

# 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

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# Offset Revenue Calculation–CFD (continued)

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



*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*

$$CRRQuantity_c \times \left(SF^{source}_{c,k,m,t} - SF^{sink}_{c,k,m,t}\right) \text{ x } Directional\ Indicator_{k,m,t} > 0?$$

$$= 1.548 \text{ x } (\,(-0.68) - 0.25)\text{x} - (1) = -1.440$$

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

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# Offset Revenue Calculation–CFD (continued)

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

$$\sum_{c=0}^{C} CFD\_FLAG_{c,k,m,t} * \left[ (SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) * CRRQuantity_c \right]$$

$$= \sum_{c \in S_p^{(obl)}} MW\ flows$$

Lets suppose the total is 23.2

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# 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)

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

$$= 35 - 23.2 - 1.35 - 0 = 10.45$$

# Offset Revenue Calculation – Alpha

- ## For option CRR portfolios:

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

- ## For obligation CRR portfolios:

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

# 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.

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# 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



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

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

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- ## Step 8, continued

$Example$: $Assume\ the\ total\ MW\ flow\ in\ a\ portfolio\ of\ Obligation$ $CRRs\ for\ SC\ XYZ\ is\ \text{-}20.\ \ Is$

$$\sum_{c \in S_p^{(obl)}} \left[ \left( SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink} \right) * CRRQuantity_c \right] *$$

$$Directional\ Indicator_{k,m,t} > 0?$$

$$= -(20)\,x - (1) = 20$$

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

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

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

# 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

$$OffsetMW_{c,k,m,t} = \alpha^{(opt)}_{c,k,m,t} * CFD_{k,m,t}$$

$$= 0.10048 \ x \ 10.45 = 1.05$$

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# 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.

$$OffsetRev_{p,k,m,t} = OffsetMW_{p,k,m,t} * \mu_{k,m,t}$$

$$= 1.05 \text{ x } \$38.3766 = \$40.29543$$

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