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Description:	NREL Presentation - Hydrogen Station Capacity Evaluation Tool - Sample Station Calculations by Sam Sprik, Dani Murphy, Taichi Kuroki, Jen Kurtz
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hySCapE Beta comment review station configurations

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

Additional submitted attachment is included below.

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Hydrogen Station Capacity Evaluation Tool – Sample Station Calculations

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August 3, 2018

Sample Station Capacity Beta Testing

- A set of example station configurations used during beta testing
- Sample station configurations based on current and planned stations and comments
- Not all variations (e.g., deliveries, fueling positions) have been included

Sample Station Capacity Calculations – Beta Testing

	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

Scenario 1: Current Station Configuration >300kg

Table 1 Bank parameters

	Eligible for fill [-]	Number of banks [-]	Volume [m3]	Maximum Pressure [MPa]	Minimum Pressure [MPa]
HP Bank	Yes	1	4.16	82	70
MP Bank	No	1	2.03	53	20
LP Bank	No	1	2.88	53	3

Table 2 Compressor parameters

	Number of compressors [-]	Maximum pressure [MPa]	Minimum pressure [MPa]	Maximum flowrate [kg/h]	Efficiency [kWh/kg]
HP Compressor	1	90	20	216	4
MP Compressor	1	40	0.5	25	2

Table 3 Delivery truck parameters

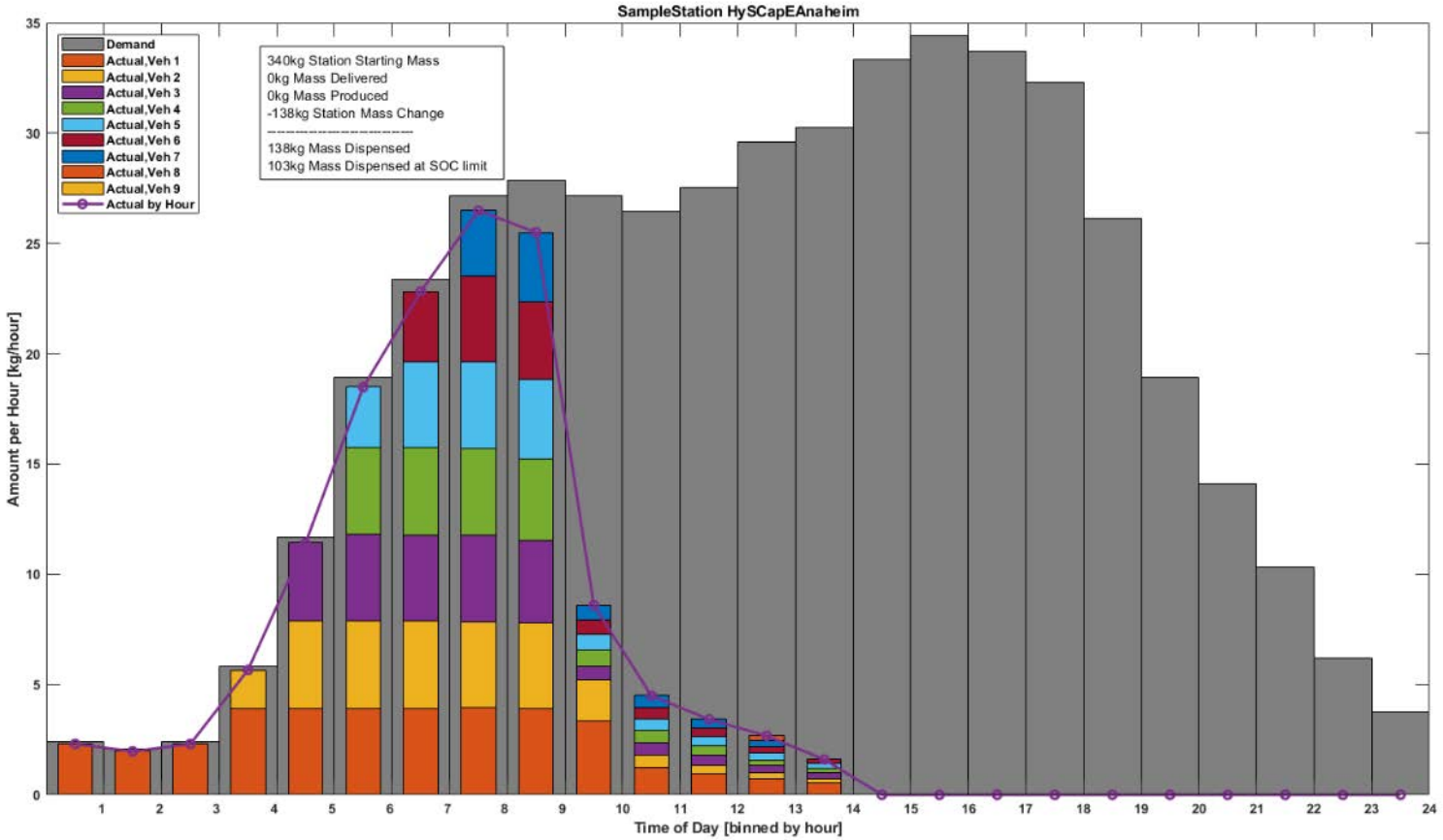
	Delivered H2 [kg]	Number of deliveries [-]	Number of banks [-]	Pressure [MPa]	Flow rate [kg/s]	Dwell time [s]	Fuel type
Delivery truck	108	1	6	45	1	2700	Gaseous

Scenario 1: Input file

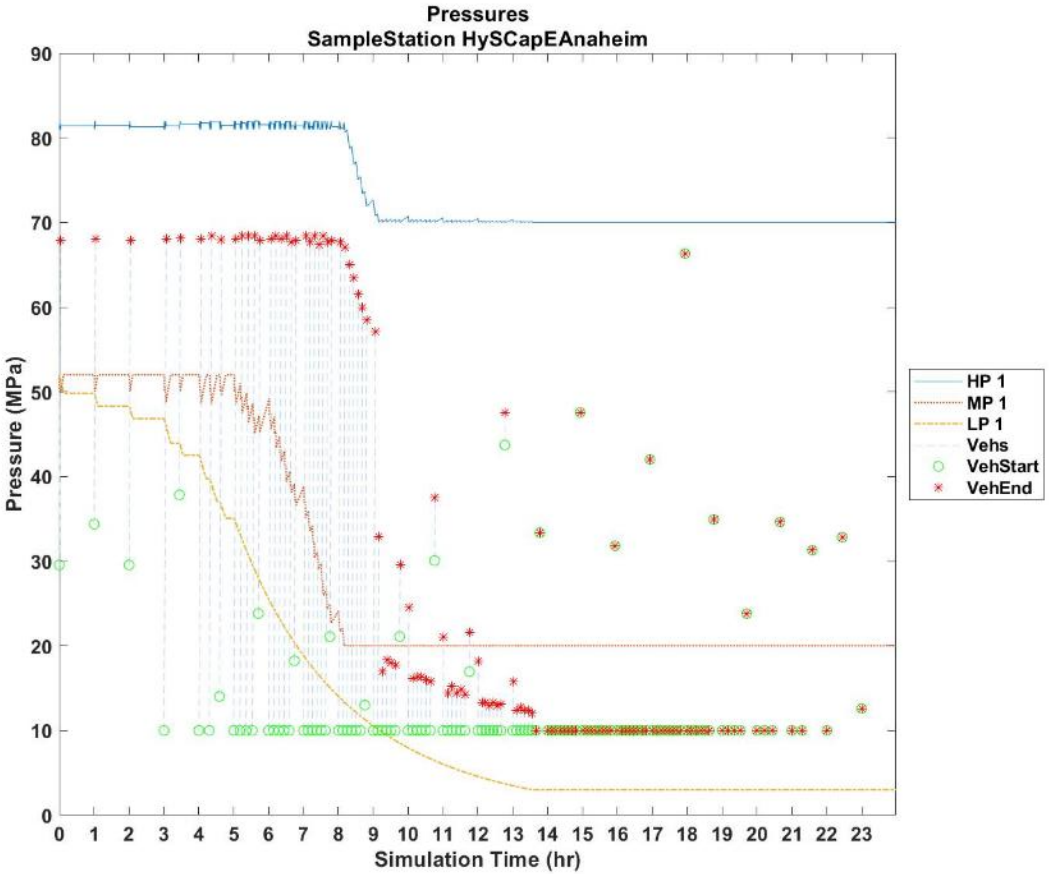
Component	Value	Units	Description
Delivery	1	logical [0,1]	Gas delivery to station
Delivery	0	logical [0,1]	Liquid delivery to station
Production	0	logical [0,1]	On-site production at station
Storage	1	logical [0,1]	High pressure storage at station
Storage	1	logical [0,1]	Medium pressure storage at station
Storage	1	logical [0,1]	Low pressure storage at station
Production	0	%	Storage level trigger for production
Production	0	kWh/kg	Production unit efficiency
Production	0	kg/h	flow/production rate
Production	0	MPa	output max pressure
Storage	4.16	m3	Volume high pressure (HP) bank %HITRF: 0.342925
Storage	2.03	m3	Volume medium pressure (MP) bank %HITRF: 1.3224;
Storage	2.88	m3	Volume low pressure (LP) bank %Default: 2.6108;
Storage	0	m3	Volume of liquid (LQ) bank (22.7125 = 6000 gallons)
Storage	1	#	Number of high prssure banks
Storage	1	#	Number of medium pressure banks
Storage	1	#	Number of low pressure banks
Storage	0	#	Number of liquid banks
Storage	70	Mpa	Minimum HP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Php is less than or equal to 0)
Storage	20	MPa	Minimum MP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Pmp is less than or equal to 0)
Storage	3	MPa	Minimum LP bank pressure
Storage	82	MPa	Maximum HP bank pressure
Storage	53	MPa	Maximum MP bank pressure
Storage	53	MPa	Maximum LP bank pressure
Storage	0	MPa	Vaporizer output pressure (must be greater than MP compressor minimum) (www.linde-engineering.com.hk/internet.le.le.hkg/zt/images/P_3_4_e_10_150dpi227_5776.pdf?v=.)
Storage	1	logical [0,1]	High pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	0	logical [0,1]	Medium pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	0	logical [0,1]	Low pressure bank Eligible for fill, 1=eligible, 0=not eligible

Compressor	1	logical [0,1]	Allow compressor to fill bank which are used for dispensing?, 1=yes, 0=no.
Compressor	1	#	Number of high pressure compressors
Compressor	1	#	Number of medium pressure compressors
Compressor	20	MPa	Minimum High pressure compressor (HPc) pressure
Compressor	0.5	MPa	Minimum Medium pressure compressor (MPc) pressure
Compressor	90	Mpa	Maximum HPc pressure
Compressor	40	Mpa	Maximum MPc pressure
Compressor	216	kg/h	HPc maximum flowrate
Compressor	25	kg/h	MPc maximum flowrate
Compressor	0	kg/h	Liquid pump maximum flowrate
Compressor	0	kg/h	Vaporizer maximum flowrate
Compressor	4	kWh/kg	HPc efficinecy (includes BOP)
Compressor	2	kWh/kg	MPc efficiency (includes BOP)
Chiller	-37	degC	Pre-cooling setpoint
Chiller	1.5	kWh/kg	Pre-cooling efficiency
Chiller	60	kW	fixed Pre-cooling power
Chiller	1800	s	
Dispenser	0.0167	kg/s	Average dispense flow rate (0.0167kg/s = 1 kg/min)
Dispenser	20	degC	Ambient temperature
Dispenser	1	#	Maximum number fueling positions capable of simultaneous fill
Delivery	108	kg	Mass per delivery
Delivery	1	#/day	Number of deliveries per day
Delivery	6	#	Number of banks delivering hydrogen
Delivery	45	MPa	Pressure of delivery truck
Delivery	1	kg/s	Delivery flow rate
Delivery	2700	s	Delivery truck dwell time
Delivery	1	selector [1,2]	Fuel delivery type, 1=gaseous, 2=liquid
Liquid	0	kg/s	Liquid truck delivery rate to storage
Liquid	0	kWh/kg	Liquid pump efficiency (kWh/kg of station capacity) (HRSAM v1.1)
Liquid	0	kWh/kg	Refrigeration efficiency (HRSAM v1.1) (is this more representative as a constant (kW/s) or as specific energy consumption (kW/kg/s)
Liquid	0	kg/day	Boil-off (HRSAM v1.1 for 200kg/day capacity station) (Not wired up yet, consider calculating boil-off based on physical properties)
Liquid	0	kWh/kg	Vaporizer efficiency (HRSAM, Evaporator heated by natural draft so no effect)

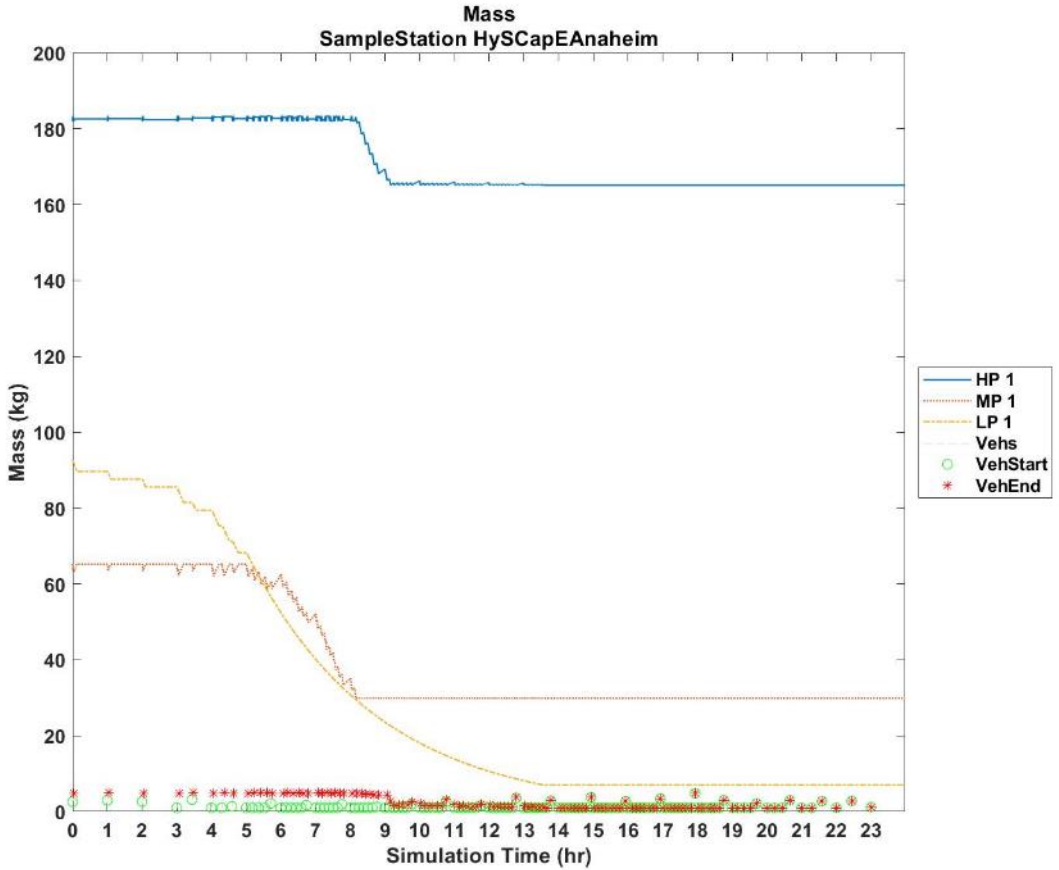
Scenario 1: Capacity Estimate



Scenario 1: Station Pressures



Scenario 1: Station Mass



Scenario 2: Low and High Pressure with Low Eligible for Cascade

Table 1 Bank parameters

	Eligible for fill [-]	Number of banks [-]	Volume [m3]	Maximum Pressure [MPa]	Minimum Pressure [MPa]
HP Bank	Yes	4	0.42	90	45
MP Bank	-	-	-	-	-
LP Bank	Yes	9	3	50	0

Table 2 Compressor parameters

	Number of compressors [-]	Maximum pressure [MPa]	Minimum pressure [MPa]	Maximum flowrate [kg/h]	Efficiency [kWh/kg]
HP Compressor	1	90	5	75	4
MP Compressor	-	-	-	-	-

Table 3 Delivery truck parameters

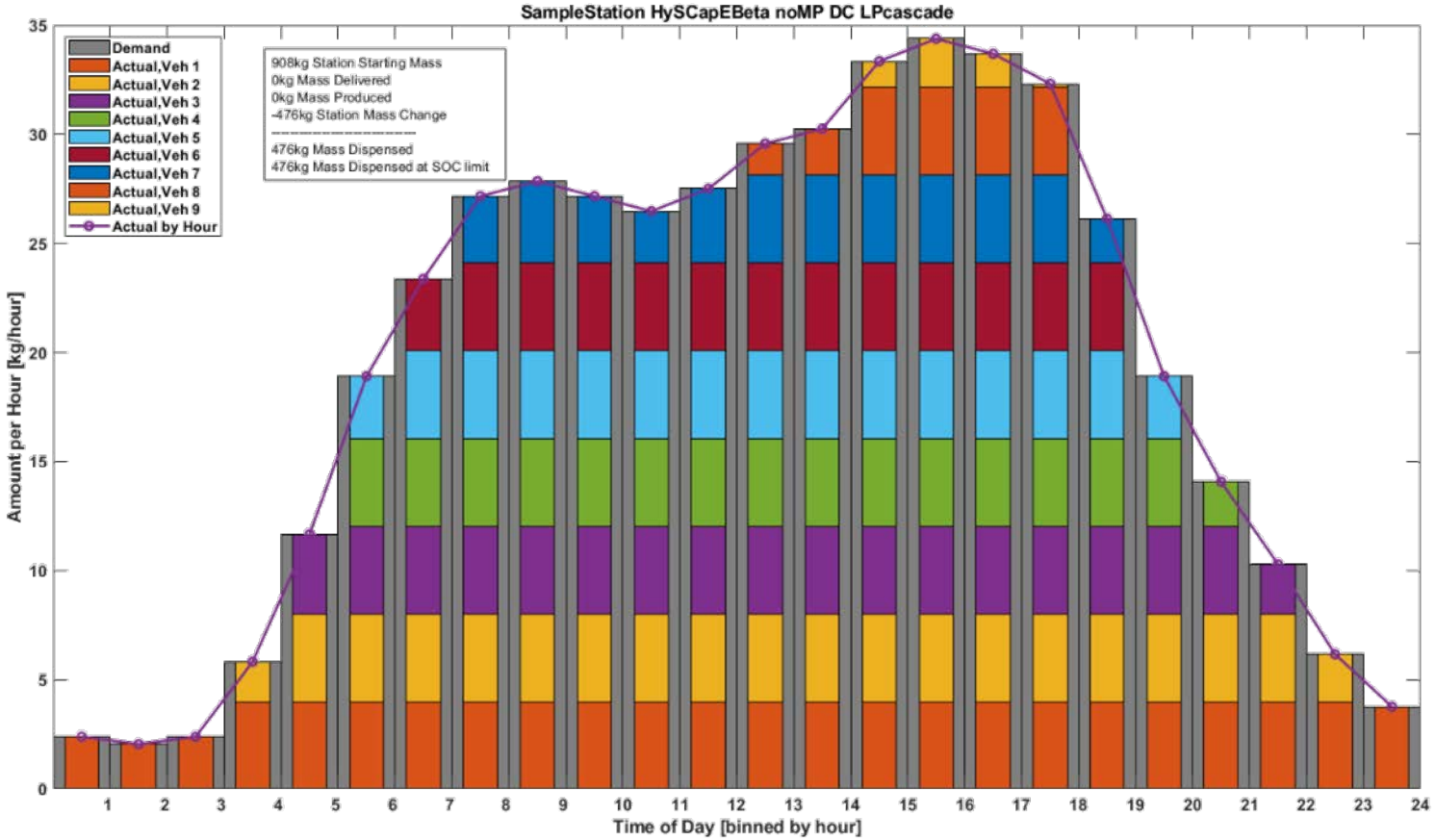
	Delivered H2 [kg]	Number of deliveries [-]	Number of banks [-]	Pressure [MPa]	Flow rate [kg/s]	Dwell time [s]	Fuel type
Delivery truck	300	1	6	35	1	3600	Gaseous

Scenario 2: Input file

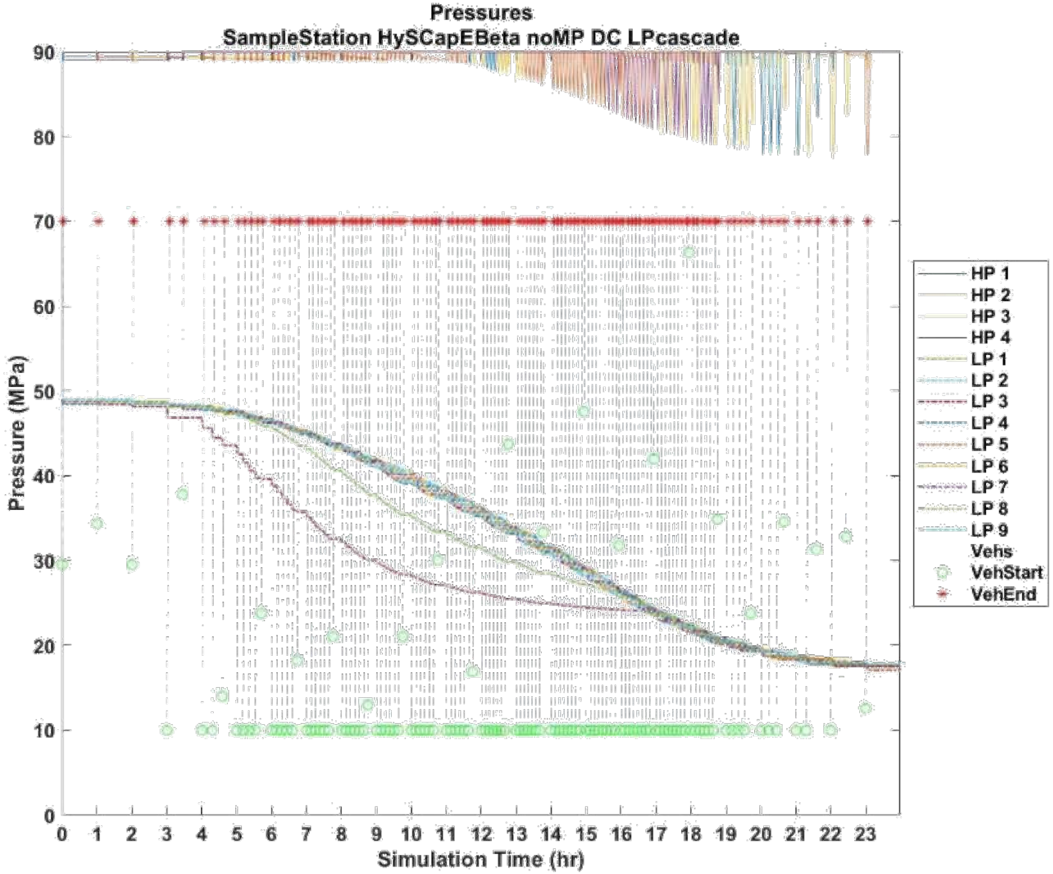
Component	Value	Units	Description
Delivery	1	logical [0,1]	Gas delivery to station
Delivery	0	logical [0,1]	Liquid delivery to station
Production	0	logical [0,1]	On-site production at station
Storage	1	logical [0,1]	High pressure storage at station
Storage	0	logical [0,1]	Medium pressure storage at station
Storage	1	logical [0,1]	Low pressure storage at station
Production	0	%	Storage level trigger for production
Production	0	kWh/kg	Production unit efficiency
Production	0	kg/h	flow/production rate
Production	0	MPa	output max pressure
Storage	0.42	m3	Volume high pressure (HP) bank %HITRF: 0.342925
Storage	0	m3	Volume medium pressure (MP) bank %HITRF: 1.3224;
Storage	3	m3	Volume low pressure (LP) bank %Default: 2.6108;
Storage	0	m3	Volume of liquid (LQ) bank (22.7125 = 6000 gallons)
Storage	4	#	Number of high prssure banks
Storage	0	#	Number of medium pressure banks
Storage	9	#	Number of low pressure banks
Storage	0	#	Number of liquid banks
Storage	45	Mpa	Minimum HP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Php is less than or equal to 0)
Storage	0	MPa	Minimum MP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Pmp is less than or equal to 0)
Storage	0	MPa	Minimum LP bank pressure
Storage	90	MPa	Maximum HP bank pressure
Storage	0	MPa	Maximum MP bank pressure
Storage	50	MPa	Maximum LP bank pressure
Storage	0	MPa	Vaporizer output pressure (must be greater than MP compressor minimum) (www.linde-engineering.com.hk/internet.le.le.hkg/zt/images/P_3_4_e_10_150dpi227_5776.pdf?v=.)
Storage	1	logical [0,1]	High pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	0	logical [0,1]	Medium pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	1	logical [0,1]	Low pressure bank Eligible for fill, 1=eligible, 0=not eligible

Compressor	1	logical [0,1]	Allow compressor to fill bank which are used for dispensing?, 1=yes, 0=no.
Compressor	1	#	Number of high pressure compressors
Compressor	0	#	Number of medium pressure compressors
Compressor	5	MPa	Minimum High pressure compressor (HPc) pressure
Compressor	0	MPa	Minimum Medium pressure compressor (MPc) pressure
Compressor	90	Mpa	Maximum HPc pressure
Compressor	0	Mpa	Maximum MPc pressure
Compressor	75	kg/h	HPc maximum flowrate
Compressor	0	kg/h	MPc maximum flowrate
Compressor	0	kg/h	Liquid pump maximum flowrate
Compressor	0	kg/h	Vaporizer maximum flowrate
Compressor	4	kWh/kg	HPc efficinecy (includes BOP)
Compressor	0	kWh/kg	MPc efficiency (includes BOP)
Chiller	-35	degC	Pre-cooling setpoint
Chiller	1.5	kWh/kg	Pre-cooling efficiency
Chiller	0	kW	fixed Pre-cooling power
Chiller	1800	s	
Dispenser	0.0167	kg/s	Average dispense flow rate (0.0167kg/s = 1 kg/min)
Dispenser	20	degC	Ambient temperature
Dispenser	1	#	Maximum number fueling positions capable of simultaneous fill
Delivery	300	kg	Mass per delivery
Delivery	1	#/day	Number of deliveries per day
Delivery	6	#	Number of banks delivering hydrogen
Delivery	35	MPa	Pressure of delivery truck
Delivery	1	kg/s	Delivery flow rate
Delivery	3600	s	Delivery truck dwell time
Delivery	1	selector [1,2]	Fuel delivery type, 1=gaseous, 2=liquid
Liquid	0	kg/s	Liquid truck delivery rate to storage
Liquid	0	kWh/kg	Liquid pump efficiency (kWh/kg of station capacity) (HRSAM v1.1)
Liquid	0	kWh/kg	Refrigeration efficiency (HRSAM v1.1) (is this more representative as a constant (kW/s) or as specific energy consumption (kW/kg/s)
Liquid	0	kg/day	Boil-off (HRSAM v1.1 for 200kg/day capacity station) (Not wired up yet, consider calculating boil-off based on physical properties)
Liquid	0	kWh/kg	Vaporizer efficiency (HRSAM, Evaporator heated by natural draft so no effect)

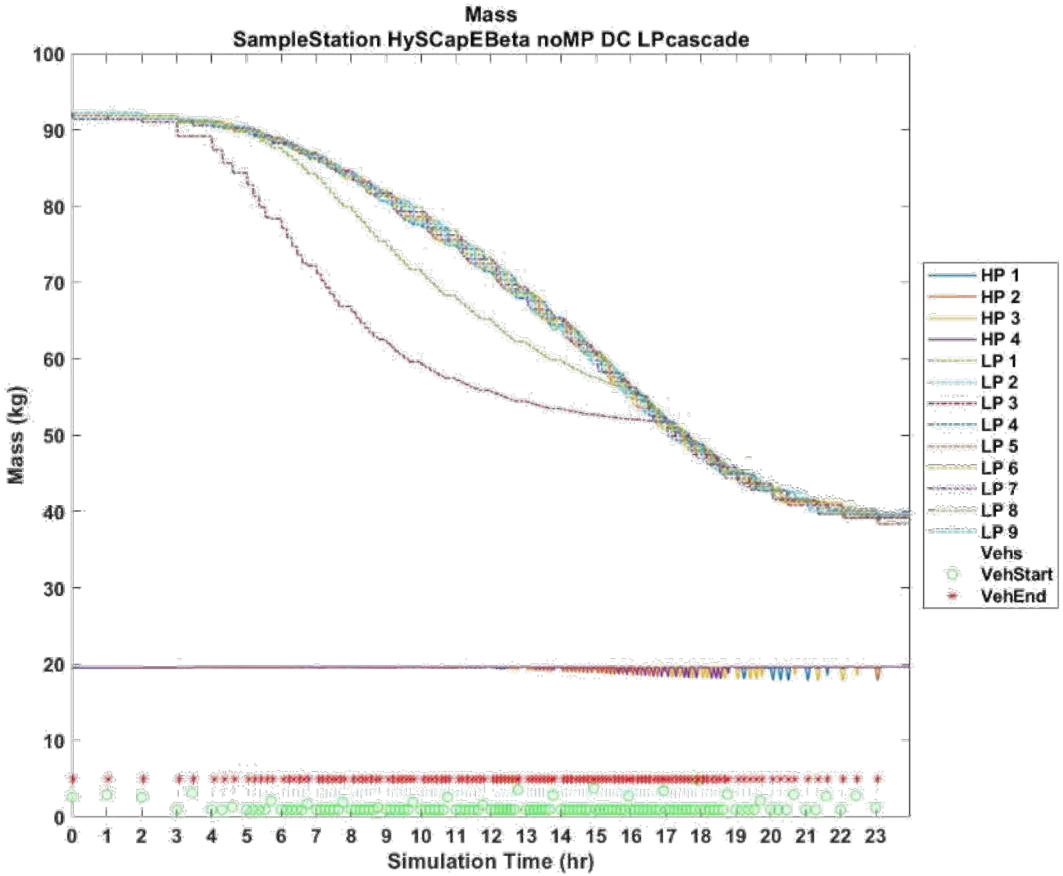
Scenario 2: Capacity Estimate



Scenario 2: Station Pressures



Scenario 2: Station Mass



Scenario 3: Scenario 2 with 2 Fueling Positions

Table 1 Bank parameters

	Eligible for fill [-]	Number of banks [-]	Volume [m3]	Maximum Pressure [MPa]	Minimum Pressure [MPa]
HP Bank	Yes	4	0.42	90	45
MP Bank	-	-	-	-	-
LP Bank	Yes	9	3	50	0

Table 2 Compressor parameters

	Number of compressors [-]	Maximum pressure [MPa]	Minimum pressure [MPa]	Maximum flowrate [kg/h]	Efficiency [kWh/kg]
HP Compressor	1	90	5	75	4
MP Compressor	-	-	-	-	-

Table 3 Delivery truck parameters

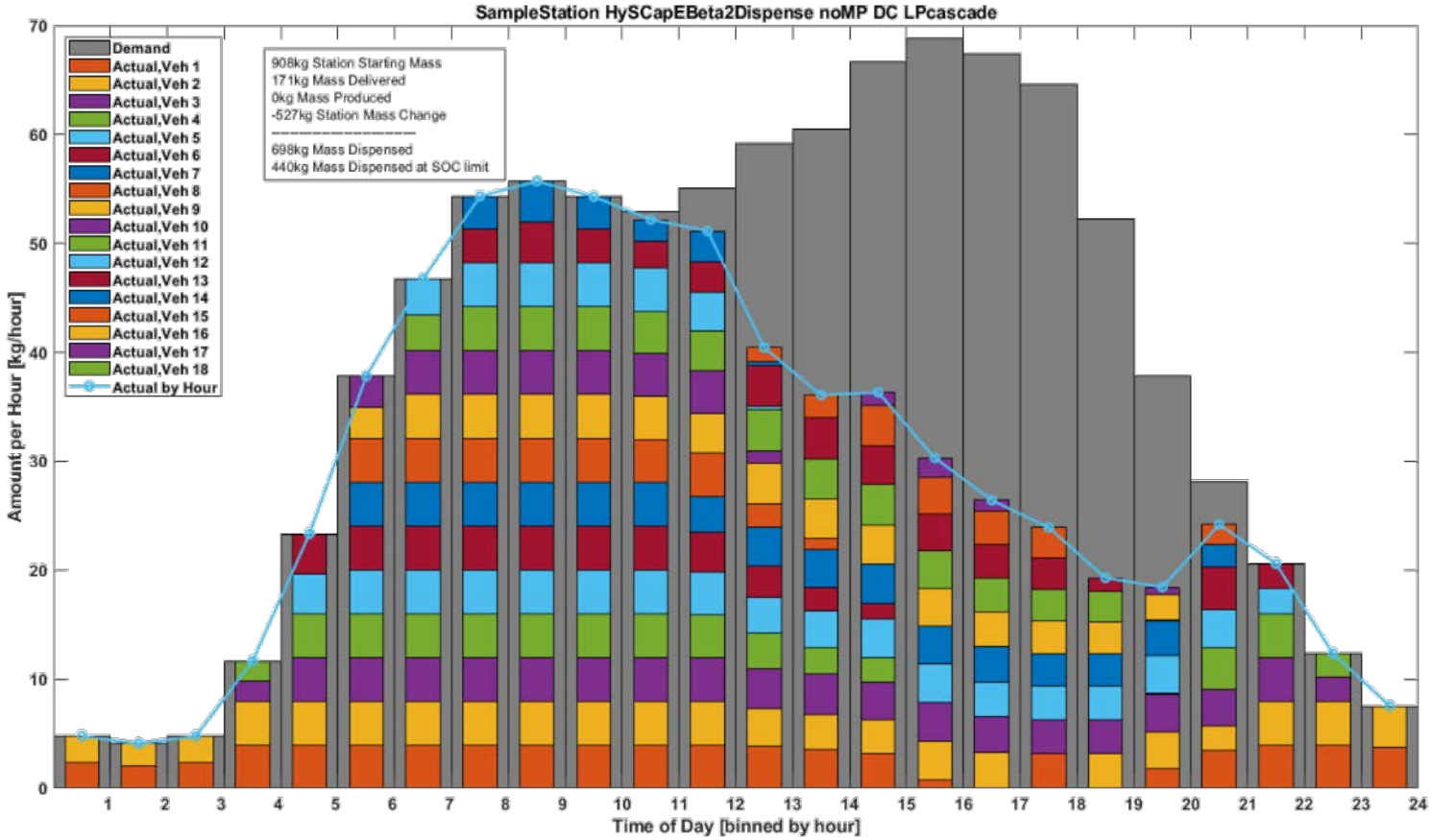
	Delivered H2 [kg]	Number of deliveries [-]	Number of banks [-]	Pressure [MPa]	Flow rate [kg/s]	Dwell time [s]	Fuel type
Delivery truck	300	1	6	35	1	3600	Gaseous

Scenario 3: Input file

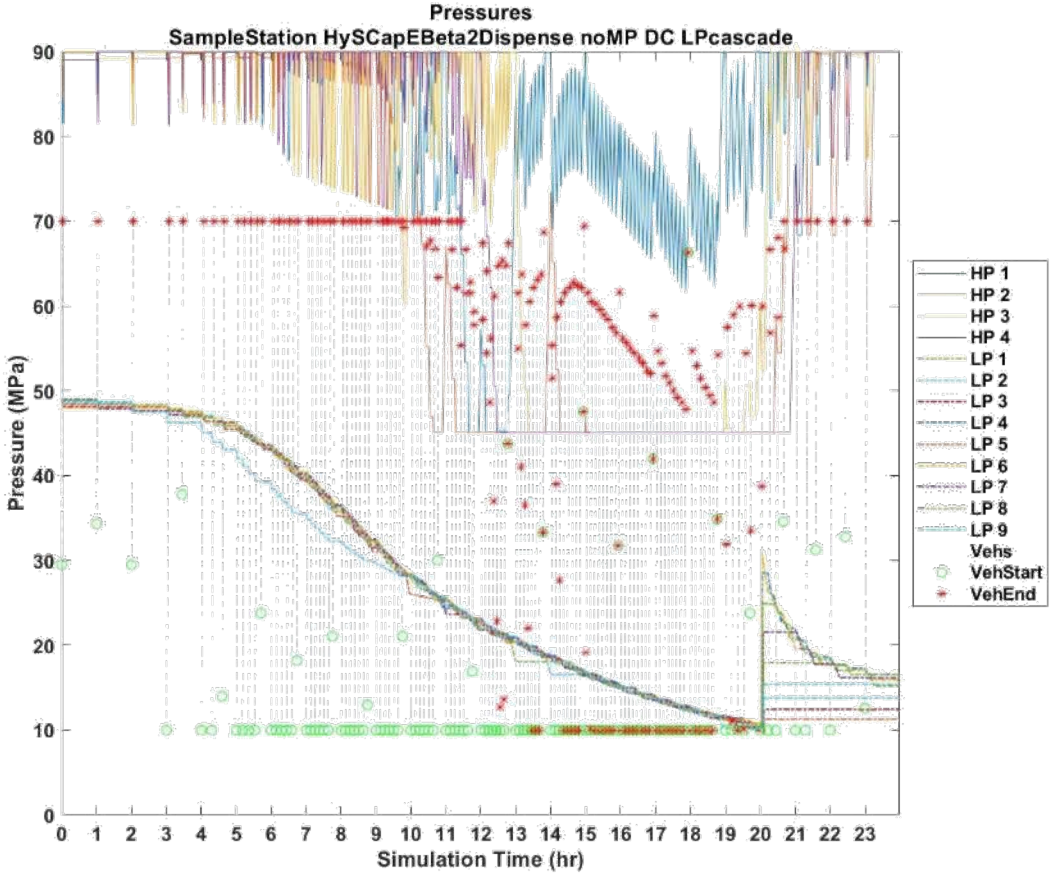
Component	Value	Units	Description
Delivery	1	logical [0,1]	Gas delivery to station
Delivery	0	logical [0,1]	Liquid delivery to station
Production	0	logical [0,1]	On-site production at station
Storage	1	logical [0,1]	High pressure storage at station
Storage	0	logical [0,1]	Medium pressure storage at station
Storage	1	logical [0,1]	Low pressure storage at station
Production	0	%	Storage level trigger for production
Production	0	kWh/kg	Production unit efficiency
Production	0	kg/h	flow/production rate
Production	0	MPa	output max pressure
Storage	0.42	m3	Volume high pressure (HP) bank %HITRF: 0.342925
Storage	0	m3	Volume medium pressure (MP) bank %HITRF: 1.3224;
Storage	3	m3	Volume low pressure (LP) bank %Default: 2.6108;
Storage	0	m3	Volume of liquid (LQ) bank (22.7125 = 6000 gallons)
Storage	4	#	Number of high prssure banks
Storage	0	#	Number of medium pressure banks
Storage	9	#	Number of low pressure banks
Storage	0	#	Number of liquid banks
Storage	45	Mpa	Minimum HP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Php is less than or equal to 0)
Storage	0	MPa	Minimum MP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Pmp is less than or equal to 0)
Storage	0	MPa	Minimum LP bank pressure
Storage	90	MPa	Maximum HP bank pressure
Storage	0	MPa	Maximum MP bank pressure
Storage	50	MPa	Maximum LP bank pressure
Storage	0	MPa	Vaporizer output pressure (must be greater than MP compressor minimum) (www.linde-engineering.com.hk/internet.le.le.hkg/zt/images/P_3_4_e_10_150dpi227_5776.pdf?v=.)
Storage	1	logical [0,1]	High pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	0	logical [0,1]	Medium pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	1	logical [0,1]	Low pressure bank Eligible for fill, 1=eligible, 0=not eligible

Compressor	1	logical [0,1]	Allow compressor to fill bank which are used for dispensing?, 1=yes, 0=no.
Compressor	1	#	Number of high pressure compressors
Compressor	0	#	Number of medium pressure compressors
Compressor	5	MPa	Minimum High pressure compressor (HPc) pressure
Compressor	0	MPa	Minimum Medium pressure compressor (MPc) pressure
Compressor	90	Mpa	Maximum HPc pressure
Compressor	0	Mpa	Maximum MPc pressure
Compressor	75	kg/h	HPc maximum flowrate
Compressor	0	kg/h	MPc maximum flowrate
Compressor	0	kg/h	Liquid pump maximum flowrate
Compressor	0	kg/h	Vaporizer maximum flowrate
Compressor	4	kWh/kg	HPc efficinecy (includes BOP)
Compressor	0	kWh/kg	MPc efficiency (includes BOP)
Chiller	-35	degC	Pre-cooling setpoint
Chiller	1.5	kWh/kg	Pre-cooling efficiency
Chiller	0	kW	fixed Pre-cooling power
Chiller	1800	s	
Dispenser	0.0167	kg/s	Average dispense flow rate (0.0167kg/s = 1 kg/min)
Dispenser	20	degC	Ambient temperature
Dispenser	2	#	Maximum number fueling positions capable of simultaneous fill
Delivery	300	kg	Mass per delivery
Delivery	1	#/day	Number of deliveries per day
Delivery	6	#	Number of banks delivering hydrogen
Delivery	35	MPa	Pressure of delivery truck
Delivery	1	kg/s	Delivery flow rate
Delivery	3600	s	Delivery truck dwell time
Delivery	1	selector [1,2]	Fuel delivery type, 1=gaseous, 2=liquid
Liquid	0	kg/s	Liquid truck delivery rate to storage
Liquid	0	kWh/kg	Liquid pump efficiency (kWh/kg of station capacity) (HRSAM v1.1)
Liquid	0	kWh/kg	Refrigeration efficiency (HRSAM v1.1) (is this more representative as a constant (kW/s) or as specific energy consumption (kW/kg/s)
Liquid	0	kg/day	Boil-off (HRSAM v1.1 for 200kg/day capacity station) (Not wired up yet, consider calculating boil-off based on physical properties)
Liquid	0	kWh/kg	Vaporizer efficiency (HRSAM, Evaporator heated by natural draft so no effect)

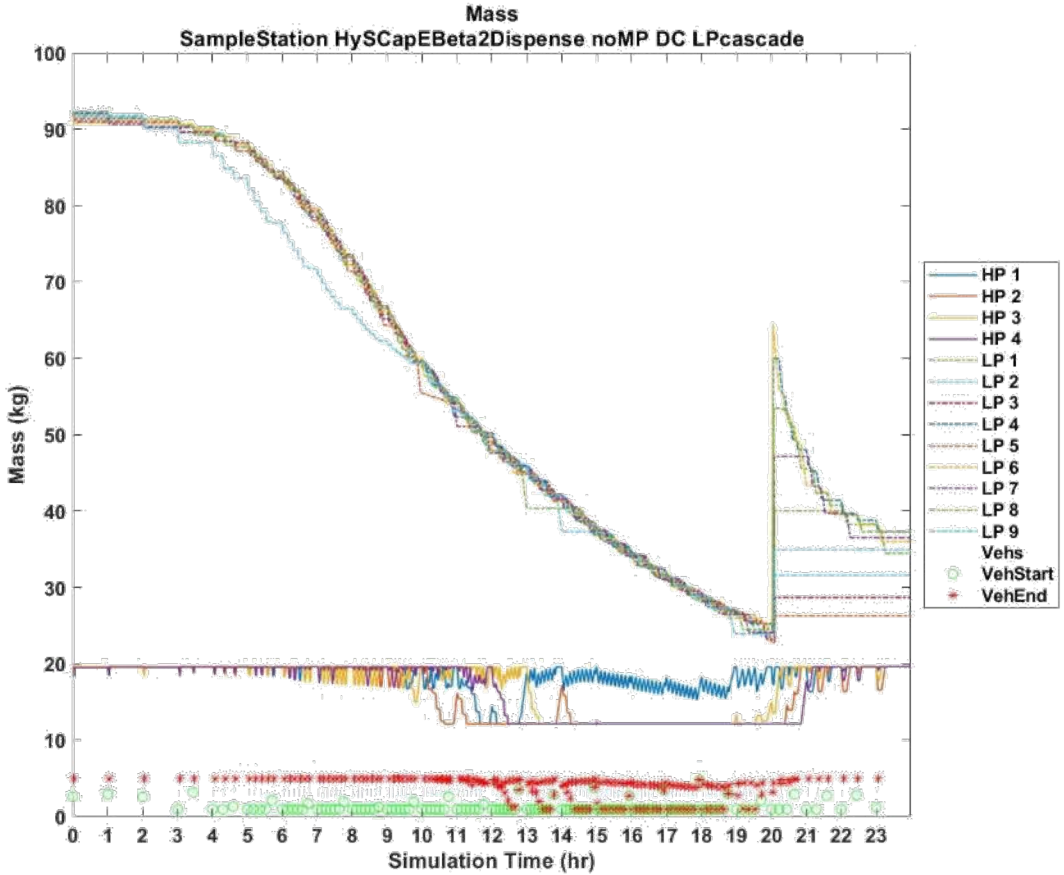
Scenario 3: Capacity Estimate



Scenario 3: Station Pressures



Scenario 3: Station Mass



Scenario 4: Low, Medium, and High Pressure with Gas Delivery

Table 1 Bank parameters

	Eligible for fill [-]	Number of banks [-]	Volume [m3]	Maximum Pressure [MPa]	Minimum Pressure [MPa]
HP Bank	Yes	12	0.33	90	45
MP Bank	Yes	6	1	41	0
LP Bank	Yes	8	2.6	24	0

Table 2 Compressor parameters

	Number of compressors [-]	Maximum pressure [MPa]	Minimum pressure [MPa]	Maximum flowrate [kg/h]	Efficiency [kWh/kg]
HP Compressor	1	93	20	30	4
MP Compressor	1	42	0.5	20	2

Table 3 Delivery truck parameters

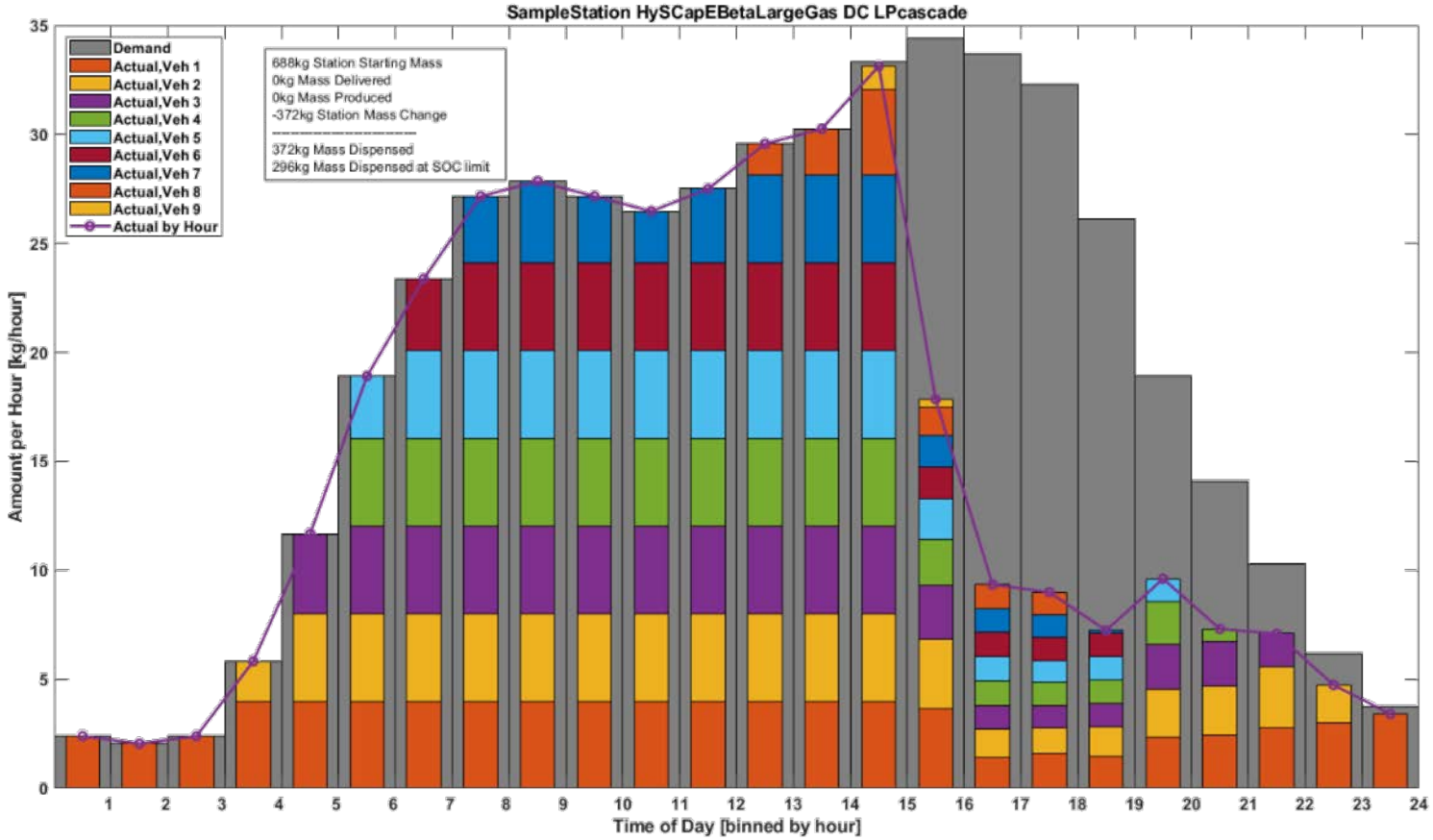
	Delivered H2 [kg]	Number of deliveries [-]	Number of banks [-]	Pressure [MPa]	Flow rate [kg/s]	Dwell time [s]	Fuel type
Delivery truck	200	1	6	35	1	3600	Gaseous

Scenario 4: Input file

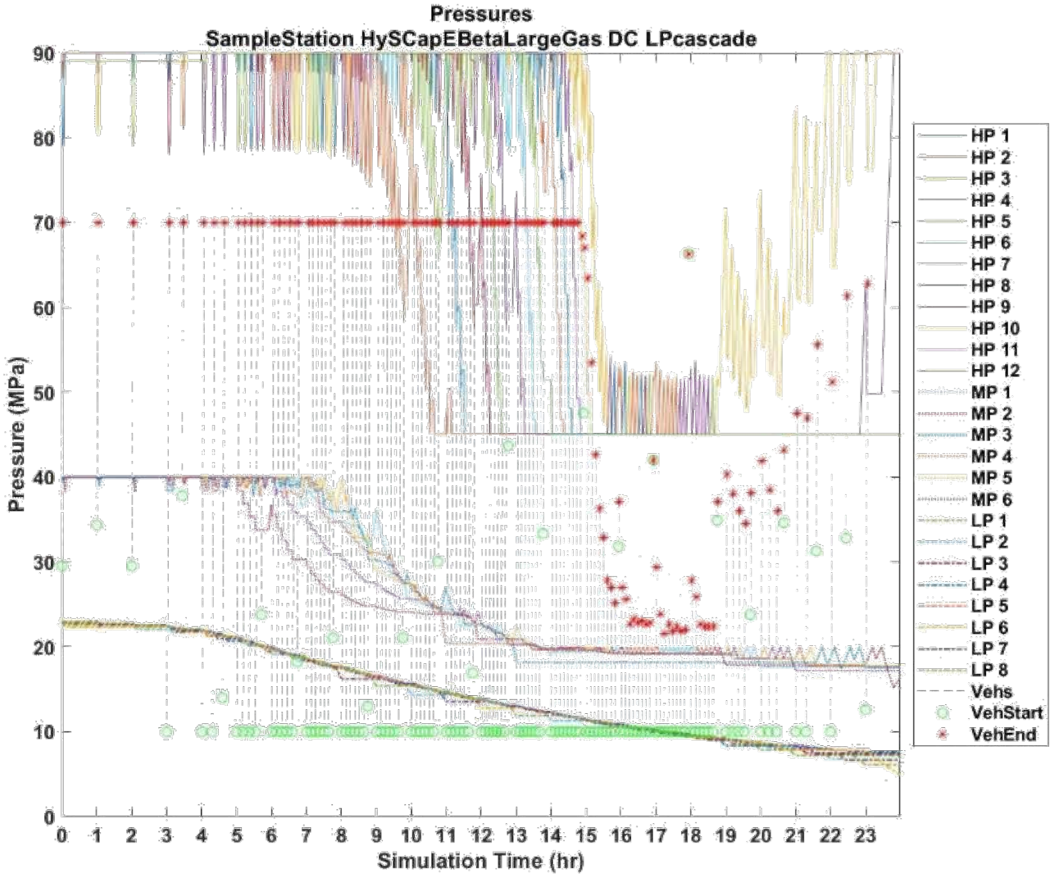
Component	Value	Units	Description
Delivery	1	logical [0,1]	Gas delivery to station
Delivery	0	logical [0,1]	Liquid delivery to station
Production	0	logical [0,1]	On-site production at station
Storage	1	logical [0,1]	High pressure storage at station
Storage	1	logical [0,1]	Medium pressure storage at station
Storage	1	logical [0,1]	Low pressure storage at station
Production	0	%	Storage level trigger for production
Production	0	kWh/kg	Production unit efficiency
Production	0	kg/h	flow/production rate
Production	0	MPa	output max pressure
Storage	0.33	m3	Volume high pressure (HP) bank %HITRF: 0.342925
Storage	1	m3	Volume medium pressure (MP) bank %HITRF: 1.3224;
Storage	2.6	m3	Volume low pressure (LP) bank %Default: 2.6108;
Storage	0	m3	Volume of liquid (LQ) bank (22.7125 = 6000 gallons)
Storage	12	#	Number of high prssure banks
Storage	6	#	Number of medium pressure banks
Storage	8	#	Number of low pressure banks
Storage	0	#	Number of liquid banks
Storage	45	Mpa	Minimum HP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Php is less than or equal to 0)
Storage	0	MPa	Minimum MP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Pmp is less than or equal to 0)
Storage	0	MPa	Minimum LP bank pressure
Storage	90	MPa	Maximum HP bank pressure
Storage	41	MPa	Maximum MP bank pressure
Storage	24	MPa	Maximum LP bank pressure
Storage	0	MPa	Vaporizer output pressure (must be greater than MP compressor minimum) (www.linde-engineering.com.hk/internet.le.le.hkg/zt/images/P_3_4_e_10_150dpi227_5776.pdf?v=.)
Storage	1	logical [0,1]	High pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	1	logical [0,1]	Medium pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	1	logical [0,1]	Low pressure bank Eligible for fill, 1=eligible, 0=not eligible

Compressor	1	logical [0,1]	Allow compressor to fill bank which are used for dispensing?, 1=yes, 0=no.
Compressor	1	#	Number of high pressure compressors
Compressor	1	#	Number of medium pressure compressors
Compressor	20	MPa	Minimum High pressure compressor (HPc) pressure
Compressor	0.5	MPa	Minimum Medium pressure compressor (MPc) pressure
Compressor	93	Mpa	Maximum HPc pressure
Compressor	42	Mpa	Maximum MPc pressure
Compressor	30	kg/h	HPc maximum flowrate
Compressor	20	kg/h	MPc maximum flowrate
Compressor	0	kg/h	Liquid pump maximum flowrate
Compressor	0	kg/h	Vaporizer maximum flowrate
Compressor	4	kWh/kg	HPc efficinecy (includes BOP)
Compressor	2	kWh/kg	MPc efficiency (includes BOP)
Chiller	-35	degC	Pre-cooling setpoint
Chiller	1.5	kWh/kg	Pre-cooling efficiency
Chiller	0	kW	fixed Pre-cooling power
Chiller	1800	s	
Dispenser	0.0167	kg/s	Average dispense flow rate (0.0167kg/s = 1 kg/min)
Dispenser	20	degC	Ambient temperature
Dispenser	1	#	Maximum number fueling positions capable of simultaneous fill
Delivery	200	kg	Mass per delivery
Delivery	1	#/day	Number of deliveries per day
Delivery	6	#	Number of banks delivering hydrogen
Delivery	35	MPa	Pressure of delivery truck
Delivery	1	kg/s	Delivery flow rate
Delivery	3600	s	Delivery truck dwell time
Delivery	1	selector [1,2]	Fuel delivery type, 1=gaseous, 2=liquid
Liquid	0	kg/s	Liquid truck delivery rate to storage
Liquid	0	kWh/kg	Liquid pump efficiency (kWh/kg of station capacity) (HRSAM v1.1)
Liquid	0	kWh/kg	Refrigeration efficiency (HRSAM v1.1) (is this more representative as a constant (kW/s) or as specific energy consumption (kW/kg/s)
Liquid	0	kg/day	Boil-off (HRSAM v1.1 for 200kg/day capacity station) (Not wired up yet, consider calculating boil-off based on physical properties)
Liquid	0	kWh/kg	Vaporizer efficiency (HRSAM, Evaporator heated by natural draft so no effect)

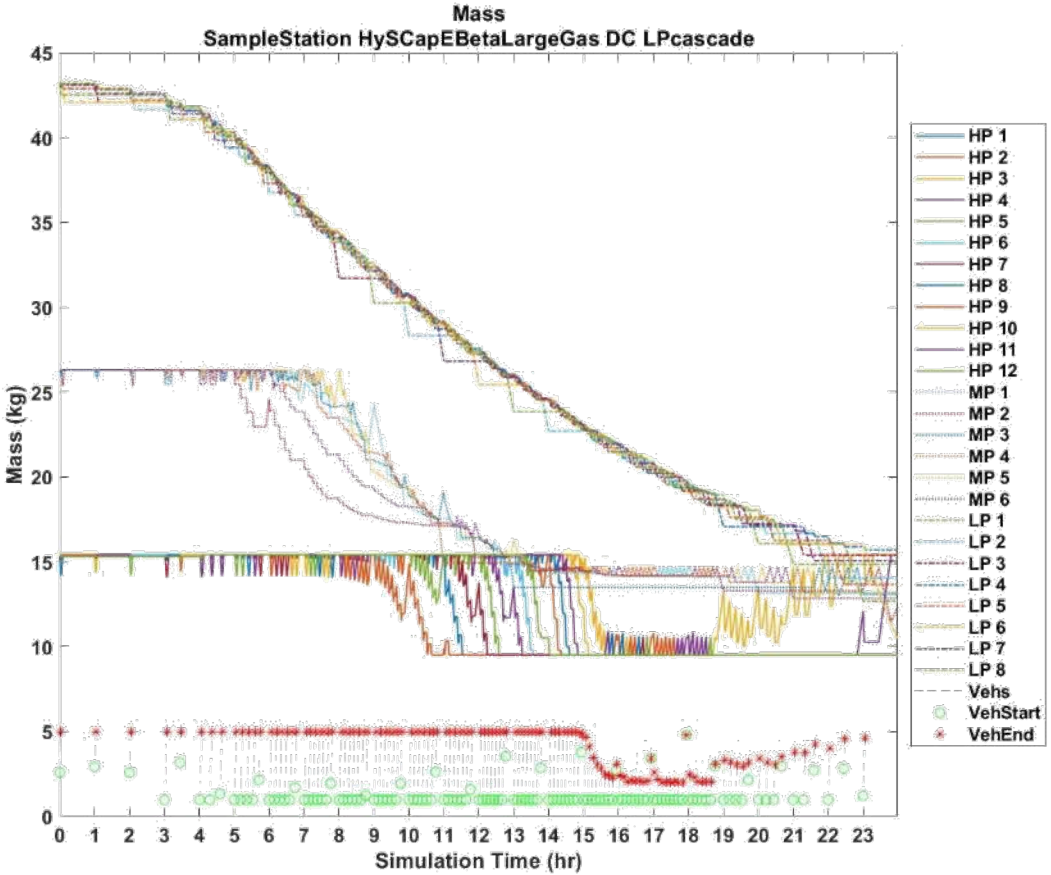
Scenario 4: Capacity Estimate



Scenario 4: Station Pressures



Scenario 4: Station Mass



Scenario 5: Medium and High Pressure with Gas Delivery

Table 1 Bank parameters

	Eligible for fill [-]	Number of banks [-]	Volume [m3]	Maximum Pressure [MPa]	Minimum Pressure [MPa]
HP Bank	Yes	12	0.33	90	45
MP Bank	Yes	6	1	41	0
LP Bank	No	8	2.6	24	0

Table 2 Compressor parameters

	Number of compressors [-]	Maximum pressure [MPa]	Minimum pressure [MPa]	Maximum flowrate [kg/h]	Efficiency [kWh/kg]
HP Compressor	-	-	-	-	-
MP Compressor	-	-	-	-	-

Table 3 Delivery truck parameters

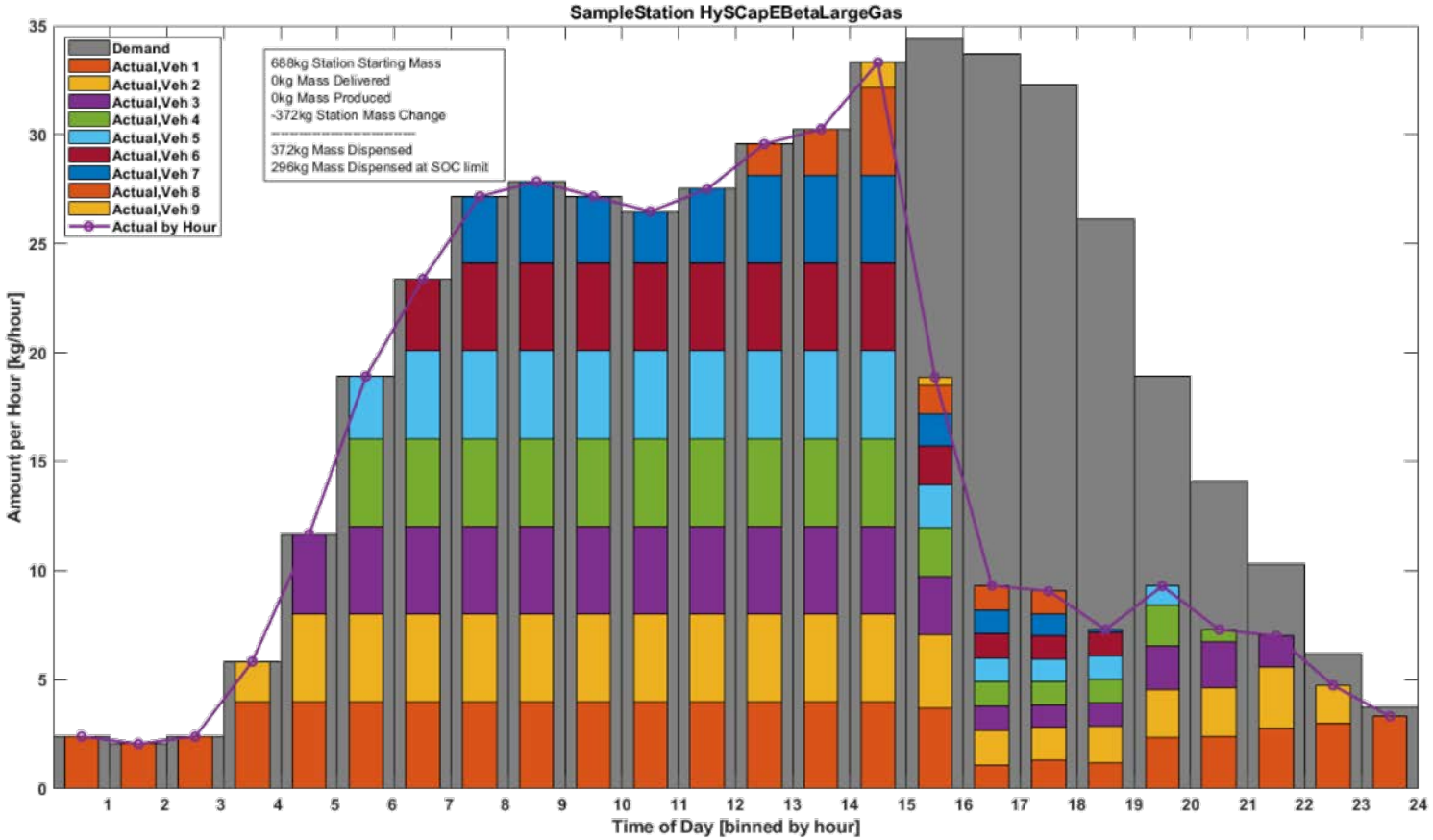
	Delivered H2 [kg]	Number of deliveries [-]	Number of banks [-]	Pressure [MPa]	Flow rate [kg/s]	Dwell time [s]	Fuel type
Delivery truck	200	1	6	35	1	3600	Gaseous

Scenario 5: Input file

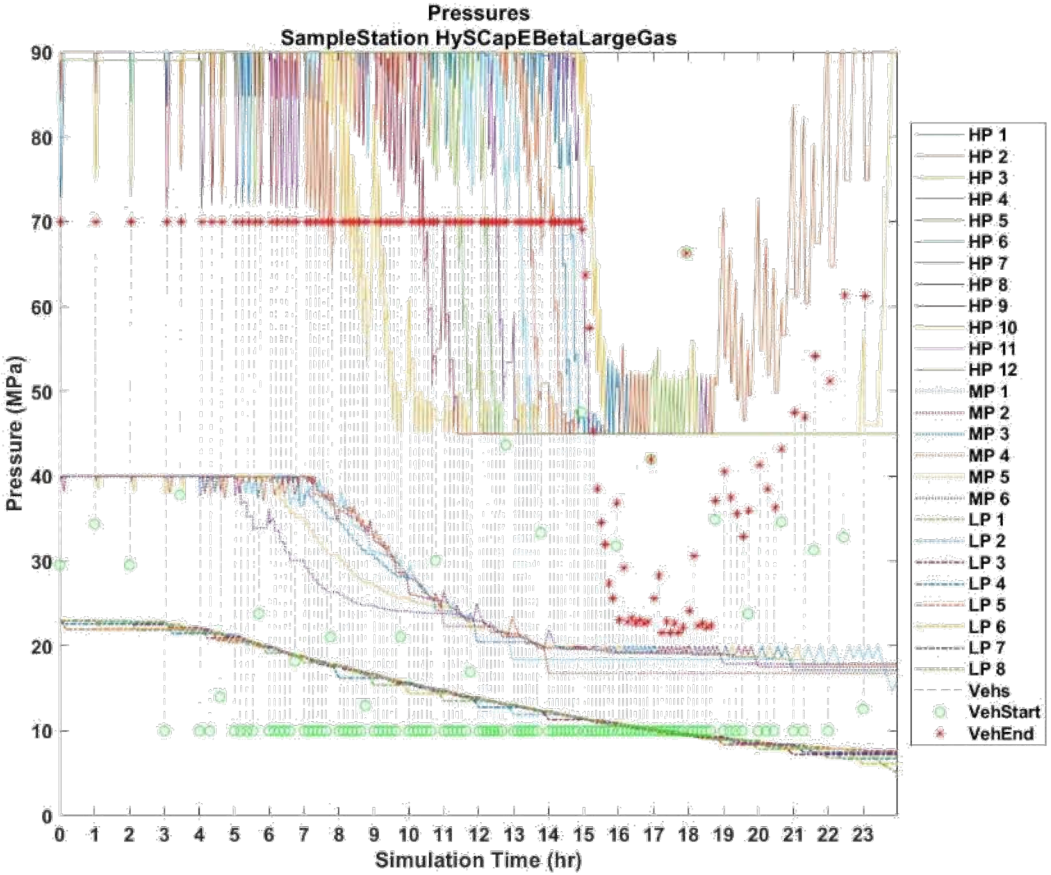
Component	Value	Units	Description
Delivery	1	logical [0,1]	Gas delivery to station
Delivery	0	logical [0,1]	Liquid delivery to station
Production	0	logical [0,1]	On-site production at station
Storage	1	logical [0,1]	High pressure storage at station
Storage	1	logical [0,1]	Medium pressure storage at station
Storage	1	logical [0,1]	Low pressure storage at station
Production	0	%	Storage level trigger for production
Production	0	kWh/kg	Production unit efficiency
Production	0	kg/h	flow/production rate
Production	0	MPa	output max pressure
Storage	0.33	m3	Volume high pressure (HP) bank %HITRF: 0.342925
Storage	1	m3	Volume medium pressure (MP) bank %HITRF: 1.3224;
Storage	2.6	m3	Volume low pressure (LP) bank %Default: 2.6108;
Storage	0	m3	Volume of liquid (LQ) bank (22.7125 = 6000 gallons)
Storage	12	#	Number of high prssure banks
Storage	6	#	Number of medium pressure banks
Storage	8	#	Number of low pressure banks
Storage	0	#	Number of liquid banks
Storage	45	Mpa	Minimum HP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Php is less than or equal to 0)
Storage	0	MPa	Minimum MP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Pmp is less than or equal to 0)
Storage	0	MPa	Minimum LP bank pressure
Storage	90	MPa	Maximum HP bank pressure
Storage	41	MPa	Maximum MP bank pressure
Storage	24	MPa	Maximum LP bank pressure
Storage	0	MPa	Vaporizer output pressure (must be greater than MP compressor minimum) (www.linde-engineering.com.hk/internet.le.le.hkg/zt/images/P_3_4_e_10_150dpi227_5776.pdf?v=.)
Storage	1	logical [0,1]	High pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	1	logical [0,1]	Medium pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	0	logical [0,1]	Low pressure bank Eligible for fill, 1=eligible, 0=not eligible

Compressor	0	logical [0,1]	Allow compressor to fill bank which are used for dispensing?, 1=yes, 0=no.
Compressor	1	#	Number of high pressure compressors
Compressor	1	#	Number of medium pressure compressors
Compressor	20	MPa	Minimum High pressure compressor (HPc) pressure
Compressor	0.5	MPa	Minimum Medium pressure compressor (MPc) pressure
Compressor	93	Mpa	Maximum HPc pressure
Compressor	42	Mpa	Maximum MPc pressure
Compressor	30	kg/h	HPc maximum flowrate
Compressor	20	kg/h	MPc maximum flowrate
Compressor	0	kg/h	Liquid pump maximum flowrate
Compressor	0	kg/h	Vaporizer maximum flowrate
Compressor	4	kWh/kg	HPc efficinecy (includes BOP)
Compressor	2	kWh/kg	MPc efficiency (includes BOP)
Chiller	-35	degC	Pre-cooling setpoint
Chiller	1.5	kWh/kg	Pre-cooling efficiency
Chiller	0	kW	fixed Pre-cooling power
Chiller	1800	s	
Dispenser	0.0167	kg/s	Average dispense flow rate (0.0167kg/s = 1 kg/min)
Dispenser	20	degC	Ambient temperature
Dispenser	1	#	Maximum number fueling positions capable of simultaneous fill
Delivery	200	kg	Mass per delivery
Delivery	1	#/day	Number of deliveries per day
Delivery	6	#	Number of banks delivering hydrogen
Delivery	35	MPa	Pressure of delivery truck
Delivery	1	kg/s	Delivery flow rate
Delivery	3600	s	Delivery truck dwell time
Delivery	1	selector [1,2]	Fuel delivery type, 1=gaseous, 2=liquid
Liquid	0	kg/s	Liquid truck delivery rate to storage
Liquid	0	kWh/kg	Liquid pump efficiency (kWh/kg of station capacity) (HRSAM v1.1)
Liquid	0	kWh/kg	Refrigeration efficiency (HRSAM v1.1) (is this more representative as a constant (kW/s) or as specific energy consumption (kW/kg/s)
Liquid	0	kg/day	Boil-off (HRSAM v1.1 for 200kg/day capacity station) (Not wired up yet, consider calculating boil-off based on physical properties)
Liquid	0	kWh/kg	Vaporizer efficiency (HRSAM, Evaporator heated by natural draft so no effect)

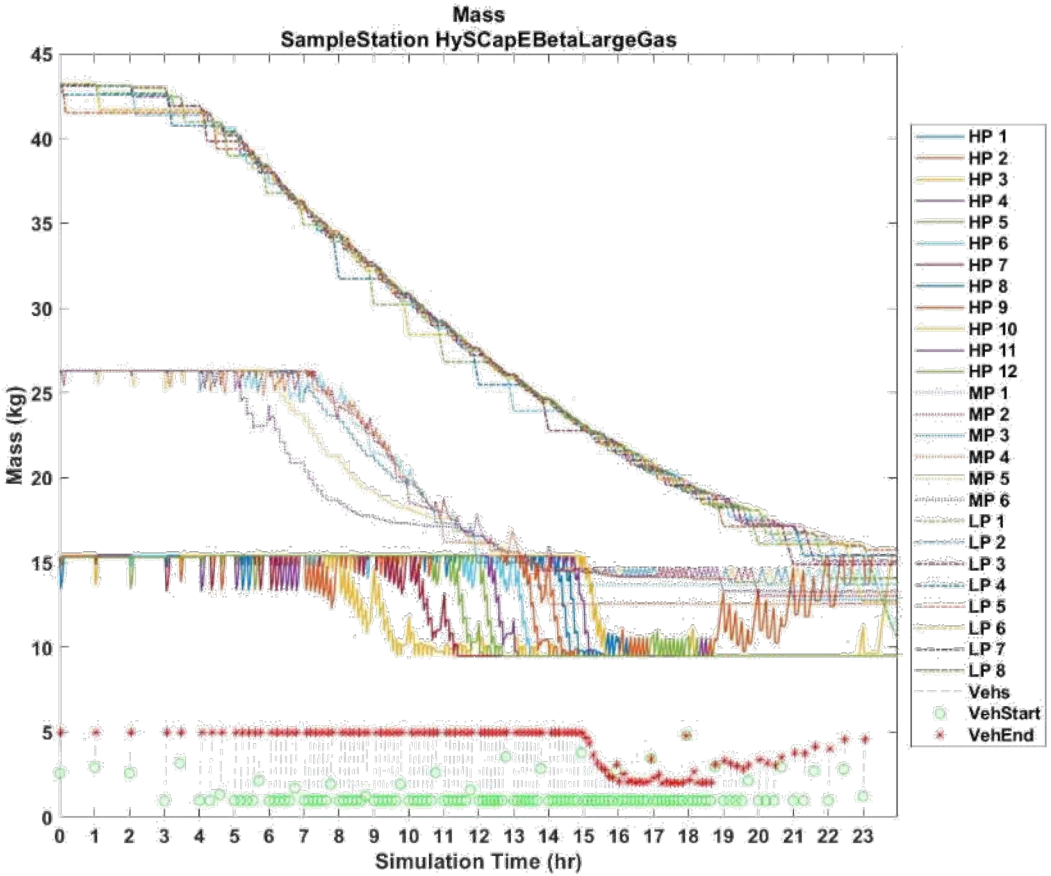
Scenario 5: Capacity Estimate



Scenario 5: Station Pressures



Scenario 5: Station Mass



Scenario 6: Liquid Storage

Table 1 Bank parameters

	Eligible for fill [-]	Number of banks [-]	Volume [m3]	Maximum Pressure [MPa]	Minimum Pressure [MPa]	Vaporizer outlet pressure [MPa]
HP Bank	Yes	4	0.33	90	45	-
MP Bank	-	-	-	-	-	-
LP Bank	-	-	-	-	-	-
LQ Bank	-	1	20	-	-	0.92

Table 2 Compressor parameters

	Number of compressors [-]	Maximum pressure [MPa]	Minimum pressure [MPa]	Maximum flowrate [kg/h]	Efficiency [kWh/kg]	Vaporizer maximum flow rate [kg/h]
HP Compressor	1	93	20	25	4	100
MP Compressor	-	-	-	-	-	-

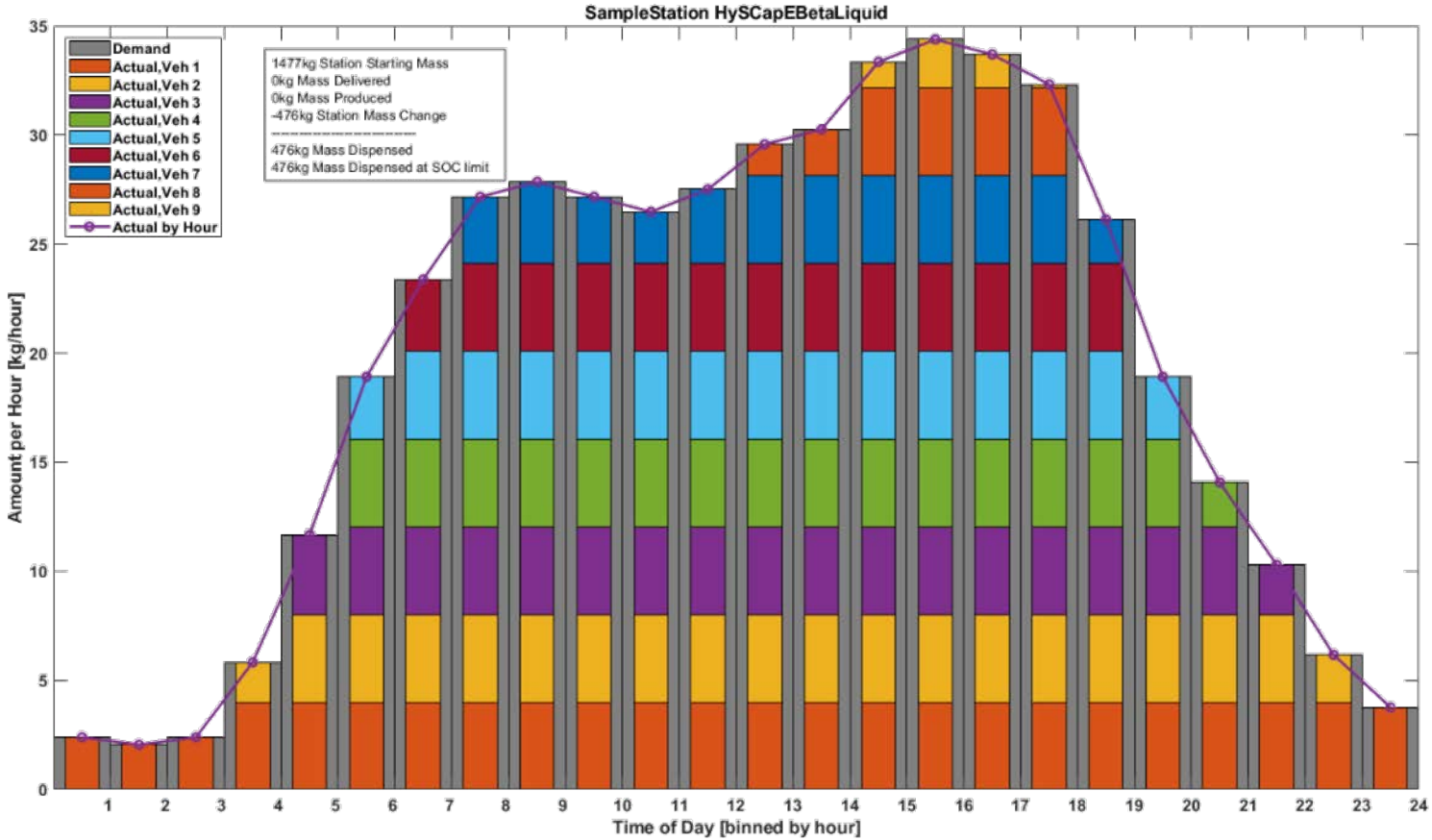
Table 3 LQ Delivery truck parameters

	Delivery rate [kg/s]	Pump efficiency [kWh/kg]	Refrigeration efficiency [-]	Boil-off [kg/day]	Vaporizer efficiency [kWh/kg]
Delivery truck for LQ	0.4464	0.6644	0.26	0	0

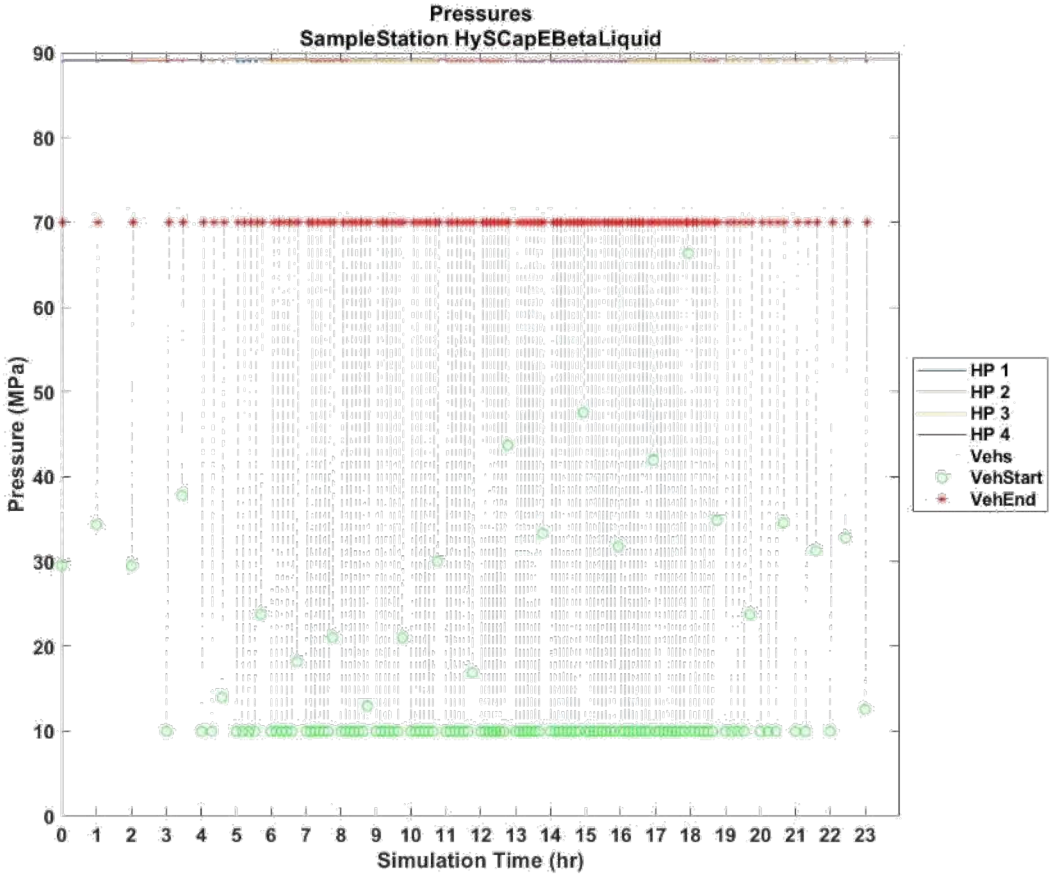
Scenario 6: Input file

Component	Value	Units	Description
Delivery	0	logical [0,1]	Gas delivery to station
Delivery	1	logical [0,1]	Liquid delivery to station
Production	0	logical [0,1]	On-site production at station
Storage	1	logical [0,1]	High pressure storage at station
Storage	0	logical [0,1]	Medium pressure storage at station
Storage	0	logical [0,1]	Low pressure storage at station
Production	0	%	Storage level trigger for production
Production	0	kWh/kg	Production unit efficiency
Production	0	kg/h	flow/production rate
Production	0	MPa	output max pressure
Storage	0.33	m3	Volume high pressure (HP) bank %HITRF: 0.342925
Storage	0	m3	Volume medium pressure (MP) bank %HITRF: 1.3224;
Storage	0	m3	Volume low pressure (LP) bank %Default: 2.6108;
Storage	20	m3	Volume of liquid (LQ) bank (22.7125 = 6000 gallons)
Storage	4	#	Number of high prssure banks
Storage	0	#	Number of medium pressure banks
Storage	0	#	Number of low pressure banks
Storage	1	#	Number of liquid banks
Storage	45	Mpa	Minimum HP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Php is less than or equal to 0)
Storage	0	MPa	Minimum MP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Pmp is less than or equal to 0)
Storage	0	MPa	Minimum LP bank pressure
Storage	90	MPa	Maximum HP bank pressure
Storage	0	MPa	Maximum MP bank pressure
Storage	0	MPa	Maximum LP bank pressure
Storage	0.92	MPa	Vaporizer output pressure (must be greater than HP compressor minimum) (www.linde-engineering.com.hk/internet.le.le.hkg/zt/images/P_3_4_e_10_150dpi227_5776.pdf?v=.)
Storage	1	logical [0,1]	High pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	0	logical [0,1]	Medium pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	0	logical [0,1]	Low pressure bank Eligible for fill, 1=eligible, 0=not eligible
Compressor	1	logical [0,1]	Allow compressor to fill bank which are used for dispensing?, 1=yes, 0=no.
Compressor	1	#	Number of high pressure compressors
Compressor	0	#	Number of medium pressure compressors
Compressor	20	MPa	Minimum High pressure compressor (HPc) pressure
Compressor	0	MPa	Minimum Medium pressure compressor (MPc) pressure
Compressor	93	Mpa	Maximum HPc pressure
Compressor	0	Mpa	Maximum MPc pressure
Compressor	25	kg/h	HPc maximum flowrate
Compressor	0	kg/h	MPc maximum flowrate
Compressor	0	kg/h	Liquid pump maximum flowrate
Compressor	100	kg/h	Vaporizer maximum flowrate
Compressor	4	kWh/kg	HPc efficinecy (includes BOP)
Compressor	0	kWh/kg	MPc efficiency (includes BOP)
Chiller	-35	degC	Pre-cooling setpoint
Chiller	1.5	kWh/kg	Pre-cooling efficiency
Chiller	0	kW	fixed Pre-cooling power
Chiller	1800	s	
Dispenser	0.0167	kg/s	Average dispense flow rate (0.0167kg/s = 1 kg/min)
Dispenser	20	degC	Ambient temperature
Dispenser	1	#	Maximum number fueling positions capable of simultaneous fill
Delivery	0	kg	Mass per delivery
Delivery	0	#/day	Number of deliveries per day
Delivery	0	#	Number of banks delivering hydrogen
Delivery	0	MPa	Pressure of delivery truck
Delivery	0	kg/s	Delivery flow rate
Delivery	3600	s	Delivery truck dwell time
Delivery	1	selector [1,2]	Fuel delivery type, 1=gaseous, 2=liquid
Liquid	0.4464	kg/s	Liquid truck delivery rate to storage
Liquid	0.6644	kWh/kg	Liquid pump efficiency (kWh/kg of station capacity) (HRSAM v1.1)
Liquid	0.26	kWh/kg	Refrigeration efficiency (HRSAM v1.1) (is this more representative as a constant (kW/s) or as specific energy consumption (kW/kg/s)
Liquid	0	kg/day	Boil-off (HRSAM v1.1 for 200kg/day capacity station) (Not wired up yet, consider calculating boil-off based on physical properties)
Liquid	0	kWh/kg	Vaporizer efficiency (HRSAM, Evaporator heated by natural draft so no effect)

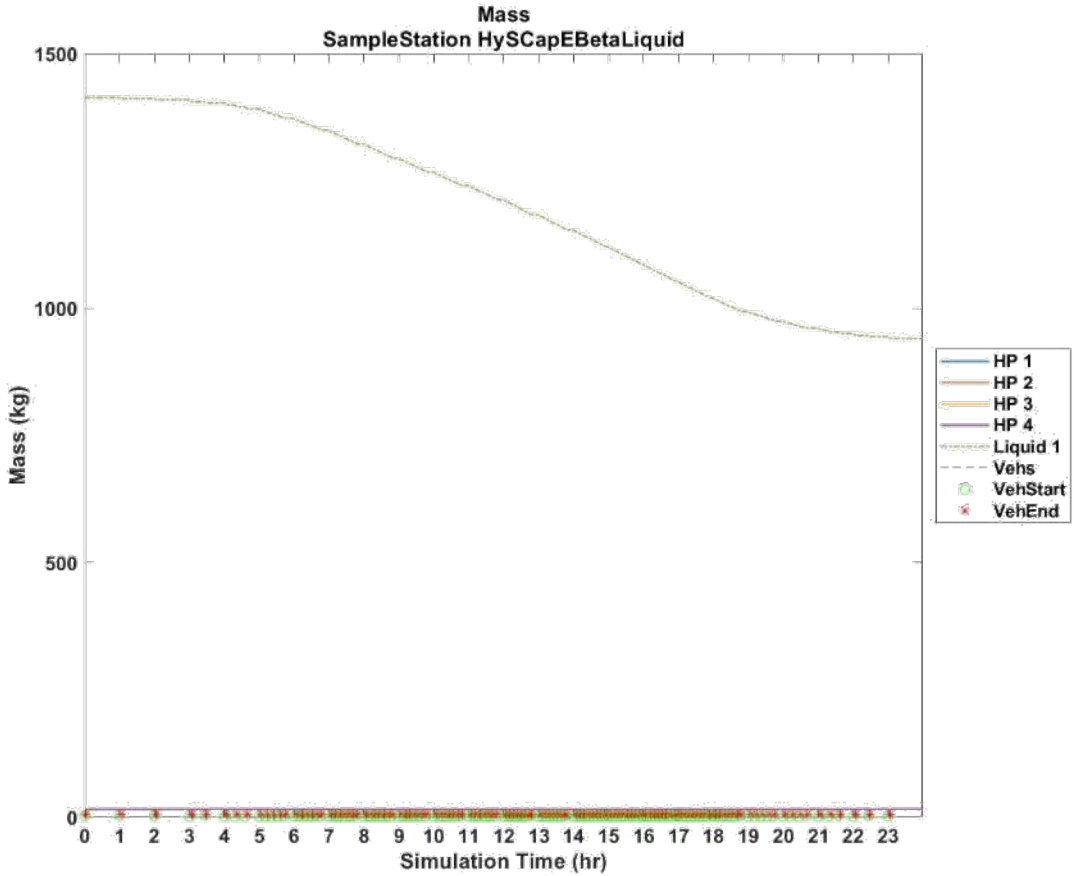
Scenario 6: Capacity Estimate



Scenario 6: Station Pressures



Scenario 6: Station Mass



Scenario 7: On-site Production

Table 1 Bank parameters

	Eligible for fill [-]	Number of banks [-]	Volume [m3]	Maximum Pressure [MPa]	Minimum Pressure [MPa]
HP Bank	Yes	4	0.33	90	45
MP Bank	Yes	3	1	41	0
LP Bank	No	8	2.6	3	0

Table 2 Compressor parameters

	Number of compressors [-]	Maximum pressure [MPa]	Minimum pressure [MPa]	Maximum flowrate [kg/h]	Efficiency [kWh/kg]
HP Compressor	1	93	20	25	4
MP Compressor	1	42	0.5	10	2

Table 3 Production parameters

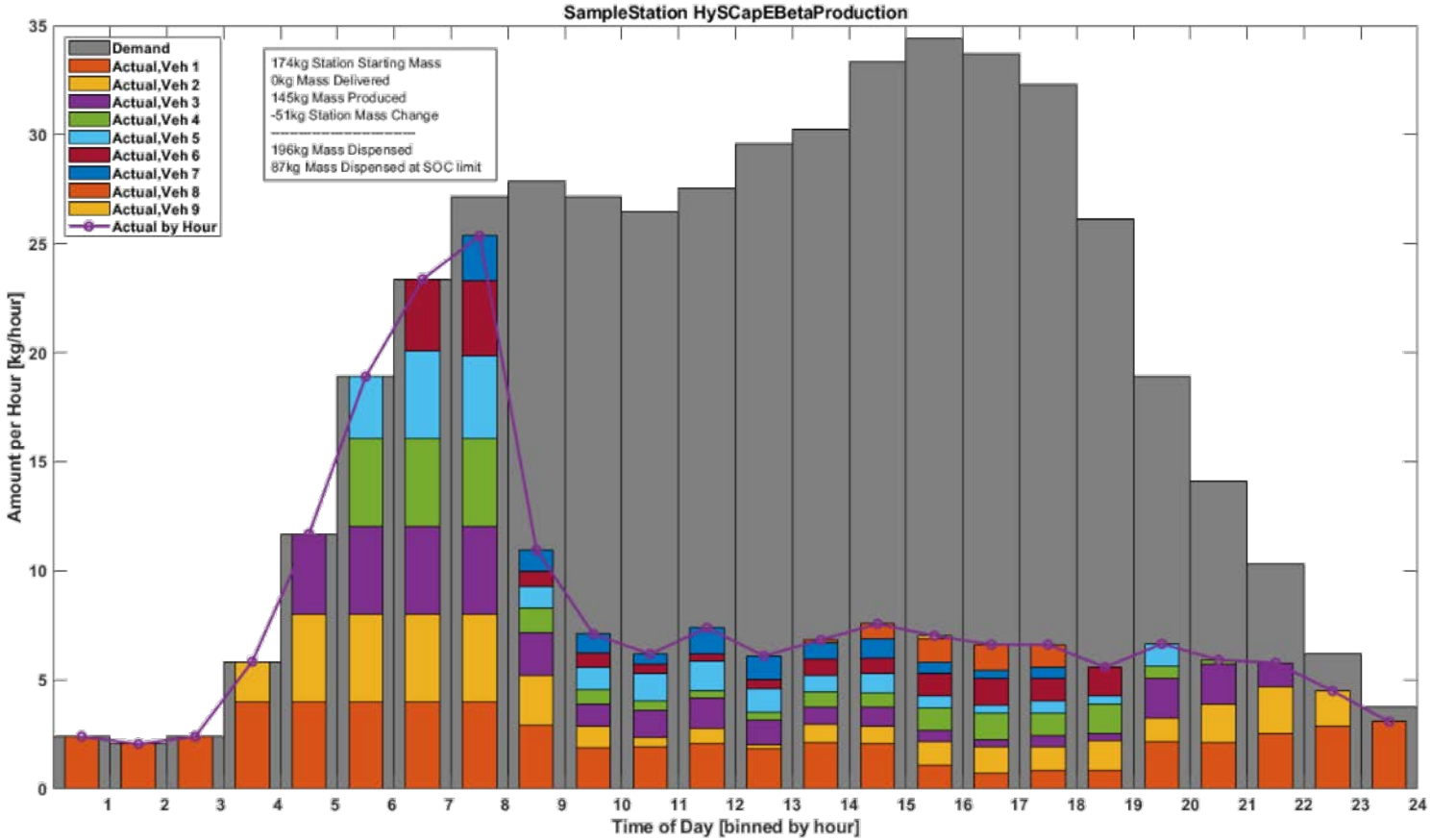
	Trigger for production [%]	Efficiency [kWh/kg]	Production rate [kg/h]	Output maximum pressure [MPa]
Production	90	54	8	3

Scenario 7: Input file

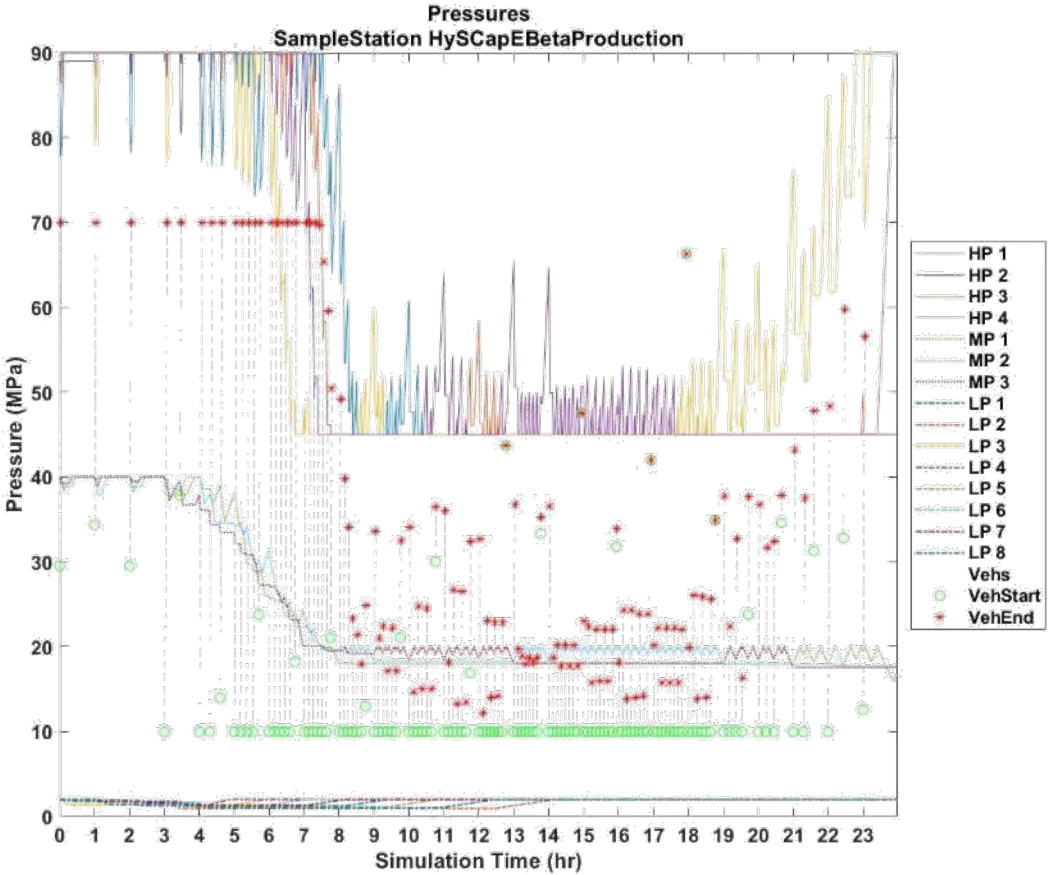
Component	Value	Units	Description
Delivery	0	logical [0,1]	Gas delivery to station
Delivery	0	logical [0,1]	Liquid delivery to station
Production	1	logical [0,1]	On-site production at station
Storage	1	logical [0,1]	High pressure storage at station
Storage	1	logical [0,1]	Medium pressure storage at station
Storage	1	logical [0,1]	Low pressure storage at station
Production	90	%	Storage level trigger for production
Production	54	kWh/kg	Production unit efficiency
Production	8	kg/h	flow/production rate
Production	3	MPa	output max pressure
Storage	0.33	m3	Volume high pressure (HP) bank %HITRF: 0.342925
Storage	1	m3	Volume medium pressure (MP) bank %HITRF: 1.3224;
Storage	2.6	m3	Volume low pressure (LP) bank %Default: 2.6108;
Storage	0	m3	Volume of liquid (LQ) bank (22.7125 = 6000 gallons)
Storage	4	#	Number of high prssure banks
Storage	3	#	Number of medium pressure banks
Storage	8	#	Number of low pressure banks
Storage	0	#	Number of liquid banks
Storage	45	Mpa	Minimum HP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Php is less than or equal to 0)
Storage	0	MPa	Minimum MP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Pmp is less than or equal to 0)
Storage	0	MPa	Minimum LP bank pressure
Storage	90	MPa	Maximum HP bank pressure
Storage	41	MPa	Maximum MP bank pressure
Storage	3	MPa	Maximum LP bank pressure
Storage	0	MPa	Vaporizer output pressure (must be greater than MP compressor minimum) (www.linde-engineering.com.hk/internet.le.le.hkg/zt/images/P_3_4_e_10_150dpi227_5776.pdf?v=.)
Storage	1	logical [0,1]	High pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	1	logical [0,1]	Medium pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	0	logical [0,1]	Low pressure bank Eligible for fill, 1=eligible, 0=not eligible

Compressor	1	logical [0,1]	Allow compressor to fill bank which are used for dispensing?, 1=yes, 0=no.
Compressor	1	#	Number of high pressure compressors
Compressor	1	#	Number of medium pressure compressors
Compressor	20	MPa	Minimum High pressure compressor (HPc) pressure
Compressor	0.5	MPa	Minimum Medium pressure compressor (MPc) pressure
Compressor	93	Mpa	Maximum HPc pressure
Compressor	42	Mpa	Maximum MPc pressure
Compressor	25	kg/h	HPc maximum flowrate
Compressor	10	kg/h	MPc maximum flowrate
Compressor	0	kg/h	Liquid pump maximum flowrate
Compressor	0	kg/h	Vaporizer maximum flowrate
Compressor	4	kWh/kg	HPc efficinecy (includes BOP)
Compressor	2	kWh/kg	MPc efficiency (includes BOP)
Chiller	-35	degC	Pre-cooling setpoint
Chiller	1.5	kWh/kg	Pre-cooling efficiency
Chiller	0	kW	fixed Pre-cooling power
Chiller	1800	s	
Dispenser	0.0167	kg/s	Average dispense flow rate (0.0167kg/s = 1 kg/min)
Dispenser	20	degC	Ambient temperature
Dispenser	1	#	Maximum number fueling positions capable of simultaneous fill
Delivery	0	kg	Mass per delivery
Delivery	0	#/day	Number of deliveries per day
Delivery	0	#	Number of banks delivering hydrogen
Delivery	0	MPa	Pressure of delivery truck
Delivery	0	kg/s	Delivery flow rate
Delivery	3600	s	Delivery truck dwell time
Delivery	1	selector [1,2]	Fuel delivery type, 1=gaseous, 2=liquid
Liquid	0	kg/s	Liquid truck delivery rate to storage
Liquid	0	kWh/kg	Liquid pump efficiency (kWh/kg of station capacity) (HRSAM v1.1)
Liquid	0	kWh/kg	Refrigeration efficiency (HRSAM v1.1) (is this more representative as a constant (kW/s) or as specific energy consumption (kW/kg/s)
Liquid	0	kg/day	Boil-off (HRSAM v1.1 for 200kg/day capacity station) (Not wired up yet, consider calculating boil-off based on physical properties)
Liquid	0	kWh/kg	Vaporizer efficiency (HRSAM, Evaporator heated by natural draft so no effect)

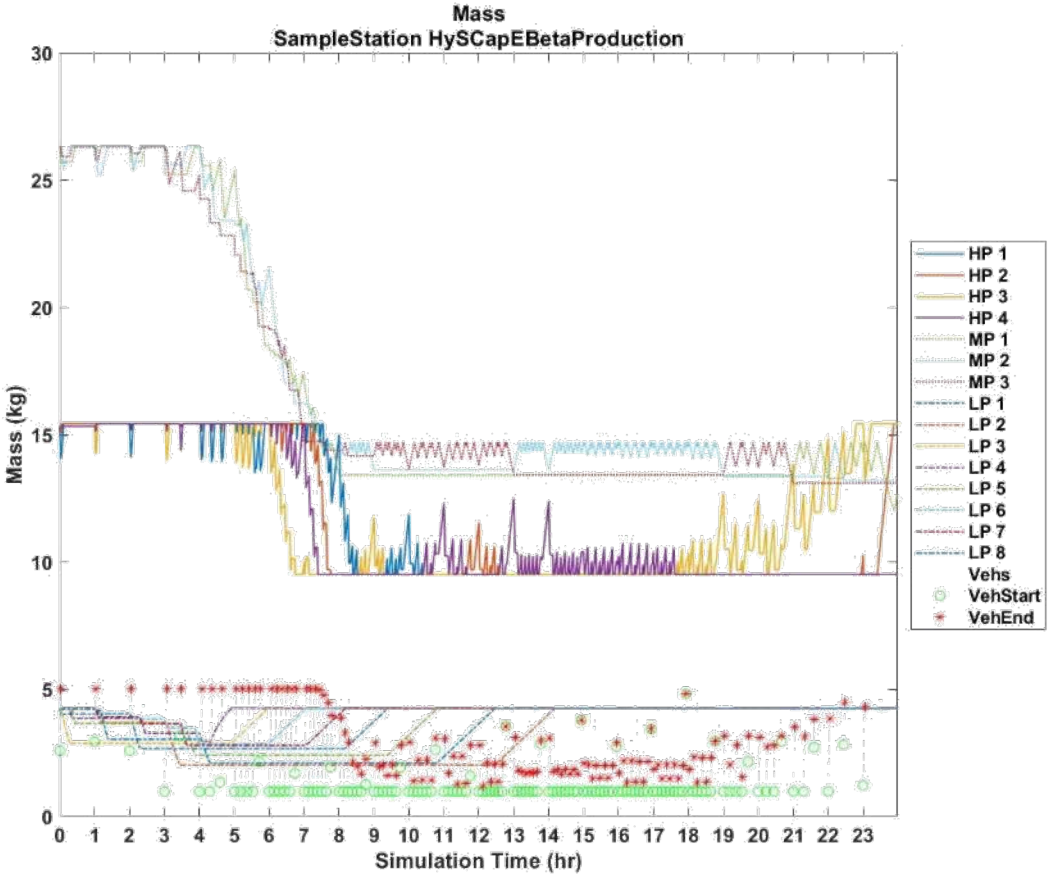
Scenario 7: Capacity Estimate



Scenario 7: Station Pressures



Scenario 7: Station Mass



Scenario 8: Pipeline with 2 Fueling Positions

Table 1 Bank parameters

	Eligible for fill [-]	Number of banks [-]	Volume [m3]	Maximum Pressure [MPa]	Minimum Pressure [MPa]
HP Bank	Yes	4	0.33	93	45
MP Bank	Yes	3	1	41	20
LP Bank	No	8	2.6	10	0

Table 2 Compressor parameters

	Number of compressors [-]	Maximum pressure [MPa]	Minimum pressure [MPa]	Maximum flowrate [kg/h]	Efficiency [kWh/kg]
HP Compressor	1	93	20	100	4
MP Compressor	1	42	0.5	50	2

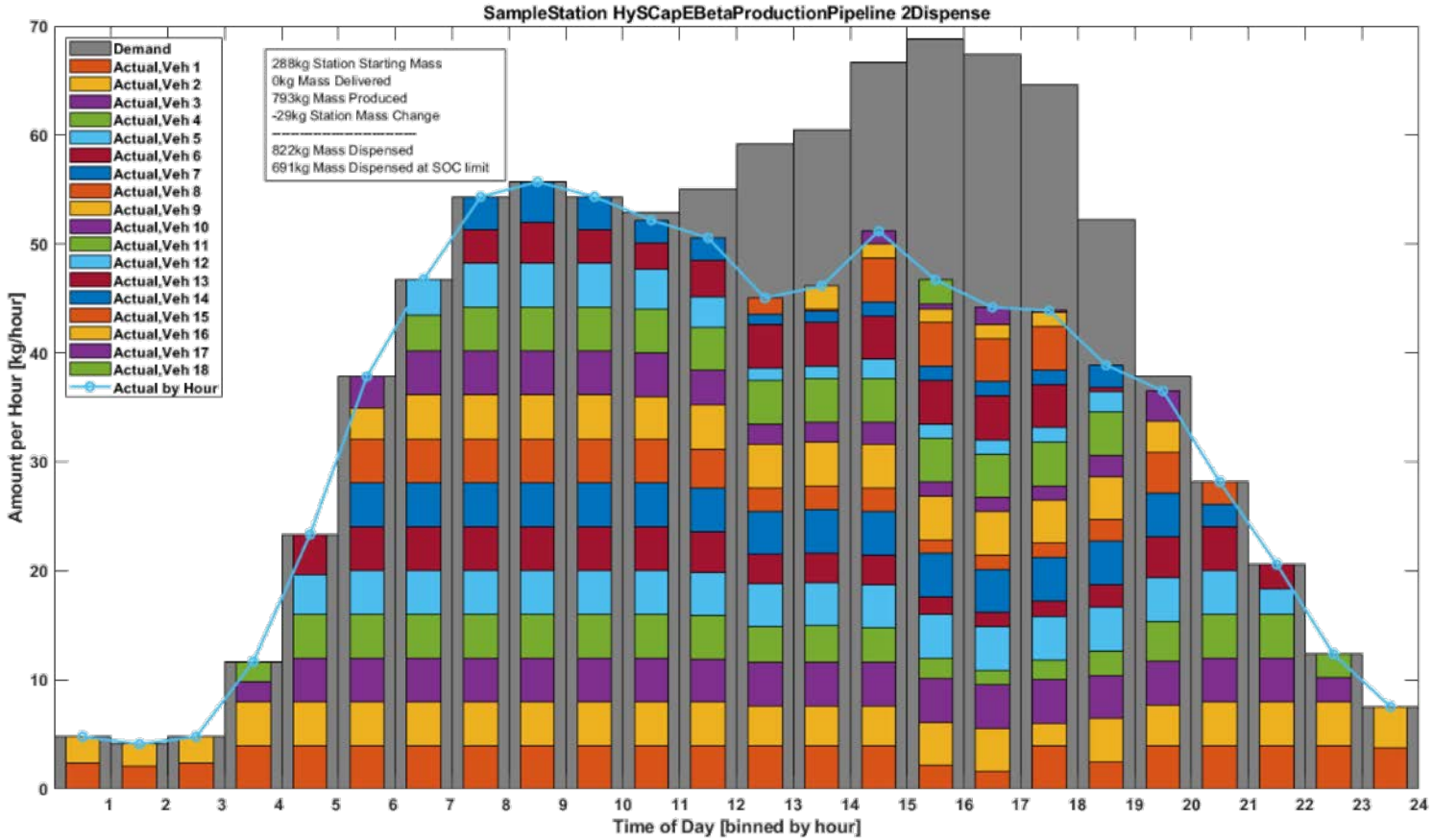
Table 3 Production parameters

	Trigger for production [%]	Efficiency [kWh/kg]	Production rate [kg/h]	Output maximum pressure [MPa]
Production	90	2	50	10

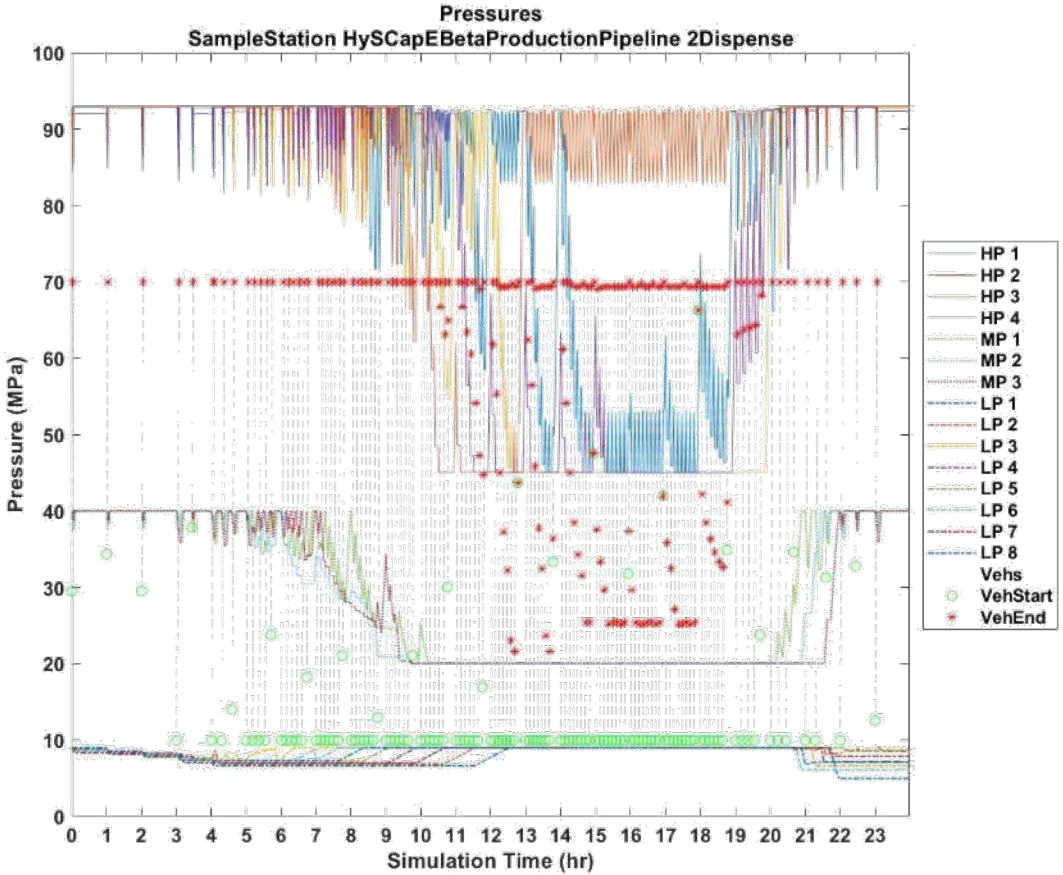
Scenario 8: Input file

Component	Value	Units	Description
Delivery	0	logical [0,1]	Gas delivery to station
Delivery	0	logical [0,1]	Liquid delivery to station
Production	1	logical [0,1]	On-site production at station
Storage	1	logical [0,1]	High pressure storage at station
Storage	1	logical [0,1]	Medium pressure storage at station
Storage	1	logical [0,1]	Low pressure storage at station
Production	90	%	Storage level trigger for production
Production	2	kWh/kg	Production unit efficiency
Production	50	kg/h	flow/production rate
Production	10	MPa	output max pressure
Storage	0.33	m3	Volume high pressure (HP) bank %HITRF: 0.342925
Storage	1	m3	Volume medium pressure (MP) bank %HITRF: 1.3224;
Storage	2.6	m3	Volume low pressure (LP) bank %Default: 2.6108;
Storage	0	m3	Volume of liquid (LQ) bank (22.7125 = 6000 gallons)
Storage	4	#	Number of high prssure banks
Storage	3	#	Number of medium pressure banks
Storage	8	#	Number of low pressure banks
Storage	0	#	Number of liquid banks
Storage	45	Mpa	Minimum HP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Php is less than or equal to 0)
Storage	20	MPa	Minimum MP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Pmp is less than or equal to 0)
Storage	0	MPa	Minimum LP bank pressure
Storage	93	MPa	Maximum HP bank pressure
Storage	41	MPa	Maximum MP bank pressure
Storage	10	MPa	Maximum LP bank pressure
Storage	0	MPa	Vaporizer output pressure (must be greater than MP compressor minimum) (www.linde-engineering.com.hk/internet.le.le.hkg/zt/images/P_3_4_e_10_150dpi227_5776.pdf?v=.)
Storage	1	logical [0,1]	High pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	1	logical [0,1]	Medium pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	0	logical [0,1]	Low pressure bank Eligible for fill, 1=eligible, 0=not eligible
Compressor	1	logical [0,1]	Allow compressor to fill bank which are used for dispensing?, 1=yes, 0=no.
Compressor	1	#	Number of high pressure compressors
Compressor	1	#	Number of medium pressure compressors
Compressor	20	MPa	Minimum High pressure compressor (HPc) pressure
Compressor	0.5	MPa	Minimum Medium pressure compressor (MPc) pressure
Compressor	93	Mpa	Maximum HPc pressure
Compressor	42	Mpa	Maximum MPc pressure
Compressor	100	kg/h	HPc maximum flowrate
Compressor	50	kg/h	MPc maximum flowrate
Compressor	0	kg/h	Liquid pump maximum flowrate
Compressor	0	kg/h	Vaporizer maximum flowrate
Compressor	4	kWh/kg	HPc efficinecy (includes BOP)
Compressor	2	kWh/kg	MPc efficiency (includes BOP)
Chiller	-35	degC	Pre-cooling setpoint
Chiller	1.5	kWh/kg	Pre-cooling efficiency
Chiller	0	kW	fixed Pre-cooling power
Chiller	1800	s	
Dispenser	0.0167	kg/s	Average dispense flow rate (0.0167kg/s = 1 kg/min)
Dispenser	20	degC	Ambient temperature
Dispenser	2	#	Maximum number fueling positions capable of simultaneous fill
Delivery	0	kg	Mass per delivery
Delivery	0	#/day	Number of deliveries per day
Delivery	0	#	Number of banks delivering hydrogen
Delivery	0	MPa	Pressure of delivery truck
Delivery	0	kg/s	Delivery flow rate
Delivery	3600	s	Delivery truck dwell time
Delivery	1	selector [1,2]	Fuel delivery type, 1=gaseous, 2=liquid
Liquid	0	kg/s	Liquid truck delivery rate to storage
Liquid	0	kWh/kg	Liquid pump efficiency (kWh/kg of station capacity) (HRSAM v1.1)
Liquid	0	kWh/kg	Refrigeration efficiency (HRSAM v1.1) (is this more representative as a constant (kW/s) or as specific energy consumption (kW/kg/s)
Liquid	0	kg/day	Boil-off (HRSAM v1.1 for 200kg/day capacity station) (Not wired up yet, consider calculating boil-off based on physical properties)
Liquid	0	kWh/kg	Vaporizer efficiency (HRSAM, Evaporator heated by natural draft so no effect)

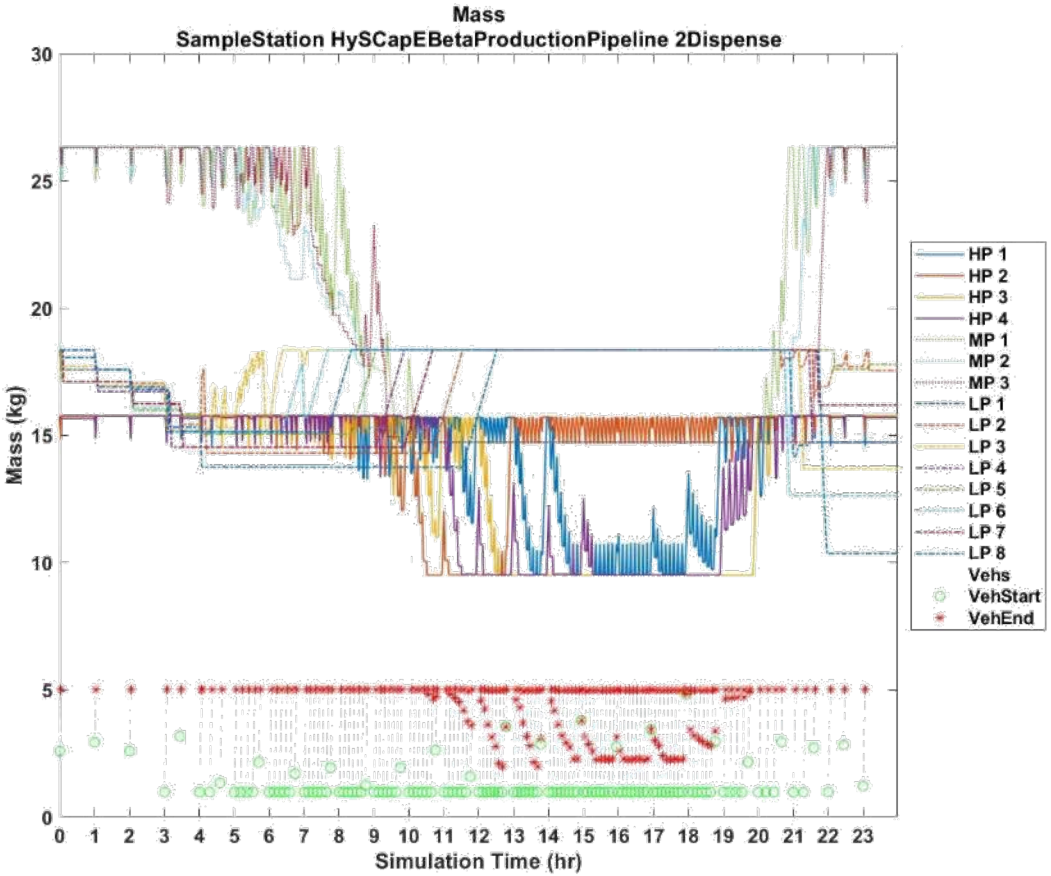
Scenario 8: Capacity Estimate



Scenario 8: Station Pressures



Scenario 8: Station Mass



Scenario 9: Current Small Station Configuration >200kg

Table 1 Bank parameters

	Eligible for fill [-]	Number of banks [-]	Volume [m3]	Maximum pressure [MPa]	Minimum pressure [MPa]
HP Bank	Yes	3	0.33	90	45
MP Bank	Yes	1	1	41	0
LP Bank	No	3	2.6	24	0

Table 2 Compressor parameters

	Number of compressors [-]	Maximum pressure [MPa]	Minimum pressure [MPa]	Maximum flowrate [kg/h]	Efficiency [kWh/kg]
HP Compressor	1	93	20	25	4
MP Compressor	1	42	0.5	10	2

Table 3 Delivery truck parameters

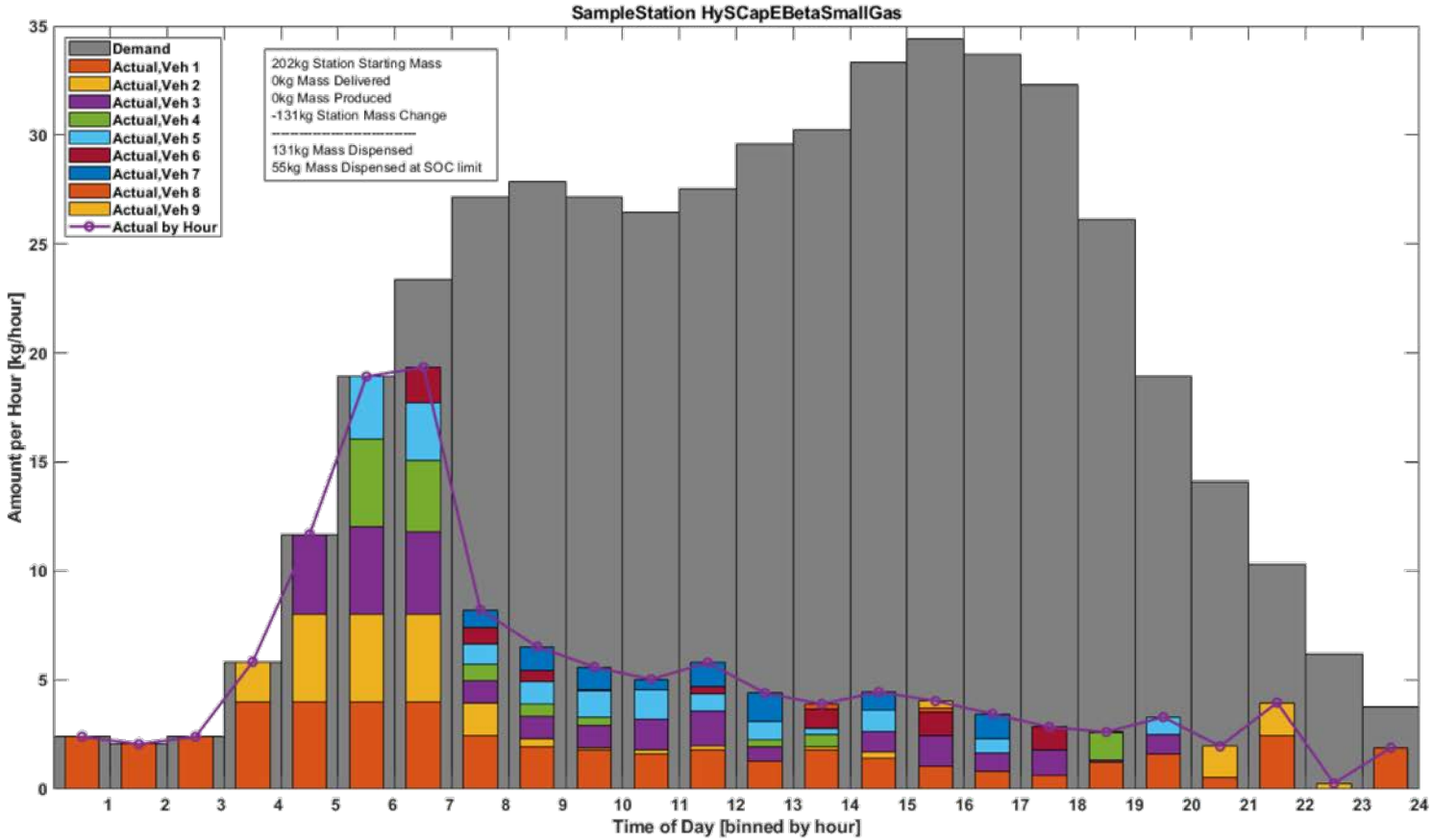
	Delivered H2 [kg]	Number of deliveries [-]	Number of banks [-]	Pressure [MPa]	Flow rate [kg/s]	Dwell time [s]	Fuel type
Delivery truck	200	1	6	35	1	3600	Gaseous

Scenario 9: Input file

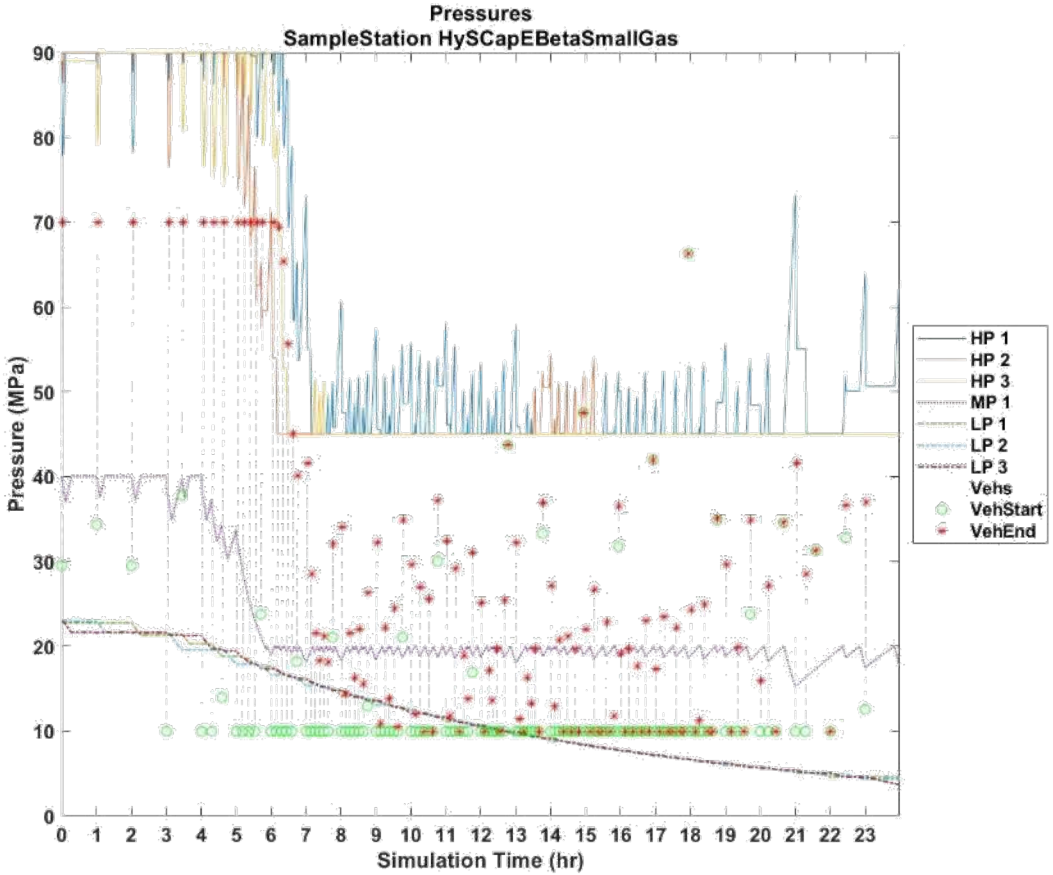
Component	Value	Units	Description
Delivery	1	logical [0,1]	Gas delivery to station
Delivery	0	logical [0,1]	Liquid delivery to station
Production	0	logical [0,1]	On-site production at station
Storage	1	logical [0,1]	High pressure storage at station
Storage	1	logical [0,1]	Medium pressure storage at station
Storage	1	logical [0,1]	Low pressure storage at station
Production	0	%	Storage level trigger for production
Production	0	kWh/kg	Production unit efficiency
Production	0	kg/h	flow/production rate
Production	0	MPa	output max pressure
Storage	0.33	m3	Volume high pressure (HP) bank %HITRF: 0.342925
Storage	1	m3	Volume medium pressure (MP) bank %HITRF: 1.3224;
Storage	2.6	m3	Volume low pressure (LP) bank %Default: 2.6108;
Storage	0	m3	Volume of liquid (LQ) bank (22.7125 = 6000 gallons)
Storage	3	#	Number of high prssure banks
Storage	1	#	Number of medium pressure banks
Storage	3	#	Number of low pressure banks
Storage	0	#	Number of liquid banks
Storage	45	Mpa	Minimum HP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Php is less than or equal to 0)
Storage	0	MPa	Minimum MP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Pmp is less than or equal to 0)
Storage	0	MPa	Minimum LP bank pressure
Storage	90	MPa	Maximum HP bank pressure
Storage	41	MPa	Maximum MP bank pressure
Storage	24	MPa	Maximum LP bank pressure
Storage	0	MPa	Vaporizer output pressure (must be greater than MP compressor minimum) (www.linde-engineering.com.hk/internet.le.le.hkg/zt/images/P_3_4_e_10_150dpi227_5776.pdf?v=.)
Storage	1	logical [0,1]	High pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	1	logical [0,1]	Medium pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	0	logical [0,1]	Low pressure bank Eligible for fill, 1=eligible, 0=not eligible

Compressor	1	logical [0,1]	Allow compressor to fill bank which are used for dispensing?, 1=yes, 0=no.
Compressor	1	#	Number of high pressure compressors
Compressor	1	#	Number of medium pressure compressors
Compressor	20	MPa	Minimum High pressure compressor (HPc) pressure
Compressor	0.5	MPa	Minimum Medium pressure compressor (MPc) pressure
Compressor	93	Mpa	Maximum HPc pressure
Compressor	42	Mpa	Maximum MPc pressure
Compressor	25	kg/h	HPc maximum flowrate
Compressor	10	kg/h	MPc maximum flowrate
Compressor	0	kg/h	Liquid pump maximum flowrate
Compressor	0	kg/h	Vaporizer maximum flowrate
Compressor	4	kWh/kg	HPc efficinecy (includes BOP)
Compressor	2	kWh/kg	MPc efficiency (includes BOP)
Chiller	-35	degC	Pre-cooling setpoint
Chiller	1.5	kWh/kg	Pre-cooling efficiency
Chiller	0	kW	fixed Pre-cooling power
Chiller	1800	s	
Dispenser	0.0167	kg/s	Average dispense flow rate (0.0167kg/s = 1 kg/min)
Dispenser	20	degC	Ambient temperature
Dispenser	1	#	Maximum number fueling positions capable of simultaneous fill
Delivery	200	kg	Mass per delivery
Delivery	1	#/day	Number of deliveries per day
Delivery	6	#	Number of banks delivering hydrogen
Delivery	35	MPa	Pressure of delivery truck
Delivery	1	kg/s	Delivery flow rate
Delivery	3600	s	Delivery truck dwell time
Delivery	1	selector [1,2]	Fuel delivery type, 1=gaseous, 2=liquid
Liquid	0	kg/s	Liquid truck delivery rate to storage
Liquid	0	kWh/kg	Liquid pump efficiency (kWh/kg of station capacity) (HRSAM v1.1)
Liquid	0	kWh/kg	Refrigeration efficiency (HRSAM v1.1) (is this more representative as a constant (kW/s) or as specific energy consumption (kW/kg/s)
Liquid	0	kg/day	Boil-off (HRSAM v1.1 for 200kg/day capacity station) (Not wired up yet, consider calculating boil-off based on physical properties)
Liquid	0	kWh/kg	Vaporizer efficiency (HRSAM, Evaporator heated by natural draft so no effect)

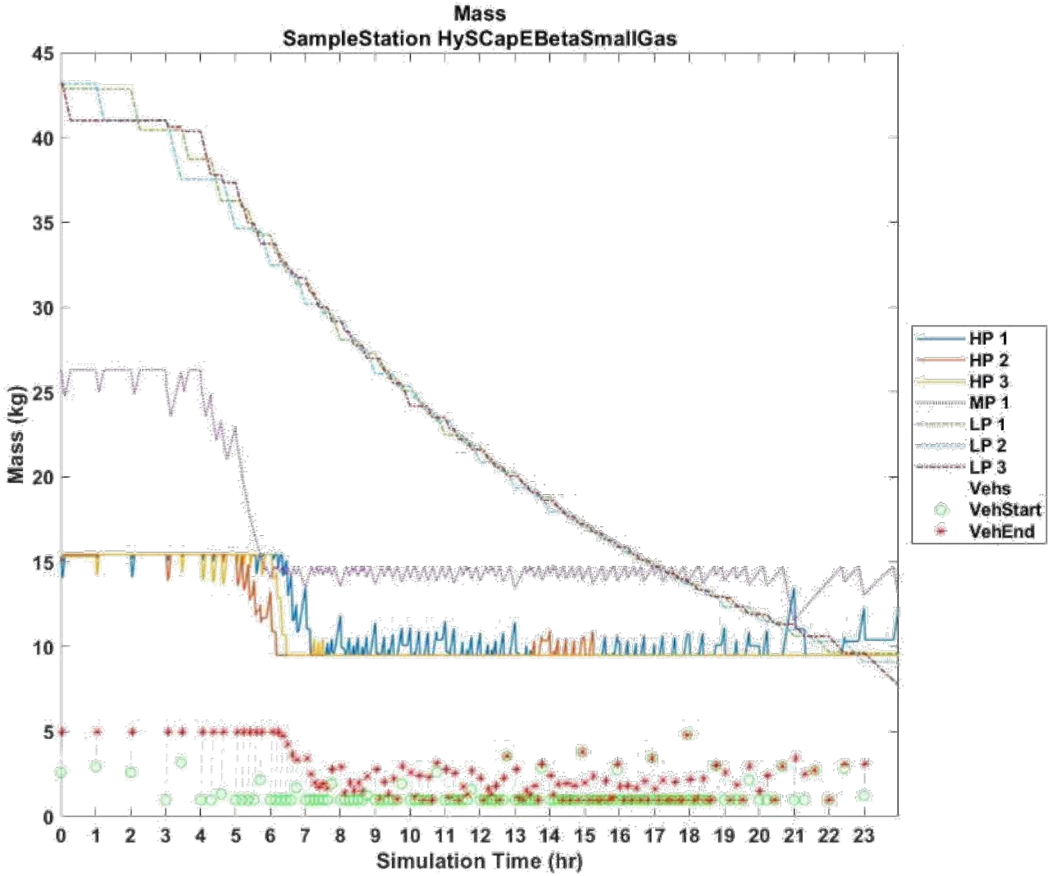
Scenario 9: Capacity Estimate



Scenario 9: Station Pressures



Scenario 9: Station Mass



Scenario 10: Scenario 9 with Low Eligible for Cascade

Table 1 Bank parameters

	Eligible for fill [-]	Number of banks [-]	Volume [m3]	Maximum pressure [MPa]	Minimum pressure [MPa]
HP Bank	Yes	3	0.33	90	45
MP Bank	Yes	1	1	41	0
LP Bank	Yes	3	2.6	24	0

Table 2 Compressor parameters

	Number of compressors [-]	Maximum pressure [MPa]	Minimum pressure [MPa]	Maximum flowrate [kg/h]	Efficiency [kWh/kg]
HP Compressor	1	93	20	25	4
MP Compressor	1	42	0.5	10	2

Table 3 Delivery truck parameters

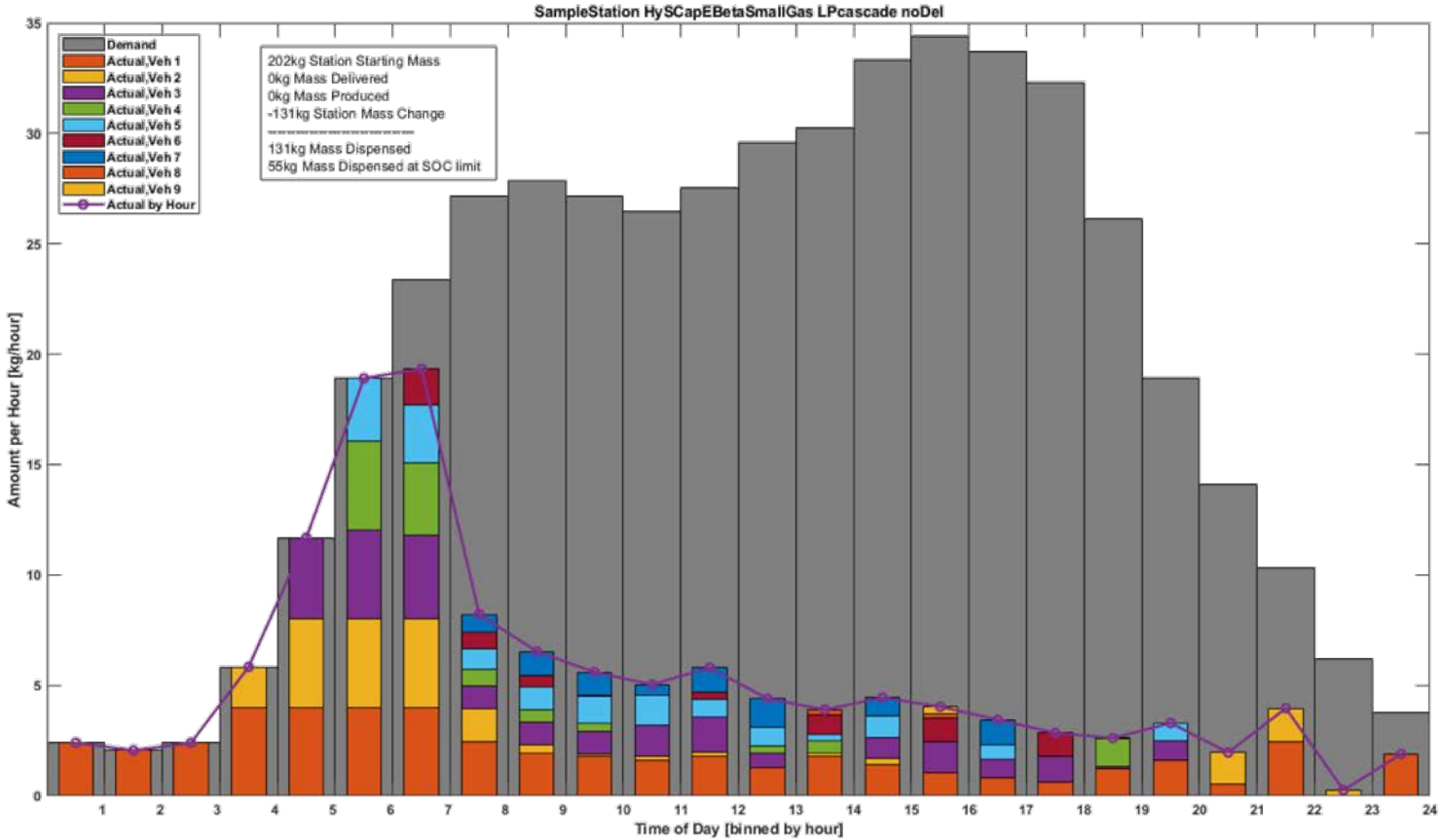
	Delivered H2 [kg]	Number of deliveries [-]	Number of banks [-]	Pressure [MPa]	Flow rate [kg/s]	Dwell time [s]	Fuel type
Delivery truck	200	1	6	35	1	3600	Gaseous

Scenario 10: Input file

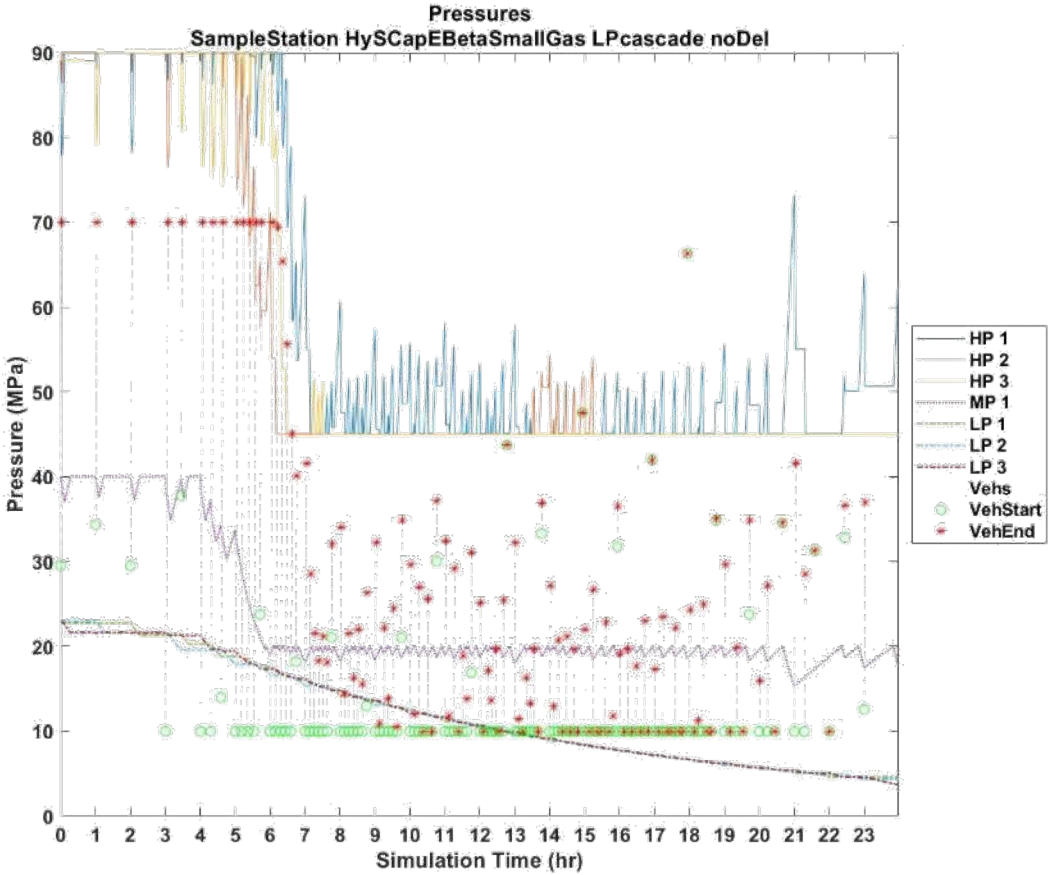
Component	Value	Units	Description
Delivery	0	logical [0,1]	Gas delivery to station
Delivery	0	logical [0,1]	Liquid delivery to station
Production	0	logical [0,1]	On-site production at station
Storage	1	logical [0,1]	High pressure storage at station
Storage	1	logical [0,1]	Medium pressure storage at station
Storage	1	logical [0,1]	Low pressure storage at station
Production	0	%	Storage level trigger for production
Production	0	kWh/kg	Production unit efficiency
Production	0	kg/h	flow/production rate
Production	0	MPa	output max pressure
Storage	0.33	m3	Volume high pressure (HP) bank %HITRF: 0.342925
Storage	1	m3	Volume medium pressure (MP) bank %HITRF: 1.3224;
Storage	2.6	m3	Volume low pressure (LP) bank %Default: 2.6108;
Storage	0	m3	Volume of liquid (LQ) bank (22.7125 = 6000 gallons)
Storage	3	#	Number of high prssure banks
Storage	1	#	Number of medium pressure banks
Storage	3	#	Number of low pressure banks
Storage	0	#	Number of liquid banks
Storage	45	Mpa	Minimum HP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Php is less than or equal to 0)
Storage	0	MPa	Minimum MP bank pressure (Must use whole numbers or adjust pressure lookup function, Must adjust dispensing algorithm if min Pmp is less than or equal to 0)
Storage	0	MPa	Minimum LP bank pressure
Storage	90	MPa	Maximum HP bank pressure
Storage	41	MPa	Maximum MP bank pressure
Storage	24	MPa	Maximum LP bank pressure
Storage	0	MPa	Vaporizer output pressure (must be greater than MP compressor minimum) (www.linde-engineering.com.hk/internet.le.le.hkg/zt/images/P_3_4_e_10_150dpi227_5776.pdf?v=.)
Storage	1	logical [0,1]	High pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	1	logical [0,1]	Medium pressure bank Eligible for fill, 1=eligible, 0=not eligible
Storage	1	logical [0,1]	Low pressure bank Eligible for fill, 1=eligible, 0=not eligible

Compressor	1	logical [0,1]	Allow compressor to fill bank which are used for dispensing?, 1=yes, 0=no.
Compressor	1	#	Number of high pressure compressors
Compressor	1	#	Number of medium pressure compressors
Compressor	20	MPa	Minimum High pressure compressor (HPc) pressure
Compressor	0.5	MPa	Minimum Medium pressure compressor (MPc) pressure
Compressor	93	Mpa	Maximum HPc pressure
Compressor	42	Mpa	Maximum MPc pressure
Compressor	25	kg/h	HPc maximum flowrate
Compressor	10	kg/h	MPc maximum flowrate
Compressor	0	kg/h	Liquid pump maximum flowrate
Compressor	0	kg/h	Vaporizer maximum flowrate
Compressor	4	kWh/kg	HPc efficinecy (includes BOP)
Compressor	2	kWh/kg	MPc efficiency (includes BOP)
Chiller	-35	degC	Pre-cooling setpoint
Chiller	1.5	kWh/kg	Pre-cooling efficiency
Chiller	0	kW	fixed Pre-cooling power
Chiller	1800	s	
Dispenser	0.0167	kg/s	Average dispense flow rate (0.0167kg/s = 1 kg/min)
Dispenser	20	degC	Ambient temperature
Dispenser	1	#	Maximum number fueling positions capable of simultaneous fill
Delivery	200	kg	Mass per delivery
Delivery	1	#/day	Number of deliveries per day
Delivery	6	#	Number of banks delivering hydrogen
Delivery	35	MPa	Pressure of delivery truck
Delivery	1	kg/s	Delivery flow rate
Delivery	3600	s	Delivery truck dwell time
Delivery	1	selector [1,2]	Fuel delivery type, 1=gaseous, 2=liquid
Liquid	0	kg/s	Liquid truck delivery rate to storage
Liquid	0	kWh/kg	Liquid pump efficiency (kWh/kg of station capacity) (HRSAM v1.1)
Liquid	0	kWh/kg	Refrigeration efficiency (HRSAM v1.1) (is this more representative as a constant (kW/s) or as specific energy consumption (kW/kg/s)
Liquid	0	kg/day	Boil-off (HRSAM v1.1 for 200kg/day capacity station) (Not wired up yet, consider calculating boil-off based on physical properties)
Liquid	0	kWh/kg	Vaporizer efficiency (HRSAM, Evaporator heated by natural draft so no effect)

Scenario 10: Capacity Estimate



Scenario 10: Station Pressures



Scenario 10: Station Mass