Analysis Group
Economic, Financial and Strategy Consultants

NYISO 2015/2016 ICAP Demand Curve Reset

Net EAS Revenue Model

June 2, 2016

Today's Presentation

- **Provide additional information on the net Energy and Ancillary Services (EAS) revenue model**
  - Draft Net EAS revenue model posted for Stakeholder review on May 20, 2016
  - Model is utilized to determine annual average net EAS revenue projections for peaking plants (both for the initial Capability Year covered by the reset period and the annual updates for the subsequent three Capability Years)
    - Used as an input to determining net cost of new entry ("CONE")
    - Ultimately, this information will be considered in developing recommended peaking unit technologies for each ICAP Demand Curve
- **Presentation includes two sections:**
  - Review of preliminary draft results for three technologies:
    - Siemens SSGT6-5000F5 ("Frame"), GE LMS100 PA+ ("LMS"), and Wartsila 18V5OSG/DF ("Wartsila")
    - GE 7HA.02 ("H") included for informational purposes
  - Model User Guide and Technical Appendix
- **Provide update on schedule and next steps with respect to model development**

Contents

Overview of the net EAS revenue model

- **Initial details, including numeric examples were presented to the ICAPWG on 2/19/2016 and 4/25/2016**
- **The net EAS revenue model estimates the net revenues a peaking plant would be expected to obtain by participating in Energy, non-spinning Operating Reserves markets under the tariff-specified level of excess conditions**
  - Model developed with SAS 9.4 (details in later slides)
    - – Utilizes data from SNL Financial subscription service and publically available data sources
    - – Unit characteristics determined during Demand Curve reset (DCR) process
- **The current version of the model includes:**
  - Co-optimization logic for Energy and non-spinning Operating Reserves to commit a peaking plant Day-Ahead and then dispatch in real-time
    - – Ability to buy out of Day-Ahead position and dispatch differently in real-time
  - Ability to model net EAS revenues in dual-fuel or gas only configuration
    - Current gas only logic in the model is preliminary and remains under consideration

Caveats to the current model

The current model is *draft/preliminary*. Several issues are under consideration and/or are pending final inputs, including:

- **Time Period:** Current model uses data **May 1 2013 through April 30 2016**
  - Final values for 2017/2018 Capability Year will be based on data from September 2013 through August 2016 (results to be updated in September 2016)
- **Data inputs:**
  - *LBMP Data:* All LBMP and A/S Price data are sourced to NYISO markets and operations and provided with the model. The NYISO is planning updates to post a RT A/S time-weighted integrated price; final data will maintain the same source but may take a different input format
  - *Level of Excess Adjustment Factor*: All adjustment factors are currently set to a value of 1.0; will be updated pending final GE MAPS modeling
  - *VSS revenues:* Adder to net revenues determined by model, based on historical settlement data provided by the NYISO; may be updated based on technology parameters
  - *Gas hubs:* initial gas hubs set to match 2015 CARIS Phase I assumptions; Analysis Group will present initial recommendations for gas hubs at June 2, 2016 ICAPWG meeting
- **Certain assumptions regarding operability within model logic remain under development:**
  - *Environmental Run Time Limitation (GHG NSPS)*: Assumes perfect knowledge and profit maximization
  - Gas only operation logic

Note: H Machine included for informational purposes only

Net EAS model assumptions

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- **For initial model release, gas hubs indexed to match the 2015 CARIS Phase 1 study assumptions:**

Zone	CARIS Phase I (2015)
NYCA - C	TETCO M3
NYCA - F	TGP Zone 6
LHV – G	TGP Zone 6
NYC - J	Transco Zn 6 NY
LI - K	Transco Zn 6 NY

- **Fuel price burdening and real-time premium/discount values are sourced from the 2015 State of the Market Report:**

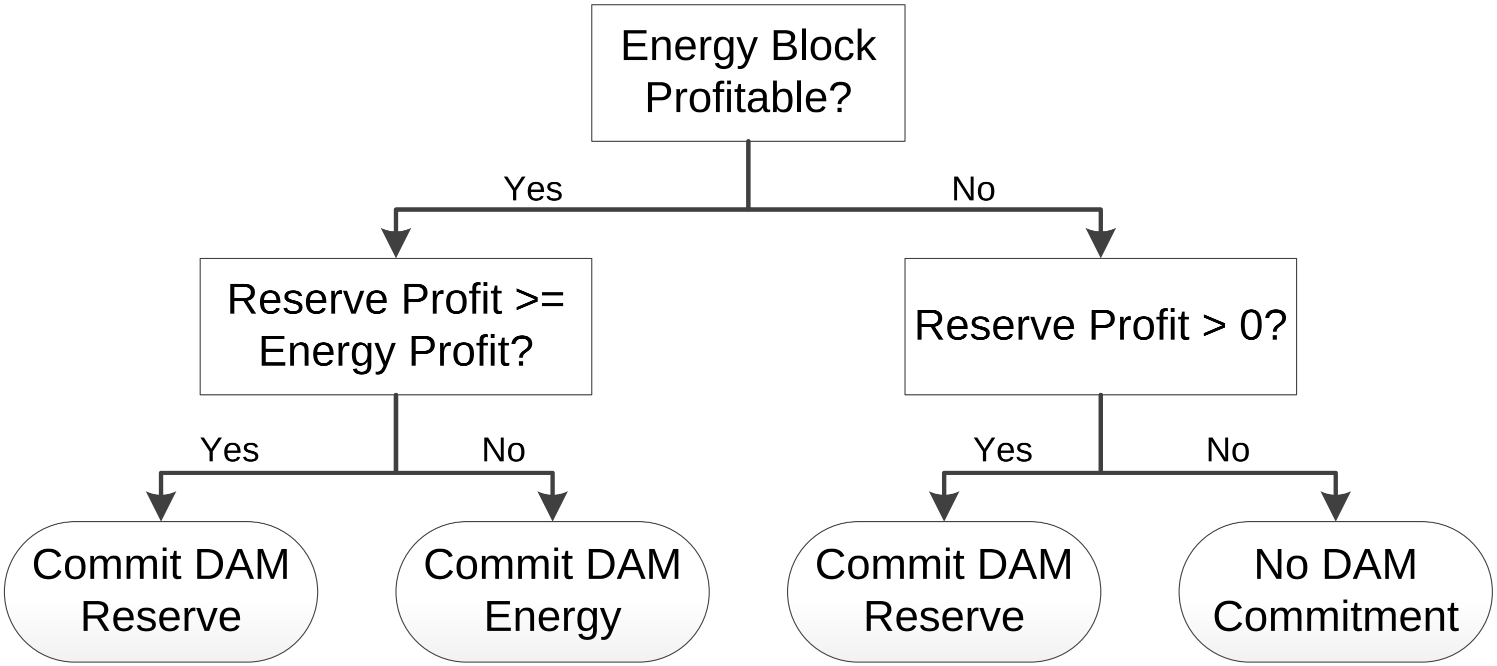
Zone	Gas Transportation ($/MMBtu)	Intraday Gas Premium/Discount	Tax (Gas; ULSD)	Oil Transportation ($/MMBtu)
Rest of State	$0.27	10%	-	$2.00
Hudson Valley	$0.27	10%	-	$1.50
New York City	$0.20	20%	6.9%; 4.5%	$1.50
Long Island	$0.25	30%	1.0% (Gas)	$1.50

Net EAS model assumptions

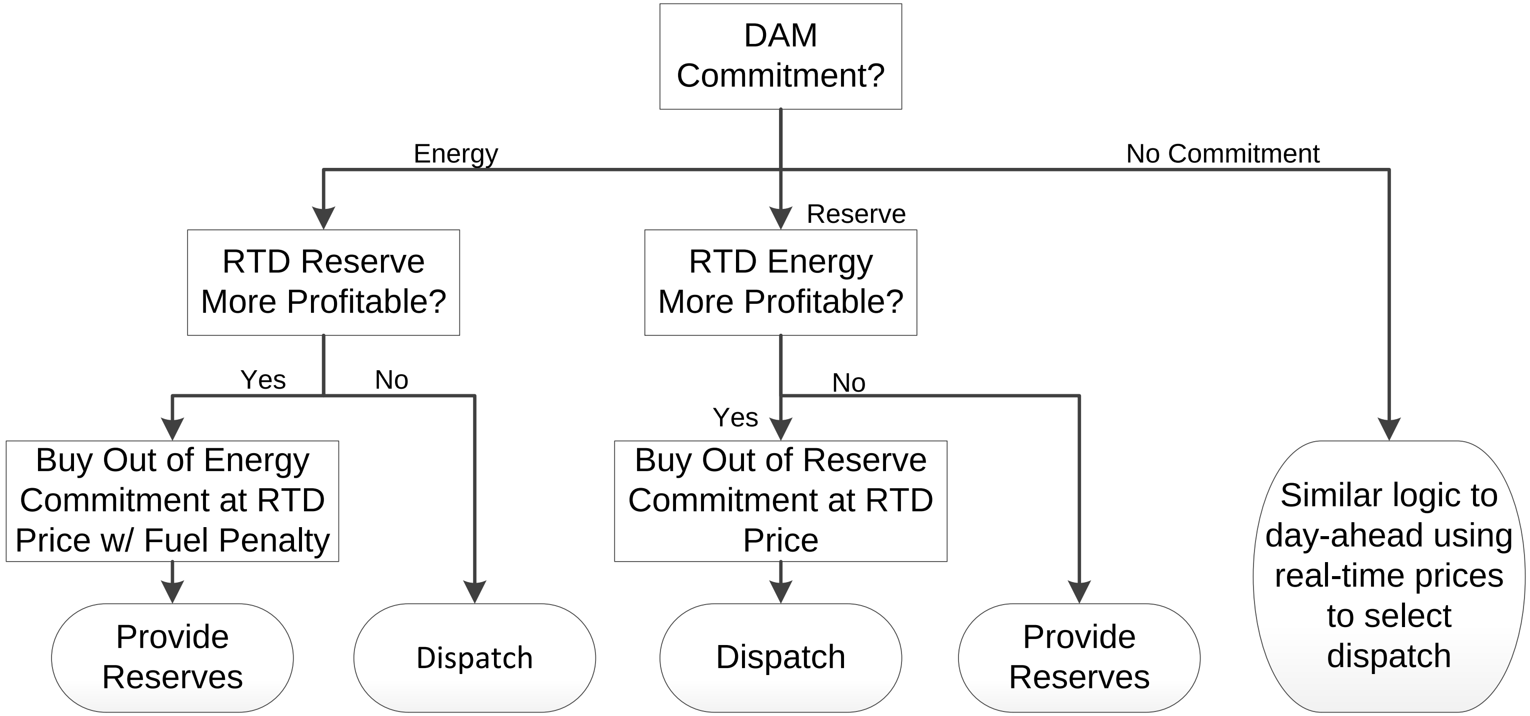
- **The Net EAS model uses geographic, temperature, and capacity values calculated by Lummus. Units are modeled using seasonal summer and winter capacity parameters**

Load Zone	Elevation (ft)	Season	Ambient Temperature (°F)	Relative Humidity	LMS Capacity (x2)	Frame Capacity (x1)	Wartsila Capacity (x12)	H Capacity (x1)
C - Central	421	Summer	77.7	46.9	99	226	16.7	322
		Winter	28.4	72.8	107	231	16.8	342
F - Capital	275	Summer	78.1	48	100	226	16.7	323
		Winter	29.2	68.3	108	231	16.8	344
G - Hudson Valley (Dutchess)	165	Summer	78.9	51	99	223	16.7	322
		Winter	32.6	66.9	108	231	16.8	345
G - Hudson Valley (Rockland)	165	Summer	79.9	48.2	99	223	16.7	322
		Winter	33.2	65.4	108	231	16.8	345
J - New York City	20	Summer	81.1	41.2	101	225	16.7	324
		Winter	38.1	55	108	230	16.8	344
K - Long Island	16	Summer	78	52.7	102	228	16.7	326
		Winter	35.9	62.2	108	231	16.8	346

- **Functionality: Day-Ahead**
  - The model evaluates profitable energy blocks and ensures that all costs, including amortized startup costs, can be recovered before committing to provide Energy
  - If Energy commitment is not profitable, the model considers committing the unit for reserves



- **Functionality: real-time**
  - Model will check to see if buying out of unit's Day-Ahead position leads to greater profit and will act accordingly
  - Model can take advantage of Day-Ahead Energy commitments to extend run time in real-time without incurring additional startup costs
  - Frame unit must recover startup costs within 2 hours; LMS and Wartsila within 1 hour



Net EAS model preliminary results (Dual fuel)

Area	Zone	3-Year Average Net EAS Revenues ($/kW-year) LMS	Frame	Wartsila	H	3-Year Average Run Hours LMS	Frame	Wartsila	H
C	Central	$57.84	$46.91	$59.91	$51.31	2,048	1,652	2,050	2,023
F	Capital	$69.02	$40.43	$72.85	$44.33	1,120	773	1,240	1,008
G	Hudson Valley (Dutchess)	$67.11	$41.38	$70.47	$44.68	1,280	973	1,389	1,250
G	Hudson Valley (Rockland)	$67.09	$41.33	$70.39	$44.57	1,278	973	1,386	1,241
J	New York City	$78.81	$54.17	$83.15	$60.28	2,116	1,775	2,253	2,364
K	Long Island	$130.65	$106.96	$138.16	$114.25	3,452	3,135	4,038	3,413

Area	Zone	3-Year Average Unit Starts LMS	Frame	Wartsila	H	Average Hours per Start LMS	Frame	Wartsila	H
C	Central	322	138	333	151	6.4	12.0	6.2	13.4
F	Capital	308	98	326	116	3.6	7.9	3.8	8.7
G	Hudson Valley (Dutchess)	291	110	307	128	4.4	8.8	4.5	9.8
G	Hudson Valley (Rockland)	290	110	305	127	4.4	8.8	4.5	9.8
J	New York City	365	152	369	176	5.8	11.7	6.1	13.5
K	Long Island	296	190	405	181	11.6	16.5	10.0	18.8

Results are preliminary and do not reflect any level of excess adjustment.

Model logic and fuel dispatch

- **The current model allows for operation in either dual fuel or gas only operation**
  - Model includes a “flag” for gas only operation
  - Current gas only operation logic is preliminary and remains under consideration

- **When operating in dual fuel configuration, net EAS revenue model maximizes hourly profits, considering:**
  - Variable Operating & Maintenance costs for oil or gas
    - See Appendix to Lummus’ presentation at 4/25/2016 ICAPWG meeting
  - Hourly fuel price (including burdening costs)

Technical appendix – User guide

- **Posted files include five folders:**
  - Model inputs, defined in Excel
  - Model programs, defined in SAS 9.4
  - Model datasets, created by SAS 9.4 and stored for reference as hourly-level SAS data files
  - Model outputs, created by SAS 9.4 and saved as an Excel file
  - Result tables, defined in Excel. These tables can be linked to the Model output to display formatted results

- **To run the model you must:**
  1. Update the model input sheets, including gas price data and emissions costs data
     1. See Slide 14 for additional information on the alignment of gas and market data
  2. Set the working directory and output file name in the SAS 9.4 code, then run the code
  3. Either view raw output or link the raw output to the results tables

- **The remainder of this presentation provides summary screen shots on how to update and run the model**

Updating model data sources

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- **There are three input files to the net EAS model:**
  - "Net EAS Model Inputs" contains all parameters to be updated annually
  - "Lummus Performance and O&M Data" contains technology specific parameters established during the DCR
  - "Level of Excess Adjustment Factors" will contain LOE adjustment factor values based on the results from GEMAPS runs. The current file contains a placeholder of 1.0 (i.e., no adjustment to historic prices)
- **Data in "EAS Model Inputs" comes from 5 sources:**
  - LBMP and A/S Price data sourced from the NYISO market and operational data
    - RT Ancillary prices on NYISO website are five minute prices; publicly available hourly integrated real-time (RT) reserves prices are currently under development. In the interim, hourly integrated RT reserve prices need to be developed manually based on posted data. See final slide for calculation details.
  - Rate Schedule 1 costs from the NYISO website
  - RGGI emission prices from public RGGI auction results (posted on RGGI website)
  - Gas and NO_x (seasonal and annual) and SO_2 emission prices from SNL Financial (subscription required)
  - Ultra Low Sulfur Diesel prices from the EIA

Updating model data sources

- **You must set the first date of the Model Run in the "Model Inputs" file. Set cell F10 of the "Instructions" sheet to the first day of the 3-year run period**

- **Sources for all data are listed explicitly in the "Data Sources" page of the Net EAS Model. Please read this tab before attempting to update the model**
  - SNL Financial data can be accessed with an SNL subscription. For this posting, the input sheets have been filled with placeholder (e.g., "$9.99") data
  - With an SNL subscription, data can be downloaded directly in Excel via the "SNL Excel Add-in". Instructions in the model assume this Add-in is installed

- **NYISO does not currently post integrated hourly real-time nonspin prices. Stakeholders can calculate the integrated hourly prices as shown on the final slide of this deck.**

Updating gas prices

- **Gas data used in model are from SNL**
  - SNL gas prices reflect prices for delivery on the following day (one day after the date stamp)
  - SAS 9.4 model aligns SNL gas prices with electricity prices by incrementing the SNL gas date by one day
    - Note: Gas prices from SNL should be downloaded for the same period (May 1, 2013 through April 30, 2016) as the model period
  - Gas prices from alternative sources that do not reflect similar date structure to SNL will require data or model modification to ensure gas-electricity date alignment
  - SAS 9.4 model is compatible with gas series from any data source
    - Note, however, that SNL Financial has been recommended as the gas price source

Data input sheet

Project: NYISO Demand Curve
Date: May 2016
Worksheet: **Instructions**

Instructions for Using NYISO Net EAS Revenues Model

Steps:

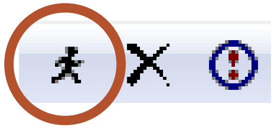
First Date of EAS Modeling Period: 5/1/2013

1 Fill in cell F10 above with first date of 3-year modeling period.
2 Update each tab in this workbook to include updated data. Maintain the same column headers and unit of observation as in this workbook.
Note: The Net EAS Model will read in the entire sheet, so it is valid to simply append updated data to the bottom of each sheet.
3 Close this file, then run the SAS 9.4 Code "1.0 Net EAS Revenues model.sas". Line 10 in the SAS 9.4 code should be updated to reflect the proper filepath.
Line 11 in the SAS 9.4 code should be updated with the name you would like to assign to the output file.
4 Link the output file in the "Output" folder to the Demand Curve Excel Model.
5 Results can also be explored by updating the links in "EAS Model Results.xlsx" to read the output from the SAS model.

Current modeling period is May 2013-April 2016. Results will be updated as data is received.

Running the model in SAS 9.4

- **The net EAS model contains extensive comments and variable labels to assist stakeholders in reviewing the code**
  - The model is split into 11 sections outlined at the top of the code
  - Each section has an additional header explaining specific steps
  - A glossary of all variables has been posted
- **The model can be run by updating just 2 lines: You must set your working directory and output name in lines 10-11 of the SAS 9.4 code.**
  - Link to the “EAS Revenues” folder so that the SAS 9.4 code can access inputs and outputs
  - Specify a unique output name for each desired model run
  - The model can be set to “gas only” mode on line 13. Otherwise the model assumes all zones are dual fuel
    - Current “gas only” mode simply removes the option of firing on oil. It does not modify unit technical parameters. This logic is preliminary and remains under consideration
- **Push F3 or click the image of a running man to run the code**



Overview of model structure

- **Model includes 11 sections, each with a detailed header of notes**

1.0 Net EAS Revenues Model (2016.05.13) *

```
*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*;
* 1. Load Annually Updated Parameters                                                          ;
* 2. Load DCR Set Parameters                                                                    ;
* 3. Merge Together Price Data for Each Hour                                                    ;
* 4. Calculate Base DAM and RTD Energy Profits in Each Hour                                     ;
* 5. DAM Energy Blocks - Set Day-Ahead Behavior and Determine if Real-Time Buyout Profitable   ;
* 6. DAM Non-Energy Hours - Determine if Units Commit Reserves or No Commitment                 ;
* 7. RTD Energy Blocks - Determine if Profitable to Change Day-Ahead Non-Energy to
                         Real-Time Energy Dispatch                                              ;
* 8. RTD Non-Energy Hours - Determine if Units Buyout or Dispatch Real-Time Reserves            ;
* 9. EFORd Adjustment                                                                           ;
* 10. Run-Time Limit for NSPS                                                                   ;
* 11. Output Model Results                                                                      ;
*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*;

*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*;
* 1. Load Annually Updated Parameters                                                          ;
*   A: Energy LBMP;
*   B: Nonspin Reserve Prices;
*   C: Fuel Prices (Gas and Oil);
*   D: Emission Prices (CO2, NOX, SO2);
*   E: RS1;
*   F: Modeling Dates;
*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*;
```

Overview of model structure

- **Model is developed with SAS version 9.4. Older versions may not be compatible with Proc IMPORT statements**

1.0 Net EAS Revenues Model (2016.05.13) *

```
*********************************************************************************;
*                              DRAFT May 2016                                   ;
*                              Model uses SAS v. 9.4                            ;
* Program:  Net EAS Revenues Model                                              ;
* Date:     May 2016                                                            ;
* Author:   Analysis Group, Inc                                                 ;
* Client:   New York Independent System Operator                                ;
* Purpose:  Calculate 3-Year Average Net EAS Revenues for Peaking Unit          ;
*********************************************************************************;

%let filepath = ...\Models\EAS Revenues;
%let output_name = EAS Model Output (2016-05-
/*Set to 'yes' for gas only*/
%let enable_gas_only = no;

/*Current Modeling Period is May 2013 Through April 2016.*/
/*TODO: Update VSS Adder */
/*TODO: Update LOE Adjustment */
/*TODO: Update inputs with final data */

options mlogic mprint;
libname neteas "&filepath.\Datasets";
%let outpath = &filepath.\Output;
%let inpath = &filepath.\Input;
```

← Update File Path name here

Viewing model outputs

- **The net EAS revenue model will output into the "Output" folder using the name you specified on line 11 of the SAS 9.4 code**

- **The model outputs can be viewed in a formatted form by updating the "Results Table" Excel file**
  - With the "output" file open:
  - To update the Results Table Excel file, open the file in Excel and then
    - Select the "Data" ribbon (Excel 2010 and later)
    - Click "Edit links"
    - Select the previous output file, and click "Change Source…"
    - Specify the new output file

Note: When linking between files, both excel spreadsheets must be open.

- **Real-time ancillary integrated hourly prices are calculated as the weighted average price in the hour using real-time ancillary prices**
  - Calculated in each region to yield a regional, hourly price for the product

- $\boldsymbol{Integrated\ Price_h = \sum_{i=1}^{I} Time\_Ratio_{i,h} * Price_{i,h}}$
  - Where Time_Ratio = Number Minutes in Price Interval / 60 minutes

- **Example two-period calculation**
  - If the **3:00 pm** (i=1) price is **$50** and the **3:30 pm** (i=2) price is **$60**
    - Each time interval is 30 minutes (3 to 3:30pm, then 3:30 to 4pm)
    - $Time\_Ratio_1$ = 30 / 60 minutes = 0.5
    - $Time\_Ratio_2$ = 30 / 60 minutes = 0.5
  - Integrated Price = (0.5 * $50) + (0.5 * $60) = $55
    - $55 would be the price for the 3:00pm – 4:00pm hour

- **Ordinarily there are twelve 5-minute intervals in a given hour**