DOCKETED	
Docket Number:	18-HYD-04
Project Title:	Draft Solicitation Concepts for Light-Duty Hydrogen Refueling Infrastructure
TN #:	229986
Document Title:	Equilon Enterprises (Shell) Comments - 18-HYD-04 HySCAPE Workshop Comments
Description:	N/A
Filer:	System
Organization:	Equilon Enterprises (Shell)
Submitter Role:	Applicant
Submission Date:	10/7/2019 4:52:52 PM
Docketed Date:	10/8/2019

Comment Received From: Equilon Enterprises (Shell)
Submitted On: 10/7/2019
Docket Number: 18-HYD-04

18-HYD-04 HySCAPE Workshop Comments

Additional submitted attachment is included below.

Shell Oil Company
910 Louisiana Street
Houston, TX 77002

October 7, 2019

California Energy Commission
Docket Unit, MS-4
1516 Ninth Street
Sacramento, CA 95814-5512
Delivered via website

Re: Docket No. 18 – HYD – 04

Dear CEC Administrator:

We respectfully submit this letter of comment to the California Energy Commission (CEC) in response to 18-HYD-04, Draft Solicitation Concepts for Light-Duty Hydrogen Refueling Infrastructure, Staff Workshop on the Hydrogen Station Capacity Evaluation Tool and Hydrogen Station Data Collection & Reporting. The letter reiterates and expands upon comments submitted to the same docket on 22 February 2019.

The Draft Solicitation Concepts for Light-Duty Hydrogen Refueling Infrastructure (18-HYD-04) is innovative and, we believe, can help to enable the increased scale and pace needed for hydrogen to contribute meaningfully to California meeting its ambitious goals for zero emission vehicles (ZEV) and emissions reductions from the transportation sector. The draft solicitation clearly articulates a structure for progress toward a viable market for hydrogen fuel cell vehicles (FCV) and the related infrastructure, accomplishing the most possible with available funds and authorization. We believe the combination of the Low Carbon Fuel Standard (LCFS) Hydrogen Refueling Infrastructure (HRI) credits adopted by the California Air Resources Board (CARB) and these Draft Solicitation Concepts can provide a strong signal of market confidence in the development of the hydrogen refueling network, to those who would bring FCV to market, those who would invest in hydrogen supply, and customers who would consider the purchase or lease of an FCV. It is therefore imperative for this Draft Solicitation to succeed in establishing the

reliable multi-year delivery of hydrogen refueling infrastructure that decreases cost, improves performance, and provides high quality customer service.

To help ensure this outcome, we kindly offer the following comments on topics raised at the Staff Workshop on the Hydrogen Station Capacity Evaluation Tool and Hydrogen Station Data Collection & Reporting held on Friday, 27 September, 2019 (the "Workshop").

Our recommendations to the CEC are in bold italics.

HYDROGEN STATION CAPACITY EVALUATION TOOL:

The Draft Solicitation Concepts include several important aspects for station technical requirements and performance, including the use of the HySCAPE model to evaluate station capacity. The HySCAPE model is a reasonable "version 1.0" model when used properly for the originally intended purpose of evaluating station capacity for the Hydrogen Refueling Infrastructure (HRI) pathway in the Low Carbon Fuel Standard (LCFS). However, the operation of this model as it relates to potential hydrogen station designs needs to be carefully understood for it to be used properly and avoid spurious results.

The HySCAPE model is not an engineering performance model and should not be used as such, as representatives from the National Renewable Energy Laboratory (NREL) stated in the Workshop. We believe the intended CEC approach as presented in the Workshop would do so in the following ways.

1. Use the input parameter for "number of deliveries per day" as a "neutral standard" for evaluating station equipment capability. This approach would ignore variation in the designed operation of station equipment, as described in more detail below.
2. Use the input parameter for "Time Between Fills" to assess the capability of the station design to serve the "Chevron Friday" profile of customer demand at full SOC by requiring the applicant to enter a value for this parameter that makes the "Mass Dispensed" result equal to the "Mass Dispensed at SOC Limit." This approach would ignore variation between station designs that may impact the residence time of customers and therefore how many customers arriving according to the "Chevron Friday" profile could be served through each fueling position. The approach is also unnecessary as the HySCAPE already provides results for both the total "Mass Dispensed" and the portion that is "Mass Dispensed at SOC Limit"; the CEC can decide which metric to consider in its evaluations (e.g., to evaluate the amount of demand the station can serve at full SOC).

These proposed approaches, which differ from the use of HySCAPE by CARB in the LCFS HRI Pathway, are "asking too much" of the HySCAPE modeling capability, with potential risk of giving "false precision" to the CEC's quantitative evaluation of hydrogen refueling station designs, and potentially resulting in systematic bias in the CEC's evaluation. We will use several examples below to illustrate these points.

Topic 1: establishing a "neutral standard" for evaluating station equipment capability & capacity with the input parameter "number of deliveries per day"

The HySCAPE model is based on evaluation of the mass flow of hydrogen as determined by system components, which uses necessary simplifications to cover a wide range of potential hydrogen station design parameters. For example, the throughput of a compressor given the inlet and outlet pressures. In this approach, HySCAPE does not model station control schemes, but rather assumes a constant flow rate through the cryo-pump of a liquid hydrogen station and assumes a decreasing flow rate through the compressor of a gaseous hydrogen station (based on decreasing inlet pressure from supply storage as mass is dispensed to customers).

However, a gaseous station can be designed with a "pressure consolidation" control scheme that maintains pressure in gaseous storage banks as the mass is drawn down, and also makes approximately 95% of the stored mass usable for dispensing to customer vehicles at full State of Charge (SOC). Since this control scheme is not modeled in HySCAPE, a proxy in previous engagements on the HySCAPE model development has been understood as a "mid-day delivery" which increases on-site storage pressure. This can be understood as either (a) an actual delivery of additional hydrogen from a delivery trailer to increase both the quantity and pressure at a gaseous station not using a "pressure consolidation" design, or (b) an approximation that still under-estimates the operation of pressure consolidation controls maintaining storage pressure and making nearly the full stored mass usable to customers.

Similarly, a liquid station will need a control scheme to maintain constant head pressure in order to maintain the constant flow rate through the cryo-pump that is assumed in the HySCAPE model. We understand there has not yet been a validation of the HySCAPE model for a liquid station.[1] In the absence of validation, NREL has assumed the cryo-pump has a constant flow rate over all storage conditions. However, if the head pressure of a cryo-tank varies as the tank empties, it could mean a decrease in flow rate through the cryo-pump of approximately 20 percent from what is modeled in HySCAPE.[2]

This difference in assumptions and lack of treatment of control schemes in HySCAPE, if not used properly, could cause a systematic bias in the HySCAPE modeled results between liquid stations represented as constant flow rate and gaseous stations represented as decreasing flow rate based on the assumptions (i.e., one presumed to have control schemes to maintain head

[1] The NREL validated a gaseous station using NREL station facility test data but has not yet done a similar validation of their liquid station model.

[2] If the cryo-tank head pressure changes, the boiling point of the hydrogen will change, and a change in the density of the liquid hydrogen will occur. Per NIST hydrogen property data, for example, if the head pressure of the LH2 Dewar changes from 1 Bar to 5 Bar absolute, the boiling point of LH2 changes from 20 K to approximately 27 K, and the associated LH2 density changes from 72 kg/m^3 to 60 kg/m^3, which is a decrease of approximately 20% that could lead to a commensurate 20% decrease in the mass flow rate of a cryo-pump. Maintaining constant head pressure is a matter of control scheme for a liquid hydrogen station design that is assumed to be achieved in HySCAPE.

pressure, the other assumed to be without pressure consolidation control schemes designed for the equivalent purpose to maintain the full compressor flow rate).

For the CEC's intended use of HySCAPE as a "neutral standard" by which to evaluate station capacity, it is therefore necessary and reasonable to establish the consistent input parameter for "number of deliveries per day" as one (1) rather than zero (0). This would represent reasonable operations for delivery frequency and/or approximate while still under-estimating the gaseous station control schemes not modeled in HySCAPE. It would be an approximation of a "neutral standard" given the simplifications and assumptions built into the HySCAPE model, and would be consistent with the CARB use of the HySCAPE model.

The CEC may wish to provide Applicants the opportunity to also provide supplemental evidence of station performance from equivalent modeling or capacity estimation methodologies justified by the proposal. In due time, the HySCAPE model may be updated to represent control schemes and modeled results may be objectively demonstrated and corroborated with full system test data on specific designs and actual station equipment. This approach may help CEC to properly interpret the HySCAPE model results and equipment capabilities, and would be consistent with the CARB use of HySCAPE in the LCFS HRI Pathway under 17 CCR Section 95486.2(a)(2)(E).

Topic 2: evaluating usable ground storage with the input parameter "number of deliveries per day"

The CEC intent for proposing zero (0) as the input parameter for "number of deliveries per day" was also represented in the Workshop as addressing concerns for failure to deliver on planned operations, specifically for the planned number of deliveries per day. In effect, the CEC may wish to evaluate equipment capability without influence from operational parameters like supply deliveries, and may be seeking to establish a requirement for usable ground storage at the station through the "number of deliveries per day" input parameter in the HySCAPE model as a means to address supply reliability and resilience.

We do not believe this approach is appropriate for several reasons:

- The performance of station equipment will be and is inextricably linked to how it is operated. To evaluate one without the other does not make sense and will not produce consistent results from modeling. For example, a gaseous station designed with a "pressure consolidation" control scheme can make approximately 95% of the stored mass usable for dispensing to customer vehicles at full State of Charge (SOC).
- Planned operations – whether hydrogen supply frequency or equipment operation and maintenance – will have an important impact on realized station capacity and performance.
- The supply disruptions that have impacted hydrogen refueling stations in California have been longer than 12 hours in duration, thus not for lack of regularly-scheduled deliveries as part of planned operations. Rather, these disruptions have been days to months in duration, and have been the result of planned and unplanned downtime in the

production facilities and distribution assets. Increasing ground storage is not a solution to supply reliability and resilience.

- As described above, the function of the input parameter for "number of deliveries per day" in the HySCAPE model may already be "over-used" to represent a "pressure consolidation" or other control scheme rather than physical supply deliveries. Seeking to establish a requirement for 24-hours of usable ground storage through the HySCAPE model via the input parameter for "number of deliveries per day" would be "asking too much" of the model, would likely give spurious results that could bias the CEC evaluations, and would not address supply reliability and resilience.

Evaluation of the usable quantity of ground storage should be accomplished outside the HySCAPE model, based on the total quantity and usable fraction.

Topic 3: assessing capability to provide full SOC using the input parameter "time between fills"

The time between fills is a design parameter for hydrogen station development, and may be related to decisions by station operators regarding the residence time of customers at the site. As such, it is appropriately an *input parameter* to the HySCAPE modeling and should not be imposed as a means to assess the capability of a station to provide customers with full SOC. Rather, the HySCAPE model provides this assessment properly through the analysis of mass flow, with resulting metrics for total "Mass Dispensed" and the portion that is "Mass Dispensed at SOC Limit."

Furthermore, changing the "Time Between Fills" input parameter to set "Mass Dispensed" equal to "Mass Dispensed at SOC Limit" is an impractical and imprecise use of the HySCAPE model, which is not an engineering performance model. For example, when seeking an exact match between these two metrics by lengthening the parameter for time between fills, the "Mass Dispensed at SOC Limit" can decrease below what it was with a shorter time between fills.

The input parameter for "Time Between Fills" should be an input from the station designer, based on and justified by evidence for the factors impacting customer residence time for payment initiation, filling, and transaction completion. We suggest the CEC should not require an applicant to specify the "Time Between Fills" that makes the HySCAPE model outputs for "Mass Dispensed" and "Mass Dispensed at SOC Limit" to be equal.

The HySCAPE models the station equipment performance in serving the full demand profile established by the "Time Between Fills" on the "Chevron Friday" profile, and returns the "Mass Dispensed" and "Mass Dispensed at SOC Limit" metrics.

For the intent of evaluating station equipment capability to dispense mass to customers at full SOC, the CEC may wish to base evaluations on the "Mass Dispensed at SOC Limit" metric.

To specify a minimum level of customer service in the potential waiting time experienced, the CEC may wish to establish an upper limit on the "Time Between Fills" at "not to exceed 255 seconds". This would be consistent with the CARB use of HySCAPE in the LCFS HRI Pathway. In our experience, the time between fills should be less than approximately 4 minutes for this purpose and we support establishing the upper limit at 255 seconds.

HYDROGEN STATION DATA COLLECTION & REPORTING

We understand a shared objective to support continued improvement in the hydrogen industry through data collection and reporting while also minimizing administrative burdens and associated obligations to promote more prudent stewardship of public funds. The updated NREL reporting tool introduced at the Workshop appears to be a significant improvement to streamline completion and remove commercially sensitive items while maintaining data quality.

As mentioned during the Workshop, however, *manual entries in the Safety & Leak Checks as well as Maintenance tabs need clarification of thresholds and requirements in order to avoid loss of data quality from inconsistency and to avoid becoming burdensome with excessive frequency or detail of entry.*

We believe data reporting to NREL for three (3) years will ensure robust data sharing over a multi-year development program. In general, we suggest that decreasing public funding should be complemented by decreasing agency involvement and requirements, as part of an effective off-ramp to a commercially viable market.

CONCLUSION

We compliment the CEC for engagement through three workshops in late 2017, and the positive response to comments that is apparent in the Draft Solicitation Concepts. However, we believe there are important corrections to the intended use of the HySCAPE model as presented in the Workshop that are needed for the CEC to achieve a successful GFO with fair, objective, and most effective results. We appreciate the opportunity to provide feedback to the CEC via this letter and welcome an opportunity to clarify as needed. We believe the changes recommended here will further support significant progress towards a healthier California by facilitating an accelerated pace of infrastructure development and hydrogen refueling station deployment. As FCV's are becoming rapidly more available, our collective ability to safely increase capacity and coverage in refueling infrastructure is paramount to customer adoption and to meeting mandated emission reductions.

Sincerely,

Wayne Leighty

Attorney-in-Fact, Equilon Enterprises LLC d/b/a Shell Oil Products US

Hydrogen Business Development Manager, North America

Tel: 832-680-9825
Email: W.Leighty@shell.com