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Target 4, Task 5: Determination of Liquid Fuel Inventory Levels

General

In LAI's view there is no "right" amount of backup fuel inventory or storage tank capacity for a dual-fuel capable power plant. *Optimizing* tank size and fuel inventory requires multi-faceted mathematical analysis of PPA specific reliability goals, weather conditions, plant-specific criteria and transportation replenishment logistics that are beyond the scope of the Target 4 / task 5 (T4/t5) research goals and objectives. The tank "bogie" is formulated for ultra-low sulfur distillate liquid fuel, usually ULSD, which would be utilized by combustion turbines in simple or combined cycle applications as an alternate or back-up fuel[1]. In developing the "bogie" for constrained locations for PPA review, LAI has relied on the results of the Target 2 analysis, but then considered other factors affecting the Participating Planning Authorities (PPAs') ability to realize the benefits of fuel assurance through dual fuel capability in lieu of incremental firm transportation. Decisions regarding tank capacity and inventory management are influenced by a wide range of factors based on grid reliability: reliability is the principal driver for traditional bilateral utilities such as TVA and IESO, and for plant owners serving market PPAs is the basis behind existing market rules and penalties for failure to generate when called on by the PPA in the Day Ahead (DA) or Real-time Market (RTM). Owners' decisions are also driven by expected return on investment, tempered by the impacts of low-probability, high-impact events. In performing this analysis, LAI did not address potential financial risk factors attributable to PJM's Capacity Performance proposal or ISO-NE's two-part settlement mechanism designed to induce performance.

For the purposes of T4/t5 of the EIPC Study, LAI will set a tank capacity/target inventory level for each power plant site selected by the PPAs, based on a consideration of the pipeline constraint frequency-duration characteristics defined in Target 2 applicable to

[1] An alternative fuel assurance strategy for generators in NEMA / Boston and SEMA would be a seasonal peak arrangement for the purchase and storage of one or more cargoes of LNG at the Suez Distrigas terminal in Everett. This strategy would surely necessitate the participation of multiple generators to overcome diseconomy of scale problems. This T4t5 analysis is limited to ULSD as a back-up fuel for new CT-based (Single Cycle (SC) or Combined Cycle (CC)) generators. Logistics for existing dual-fuel capable plants, including steam plants using residual oil as backup/alternative fuel, are covered in T4t1.

the site, along with the expected operation profile[2] (5 days/week x 16 hours/day for CC, 5 x 8 for SC) and identifiable characteristics of the local ULSD delivery infrastructure.

Plant Owner Considerations

The objective of a plant owner is to optimize cash flows, once system reliability/fuel assurance goals have been met. In establishing tank size and/or target inventory level for backup fuel, owners are likely to consider the following list of factors:

1. Frequency and duration of pipeline limitations on the scheduling of natural gas during the peak heating season, January, February and December. To the extent non-firm shippers are exposed to curtailments or interruptions, timely nominations in accord with the existing or anticipated changes to NAESB scheduling protocols may limit a generator's ability to obtain all or a portion of the daily fuel requirements to meet the expected dispatch regime in the DA or RTM. Curtailment can be characterized by both frequency and duration of curtailment events. Even without actual curtailment, pipeline constraints can result in difficulty in scheduling gas delivery to match required dispatch profiles. Under usual wintertime operating conditions, there are no restrictions on the scheduling of natural gas if the generator holds a firm entitlement equal to or approximately equal to the Maximum Daily Quantity (MDQ). However, to the extent the pipeline posts an Operational Flow Order (OFO) during a critical event, the generator's ability to schedule natural gas during such an event may be limited due to penalty exposure for violation of the non-ratable take provision in the tariff.

2. Economics of operation on back-up fuel. For what fraction of the winter days is operation on backup fuel likely to be "in-the-money" relative to prevailing market energy prices? To what extent are such days likely to be consecutive? How many hours of equivalent full load operation per day can be expected when dispatched on backup fuel?

3. Delivery lag time for backup fuel delivery. How many hours are likely to pass between ordering replenishment service from a supplier and the arrival of first deliveries? Depending on the location and size of available transportation fleets (truck or barge), this lag could vary between one day or less and several days or

[2] The operation profile of the CC is based on the typical dispatch regime of a new CC observed in AURORAxmp, as well as a simplifying assumption for the SC. The 5 x 8 operation profile of the SC accounts for the real option value of an efficient, quick-start SC in the DA and RT markets.

more. Under normal road conditions, the lag time for initiation of delivery by truck is typically about one day. Barge deliveries typically have longer lead times. Barge logistics are aided somewhat by the much larger volume of deliveries as compared with truck where the typical tanker truck delivers around 10,000 gallons and a river barge can deliver 600,000 to 1 million gallons.

4. Impact of severe weather events on backup fuel delivery capacity. To what extent can severe winter weather events, particularly snow (for truck delivery) or severe cold (for barge delivery) slow down or stop a contracted delivery stream to the plant? During a severe storm lasting 3 to 7 consecutive days, operators may not be able to reach oil terminals for delivery via truck due to lags in plowing and sanding secondary and tertiary roads. Barge deliveries may be faced with limitations on movements due to waterway icing.

5. Impact of failure to deliver dispatched energy or to offer into market due to unavailability of fuel on plant net revenues. In particular, does failure to generate during a fuel constraint event result in a significant loss of capacity revenue or a penalty with similar effect?

Existing dual-fuel capable plants have distillate fuel tank capacities that can range depending on location and specific plant conditions from one day of full-load operation to five days or more, as shown in data developed for Target 4, Task 1.

T4/t5 Procedure for Determining Tank Capacity/Target Inventory Levels

Based on a goal of fuel assurance roughly equivalent to firm transportation for natural gas, the following approach will be implemented for each of the identified T4/t5 sites to set an inventory level, measured in days of equivalent full load fuel burn.

1. Identification of the Relevant Constraint – The appropriate constrained pipeline segment for the site will be selected from among those described in Sections 6 and 8 of the Target 2 report for RGDS S0, Winter 2018. This identification will provide the fraction of days in the season in which some level of unserved generation demand is likely to occur, along with the extent to which such days are clustered over consecutive day events. Inspection of the Frequency-Duration (F-D) results by pipeline in the recommended constrained region results in a characterization of frequency duration as “high” , “moderate”, or “low.”

2. Identification of the Relevant ULSD Supplier - The closest substantial distillate fuel terminal will be identified for each site. The time lag to initiate deliveries upon notification, normal round trip times for trucks, etc. will be defined. A

maximum daily delivery rate, based on the normal daily fuel burn, will be established.

3. Identification of ULSD Delivery Constraint Events – The likelihood and extent of events which could slow down or stop deliveries for more than a 24 hour period will be evaluated, based on the locations of the depot, the plant site, and the intervening route. Most likely, this constraint will be identified as the time that would be required to clear roads from a severe snow fall. Given the development of the transportation market for ULSD, which has resulted in large refinery runs and widespread storage and distribution facilities, there will be fewer winter availability and transportation constraints for ULSD as compared with No. 2 fuel oil supplies in the past.

4. Set the tank capacity/target inventory level per the following equation:

   TIL = (DPC + DLC + DCC) * EDF

   Where TIL = Target Inventory Level, days of Full Load Equivalent (FLE)

   Fuel Burn

   DPC = Demand Persistence Component, days (or fractional days)

   = 0 days for no identified constraint

   = 1 day for “Low” F-D of applicable constraint

   = 2 days for “Moderate” F-D

   = 3 days for “High” F-D

   DLC = Delivery Lag Component, days (or fractional days)

   DCC = Delivery Constraint Component , days (or fractional days)

   = Estimated max consecutive days of ULSD delivery constraint

   EDF = Equivalent Dispatch Factor

   = (5 x 16) / 168 = 0.476 for combined cycle plants

   = (5 x 8) / 168 = 0.238 for simple cycle plants

Example 1 (Truck Delivery):

For a site linked to a pipeline segment with a "moderate" constraint F-D pattern, a ULSD delivery lag of 24 hours, and a ULSD delivery constraint of 2 days to clear roads after a major snowstorm, the target inventory levels for CC and SC applications would be as follows:

TIL for CC = (2 + 24 / 24 + 2) * 0.476 = 2.38 days FLE

TIL for SC = (2 + 24 / 24 + 2) * 0.238 = 1.19 days FLE

Example 2 (Barge Delivery):

For a site with barge delivery facilities linked to a pipeline segment with a "high" constraint frequency-duration pattern, a ULSD delivery lag of 7 days, and a ULSD delivery constraint of 10 days to clear ice in a major cold spell, the target inventory levels for CC and SC applications would be as follows:

TIL for CC = (3 + 7 + 10) * 0.476 = 9.52 days FLE

TIL for SC = (3 + 7 + 10) * 0.238 = 4.76 days FLE

Note that, in the case of barge delivery, the target inventory level could include the capacity of one barge held at the site.