Notional and Offset Revenue Calculation Shadow Settlement

Greg Ford
Power Systems Technology and Development

3/5/2020
Agenda

• Calculation of Notional Revenue
• Calculation of Offset Revenue
Notional Revenue Calculation

For option CRRs:

\[
CRR\text{NotionalMW}_{c,k,m,t} = CRR\text{Quantity}_c \times (SF^{source}_{c,k,m,t} - SF^{sink}_{c,k,m,t})
\]

For obligation CRR portfolios:

\[
CRR\text{NotionalMW}_{p,k,m,t} = \sum_{c \in S_p^{(obl)}} [CRR\text{Quantity}_c \times (SF^{source}_{c,k,m,t} - SF^{sink}_{c,k,m,t})]
\]
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)

*Non-public data has been altered for purposes of public presentation*
Notional Revenue Calculation (continued)

- Step 4, get MW flow for the CRR

\[
MW \text{ flow} = CRR\text{Quantity}_c \times (SF_{c,k,m,t}^{\text{source}} - SF_{c,k,m,t}^{\text{sink}})
\]

\[
= 1.548 \times ((-0.68) - 0.25) = 1.440
\]

- 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

\[ CRR\text{NotionalMW}_{p,k,m,t} = \sum_{c \in S_p^{\text{obl}}} MW\text{ flows} \]

Let's 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.

\[ \text{IntervalCRRNotionalRevenue}_{p,k,m,t} = CRR\text{NotionalMW}_{p,k,m,t} \times \mu_{k,m,t} \]

\[ = 10.50 \times 38.3766 = 402.9543 \]
Offset Revenue Calculation - CFD

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

where

If hedge_type = ‘Obligation’
\[ CFD\_Flag_{c,k,m,t} = 1 \]

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

If hedge_type = 'Option' and
\[ (SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) \times CRRQuantity_c \times Directional\ Indicator_{k,m,t} < 0 \]
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
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

\[ CRR_{\text{Quantity}_c} \times (SF_{c,k,m,t}^{\text{source}} - SF_{c,k,m,t}^{\text{sink}}) \times \text{Directional Indicator}_{k,m,t} > 0? \]

\[ = 1.548 \times ( (-0.68) - 0.25)x - (1) = -1.440 \]

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

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

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

Let's suppose the total is 23.2
• 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)

\[
\text{CFD}_{k,m,t} = IFM\text{MW}_{k,m,t} - \sum_{c=0} CFD\_FLAG_{c,k,m,t} \times [(SF_{c,k,m,t}^{source} - SF_{c,k,m,t}^{sink}) \times CRR\text{Quantity}_c] - CRR\text{Clawback}_{k,m,t} - CRR\text{CircularSchedules}_{k,m,t}
\]

\[
= 35 - 23.2 - 1.35 - 0 = 10.45
\]
Offset Revenue Calculation – Alpha

• For option CRR portfolios:

\[
\alpha^{(opt)}_{c,k,m,t} = \frac{\eta^{(opt)}_{c,k,m,t} \left( (S_{source}^{c,k,m,t} - S_{sink}^{c,k,m,t}) * \text{CRRQuantity}_{c} - \text{CRRLawbackMW}_{c,k,m,t} - \text{CRRCircularSchedulingMW}_{c,k,m,t} \right)}{\sum_{p=1}^{P} \eta^{(opt)}_{c,k,m,t} \sum_{c \in S_{p}^{(opt)}} \left( (S_{source}^{c,k,m,t} - S_{sink}^{c,k,m,t}) * \text{CRRQuantity}_{c} \right)} - \text{CRRClawback}_{k,m,t} - \text{CRRCircularSchedules}_{k,m,t}
\]

• For obligation CRR portfolios:

\[
\alpha^{(obl)}_{p,k,m,t} = \frac{\eta^{(obl)}_{p,k,m,t} \sum_{c \in S_{p}^{(obl)}} \left( (S_{source}^{c,k,m,t} - S_{sink}^{c,k,m,t}) * \text{CRRQuantity}_{c} - \text{CRRClawbackMW}_{c,k,m,t} - \text{CRRCircularSchedulingMW}_{c,k,m,t} \right)}{\sum_{p=1}^{P} \eta^{(obl)}_{c,k,m,t} \sum_{c \in S_{p}^{(obl)}} \left( (S_{source}^{c,k,m,t} - S_{sink}^{c,k,m,t}) * \text{CRRQuantity}_{c} \right)} - \text{CRRClawback}_{k,m,t} - \text{CRRCircularSchedules}_{k,m,t}
\]
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

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

- Let’s assume the clawback and circular scheduling MW values are zero.
• Step 8, continued

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

\[ \sum_{c \in S_p^{(obl)}} \left[ \left( SF_{c,k,m,t}^{\text{source}} - SF_{c,k,m,t}^{\text{sink}} \right) \times CRRQuantity_c \right] \times \\
\text{Directional Indicator}_{k,m,t} > 0? \]

\[ = -(20) \times -1 = 20 \]

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

\[ \eta_{p,k,m,t}^{(obl)} \sum_{c \in S_p^{(obl)}} \left( \left( SF_{c,k,m,t}^{\text{source}} - SF_{c,k,m,t}^{\text{sink}} \right) \times CRRQuantity_c - \\
CRRClawbackMW_{c,k,m,t} - CRRCircularSchedulingMW_{c,k,m,t} \right) \]

\[ = 1 \times -(20) = -(20) \]
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

\[
= -\frac{20}{-199.04} = 0.10048
\]

• Step 11, calculate the offset MW value
  – Alpha * CFD

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

\[
= 0.10048 \times 10.45 = 1.05
\]
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.

\[
OffsetRev_{p,k,m,t} = OffsetMW_{p,k,m,t} \times \mu_{k,m,t}
\]

\[
= 1.05 \times 38.3766 = 40.29543
\]