DOCKETED	
Docket Number:	18-HYD-02
Project Title:	Hydrogen Station Capacity Model (HyC) Workshops
TN #:	224393
Document Title:	Jennifer Kurtz Comments HySCapE Beta comment review and status
Description:	N/A
Filer:	System
Organization:	Jennifer Kurtz
Submitter Role:	Public
Submission Date:	8/3/2018 1:10:18 PM
Docketed Date:	8/3/2018

Comment Received From: Jennifer Kurtz
Submitted On: 8/3/2018
Docket Number: 18-HYD-02

HySCapE Beta comment review and status

This information is distributed to provide an initial review of the collected comments. As such, comments are welcome by COB PST August 6.

Additional submitted attachment is included below.

Comment	NREL response for HySCapE 1.0 development
Assume that cars are only filled during an 18 hour window. As per FEF's data the hours between 5:00 AM and 11:00 PM represent more than 95% of the customer fueling events.Or assume that a 24 hour window is used, but use typical fueling patterns to define that capacity when customers fill their vehicles.	The baseline fueling scenario is the "Friday profile" from: https://www.energy.gov/sites/prod/files/2014/03/f11/delivery_infrastructure_analysis.pdf (Figure 2-16, page 2-39) and as referenced in CSA HGV 4.9 for light duty fueling
• 24 hour = should be able to dispense 100% of its rated capacity. • 18 hour = should be able to dispense 95% of its rated capacity. • 12 hour = should be able to dispense 75% of its rated capacity. • Peak hour (6 to 7 PM) = should be able to dispense 7% of its rated capacity.	Noted
AP wanted the full 24 hour capacity be used in determining the station capacity and the corresponding credit. AP proffered that the 18 hour window would capture 90% through-put based on station usage and a 12 hour window would be insufficient.	The baseline fueling scenario is the "Friday profile" from: https://www.energy.gov/sites/prod/files/2014/03/f11/delivery_infrastructure_analysis.pdf (Figure 2-16, page 2-39) and as referenced in CSA HGV 4.9 for light duty fueling
Given that the proposed analysis program is not a design or rating tool a 95% state of charge (SOC) should be used in the capacity calculation.	>= 95% vehicle storage SOC is as considered a complete fill (CSA HGV 4.9)
AP asked that the capacity calculation consider two deliveries of hydrogen per day that certain stations would utilize.	The baseline model allows for 1 additional delivery per 24 hour and assumes that the station starts at 100% state-of-charge at the beginning of the fueling scenario
In the absence of a full design tool, the rating of the site refrigeration requirements could be estimated. As a start, the station could have 1 ton of refrigeration for each 75 kg of daily capacity.	The model is simplified and only balances mass in version 1.0
The prescribed demand profile, if any , can be determined by and for the application. The prescribed time period, if any, can be determined by and for the application.	The baseline fueling scenario is the "Friday profile" from: https://www.energy.gov/sites/prod/files/2014/03/f11/delivery_infrastructure_analysis.pdf (Figure 2-16, page 2-39) and as referenced in CSA HGV 4.9 for light duty fueling
Schedule of periodic up-dates.	Noted
A petition process to request updates.	Noted
A more responsive consideration of change within an application of the model. For example, this could be a method with the GFO solicitation to consider information provided by an applicant regarding the model station capacity.	Noted
Use an 18-hour period, from 5:00 AM to 10:00 PM on maximum station capacity to align the incentive for station design to serve approximately 95% of customer demand in a typical gasoline station fueling profile.	The baseline fueling scenario is the "Friday profile" from: https://www.energy.gov/sites/prod/files/2014/03/f11/delivery_infrastructure_analysis.pdf (Figure 2-16, page 2-39) and as referenced in CSA HGV 4.9 for light duty fueling
If the "Chevron Friday Profile" is used, then the full 24 hour profile should be used as a 24/7 operation would match the customer service of most gasoline refueling stations.	The baseline fueling scenario is the "Friday profile" from: https://www.energy.gov/sites/prod/files/2014/03/f11/delivery_infrastructure_analysis.pdf (Figure 2-16, page 2-39) and as referenced in CSA HGV 4.9 for light duty fueling
Have a waiting period between fills, allowing the station equipment to determine the waiting period, rather than making it a fixed parameter in the Fill Scenario.	The time between fueling is a user input between 60 seconds (minimum) and 255 seconds (informed by CSA HGV 4.9). The default is set to 255 seconds.

Need to conduct a beta version of the model to validate and assess accuracy. o Test and validate model results according to a prescribed demand profile (the Chevron Friday Profile) over a range of station designs to verify expected results. o Test and validate model results for existing stations against observed loading to assess the potential magnitude of the difference between modeled capacity and actual full loading.	Beta testing of the model has been completed and 10 sample station capacity calculations have been documented.
Require a process for verifying claimed station design. o Requires a process to validate and verify the claimed station design in the model applications.	Noted
Need to identify the purpose and limitations of the model. o May consider disclaimers such as "actual may vary". Variation with the Chevron Friday Profile in customer arrivals may cause lines to form at a fully loaded station. This could be interpreted according to standard queueing theory instead of an error during the modeling of station capacity. In addition, variation in the modeled SOC when vehicles arrive along with customer behavior could change vehicle throughput and volume dispensed. Actual situation and anecdotes should be evaluated according to standard queuing theory instead as an error in modeling of station capacity.	Noted. A disclaimer will be added to the online user interface that states the capacity calculation may vary from actual dispensing because of operation variables like fueling profile and fill amount.
Program was installed to C:\Program Files\NREL\HySCapE_beta, but the default location for input/output is C:\HySCapE files. This could cause confusion.	The online user interface will simplify the input and output sources.
Is the image for the "Diagram" just a temporary placeholder? Otherwise, I don't understand the intent immediately.	Ths is a temporary placeholder. The output will be the 1) 24 hour dispensed amount histogram and total, 2) station calculated mass changes over 24 hours, and 3) station calculated pressure changes over 24 hours
Could use some more guidance on setting up the output file. For example, I tried to just copy an input file, give it a new name, and specify it as output. This led to crashing after the figures were generated and all HySCapE windows would close. Should specify a blank xlsx needs to be created and specified for output.	Noted. This is a temporary beta version issue and will be fixed with the online user interface.
I couldn't find a way to run a case, modify inputs, and then run another case without fully exiting HySCapE and restarting it. Is there a way to do this?	Each station capacity calculation will be an individual model run. The online user interface will allow for a model reset and new case without closing and restarting the model.
For the liquid example, I ran a case where the only input change I made was that I turned off liquid delivery as well as gaseous, and the output seemed pretty much the same (a fully-met Chevron filling profile), based on the figures. Is this correct? (Note: If I further limited the HP storage to 0.1 m^3, this did have an effect and the station had fewer/less complete fills).	Use of liquid storage had a bug in the beta version, which was fixed and
Error in HySCapE line 832: bad MATLAB subscript. Arrived at this by putting some admittedly nonsense variables in the input file:	Noted
This is more a conceptual/theoretical question: If we take the large gaseous station example provided, the outputs are 688 kg starting mass (so presumably this correlates to all banks at full before the first fill?), 392 kg dispensed, and only 188 kg at SOC limit. There is therefore a 1.75-3.66 times factor between a potential station rating and the size of its on-site storage. I think during the second workshop, there was an example shown with an even higher multiple, up to nearly 5. Is this reasonable based on observed station designs in the field?	A bug was identified during beta testing that was in the compression algortihm, which has been fixed and updated. See the 10 sample station capacity examples for more detail on the calculation results.
In the provided Liquid station example, the delivery type field is set to gaseous. Is this intentional?	This was a temporary beta input file issue and will be fixed with the online user interface.
Unclear what the energy per kg on the production inputs actually does in the model. Does it somehow affect the dispensing algorithm and calculations?	This was a legacy input for other model case studies and will not be included in the released 1.0 version.
There should probably be a button on the matlab input gui to restore some settings to default.	This will be added to in the online user interface.

I ran a Large gas case where I also added production. I then varied delivery volume to 100 and 300 kg. I got the same fueling result (below). Seems like the tail end of the day with only 100 kg delivered was a potential limit, but then adding the extra 200 kg doesn't seem to alleviate it. Also note: 0 delivered or produced. Is this as expected?	A bug was identified during beta testing in the delivery alogroithm which was fixed and updated.
Stations should addressed a 24-hour capacity capability, but also measure the capacity that can be met within an 18-hour time period, which consists of >90% of the stations throughput.	The baseline fueling scenario is the "Friday profile" from: https://www.energy.gov/sites/prod/files/2014/03/f11/delivery_infrastructure_analysis.pdf (Figure 2-16, page 2-39) and as referenced in CSA HGV 4.9 for light duty fueling
Stations capacity should also consider the possibility of having more than one delivery per day.	The baseline model allows for 1 additional delivery per 24 hour and assumes that the station starts at 100% state-of-charge at the beginning of the fueling scenario
Time between fills should be considered, but not a scoring requirement. In return, time between fills sould be a parameter determined by the equipment.	The time between fueling is a user input between 60 seconds (minimum) and 255 seconds (informed by CSA HGV 4.9). The default is set to 255 seconds.
Remove the dispenser flow rate input from the spreadsheet. The dispenser flow rate is a function of tank size, the ambient temperature, and the J2601 tables, not station design. Stations that use the MC Method may be able to fill a bit faster, but not significantly. This input leaves too much room for influencing the results in a way that may not be equitable.	The dispenser flow rate is no longer a user defined variable and is set to an average of 1 kg/min.
Fix the time between filling events. Using the parameters such as those in CSA HGV 4.9 could be an appropriate reference.	The time between fueling is a user input between 60 seconds (minimum) and 255 seconds (informed by CSA HGV 4.9). The default is set to 255 seconds.
Similarly, remove the Hourly Distribution option. For the program to be fair, all users should be running the same usage case.	The baseline fueling scenario is the "Friday profile" from: https://www.energy.gov/sites/prod/files/2014/03/f11/delivery_infrastructure_analysis.pdf (Figure 2-16, page 2-39) and as referenced in CSA HGV 4.9 for light duty fueling
Allow for compressor flow rates over 100 kg/hr. We can expect larger compressors to be common in the future.	We have validated that the input file will work in high pressure compressor flow rate up to 250 kg/h.
Have the input for compressor flow rate be flow rate at pressure since most compressor flow rates are a strong function of suction pressure. It would also be good to have a maximum suction pressure.	HySCapE version 1.0 assumes the maximum suction pressure is the maximum pressure of the next lowest storage bank(s). There was a compressor flow rate bug identified in beta testing and this has been fixed and updated so the compressor flow rate does vary (linearly because of the simplified model assumptions) based on suction pressure.
The program currently allows for three pressure storage levels, currently described as low, medium and high. It would be better if the program could support 4 or better yet N pressure levels	HySCapE version 1.0 will be limited to a maximum of 3 storage pressures.
It isn't exactly clear with the current inputs which banks can accept delivery, provide gas for the compressors, and can dispense. It would be good if each bank can supply gas to the compressor, supply gas to the dispenser, and accept gas from delivery.	This was fixed in the delivery, compression, and dispensing alogrithms (for example, low pressure is eligible for a cascade fill based on the user input)
Simplify the output to a single number. The purpose of this program is to determine the station capacity. Providing multiple answers and graphs distracts from the purpose of the program. The program is not intended to be a good station simulation, so the rest of the graphs are not expected to be correct.	Noted. The online user interface will reduce the output to a capacity estimate, with an option for the user to review the 24 hour dispensed, station mass, and station pressure graphs.
We believe the tool is sufficiently robust, providing a systematic, predictable and transparent method that scores proposed equipment relative to an ideal case. As such, HyC should be suitable to meet the anticipated needs of the CEC and industry.	Noted
Once a final version of the tool is released, we recommend a comprehensive evaluation of the existing operating stations in the CEC grant funding program. Such an evaluation would provide station developers with a baseline for evaluating future station designs prior to proposal or project initiation. We anticipate that such a validation program could be completed before the next CEC grant proposal solicitation.	Noted

Develop a Web Interface to the Executable – The model as an executable file presents barriers to use by corporate stakeholders as corporate IT departments are unwilling to allow installation of an executable file from a 3rd party, particularly when it is described as 'beta testing'. Approval process of 3-5 days is common. NREL and CEC suggested that the tool might be available as a website portal, such a website could be beneficial but would expose user's proprietary designs to the website host. Perhaps NREL might consider use of a secure cloud server with individual login and access for each stakeholder?	An online user interface will be developed by the fall of 2018. This online user interface will not change the model; it will improve the user experience running cases without the barrier of running an .exe as was the case for the beta testing.
Air Liquide uses a high pressure compressor configuration which allows for 216 kg/h (60 g/sec). It is not clear why HySCapE limits the high pressure compressor to 100 kg/h as a maximum input value. This limitation is a barrier to station equipment designs using a high throughput high pressure compressor.	We have validated that the input file will work in high pressure compressor flow rate up to 250 kg/h.
Implementation of the Delivery Module – The lack of a delivery module in HySCapE leads to the significant underestimate of station capacity. Without the delivery module, the program results are subject to a high degree of uncertainty.	A bug was identified during beta testing in the delivery alogroithm which was fixed and updated.
Modify the HP Cascade Process - The use of the HP buffer maximum as the cascade pressure to the vehicle is inaccurate. The actual pressure provided in the dispenser is limited to 87.5 MPa under NFPA 2. Since this is a prescribed limit, Air Liquide, consistent with good practice for controls systems sets software control limits at a pressure less than 87.5 MPa. Thus HySCapE fueling algorithm should be verified for accuracy with actual performance.	The dispensing algortihm assumes a constant flow rate of 1 kg/min, which is a simplification of actual fueling. And final fill pressure is limited to 70 Mpa for every full fill (partial fills are lower), which is alo a simplification of actual fueling.
During our review, we observed that the parameter inputs are "hard-coded" or "fixed" in the model. As a design philosophy, this type of programming will make the model inflexible to process a parametric study based on changes to the inputs. We recommend that the parameter inputs not be internal to the model, but rather as an input file that can be varied.	The parameters are hardcoded in HySCapE version 1.0 for consistency and because the model is not intended to be a design tool.
As an example of parametJ inputr, the model uses a fueling interval time for consecutive (back{o-back) fills from the CSA HGV 4.9 Appendix. This time interval in the document is presented only as a reference for a unique context, and was not intended to be a design criterion for an H2 capacity analysis. We recommend that the interval time be reduced to at least 2 minutes to reflect the conventional gasoline fueling experience.	The time between fueling is a user input between 60 seconds (minimum) and 255 seconds (informed by CSA HGV 4.9). The default is set to 255 seconds.
The functional representation of existing and future H2 station configurations in HySCapEl.0 is limited at this point in the development and review process. However, due to the use of the current baseline model by CARB in a "fixed state" for an extended term, and that the model has under-reported capacity during our initial evaluation, we recommend an approach to accommodate this variance. Specifically, we advise to consider a process for LCFS capacity review that provides an option for the applicant to propose a rev¡ew with CARB and NREL that would result in an update to the existing model configuration, or an update that adds a new configuration. The purpose would be to allow the NREL model result to more accurately reflect the applicants unique H2 station design configuration.	Noted

Summary of model fixes based on beta testing	o Fixed delivery algorithm (includes available bank, limit over pressure error o Added user input variable to allow for compression into a high pressure bank that is also being used for fueling; the simplified model keeps mass balanced and it is not optimized for compressor operation in this operation condition like start/stops o Added eligibility to use low pressure for cascade fueling o Fixed production algorithm, which can also be used for a pipeline sourced station, by assigning a high station delivery state of charge trigger (e.g, 90%) and having the low pressure limits the same as the production/pipeline. o Fixed multiple simultaneous fueling positions dispensing algortihm and fueling profile o Fixed limits to low pressure based on minimum compressor suction pressure o Fixed liquid storage algorithm with liquid pump, vaporizer, and compression; where a compressor is not required if station supplies high pressure gas from pump/vaporizer o Updated the plotting and partial fill calculation in an hour o Updated different fueling profiles for beta testing. version 1.0 will use the 24 hour Friday profile o Complete fills are counted throughout the 24 hour period even if there are partial fills during the 24 hour period o The latest beta update is at: https://pfs.nrel.gov/main.html?download&weblink=73525a9aa20573a2ecc2fecc3289271f&realfilename=HySCapE1beta20180802_Installer_web.exe o Next steps - complete the version 1.0 compiled model by 8/6/2018, finalize version 1.0 documentation, and publish the initial validation/sensitivity study
Summary of sample stations and reasons for selecting those scenarios	See "SampleStations" tab for a set of station configurations that are used as beta case studies. The sample station configuraions are based on current and planned stations

	Description	Station Storage [kg]	Total H2 Dispensed [kg]	Storage/ Dispensed	H2 Dispensed to SOC Limit [kg]	H2 Delivered [kg]	H2 Produced [kg]	Time between fills [s]
Scenario 1	Low, medium, and high pressure current station configuration with gas delivery	340	137.76	2.5	103.02	0	0	180
Scenario 2	Low and high pressure, with low eligible for cascade, same bank compress/fill, and gas delivery	908	476.01	1.9	476.01	0	0	180
Scenario 3	Scenario 2 with 2 fueling positions	908	697.61	1.3	440.36	171	0	180
Scenario 4	Low, medium, and high pressure with gas delivery	688	371.68	1.9	295.91	0	0	180
Scenario 5	Medium and high pressure with gas delivery	688	372.46	1.8	296.09	0	0	180
Scenario 6	Liquid storage	1477	476.01	3.1	476.01	0	0	180
Scenario 7	On-site production	174	196.18	0.9	86.58	0	144.75	180
Scenario 8	Pipeline with 2 fueling positions	288	822.07	0.4	690.77	0	793.24	180
Scenario 9	Low, medium, and high pressure current small station configuration with gas delivery	202	131.11	1.5	55.14	0	0	180
Scenario 10	Scenario 9 with low eligible for cascade	202	131.11	1.5	55.14	0	0	180