Technical System Targets: Onboard Hydrogen Storage for Light-Duty Fuel Cell Vehicles [a]			
Storage Parameter	**Units**	**2017**	**Ultimate**
System Gravimetric Capacity: Usable, specific-energy from H_2 (net useful energy/max system mass) [b]	kWh/kg (kg H_2/kg system)	1.8 (0.055)	2.5 (0.075)
System Volumetric Capacity: Usable energy density from H_2 (net useful energy/max system volume) [b]	kWh/L (kg H_2/L system)	1.3 (0.040)	2.3 (0.070)
Storage System Cost:	$/kWh net	12	8
	($/kg $H_{2\ stored}$)	400	266
• Fuel cost [c]	$/gge at pump	2-4	2-4
Durability/Operability:			
• Operating ambient temperature [d]	ºC	-40/60 (sun)	-40/60 (sun)
• Min/max delivery temperature	ºC	-40/85	-40/85
• Operational cycle life (1/4 tank to full)	Cycles	1500	1500
• Min delivery pressure from storage system	bar (abs)	5	3
• Max delivery pressure from storage system	bar (abs)	12	12
• Onboard Efficiency [e]	%	90	90
• "Well" to Powerplant Efficiency [e]	%	60	60
Charging / Discharging Rates:			
• System fill time (5 kg)	min	3.3	2.5
	(kg H_2/min)	(1.5)	(2.0)
• Minimum full flow rate	(g/s)/kW	0.02	0.02
• Start time to full flow (20 °C)	s	5	5
• Start time to full flow (-20 °C)	s	15	15
• Transient response at operating temperature 10%-90% and 90%-0%	s	0.75	0.75
Fuel Quality (H_2 from storage) [f]:	% H_2	SAE J2719 and ISO/PDTS 14687-2 (99.97% dry basis)	
Environmental Health & Safety:			
• Permeation & leakage [g]	-	Meets or exceeds applicable standards, for example SAE J2579	
• Toxicity	-		
• Safety	-		
• Loss of usable H_2 [h]	(g/h)/kg $H_{2\ stored}$	0.05	0.05

[a] Targets are based on the lower heating value of hydrogen, 33.3 kWh/kg H_2. Targets are for a complete system, including tank, material, valves, regulators, piping, mounting brackets, insulation, added cooling capacity, and all other balance-of-plant components. All capacities are defined as usable capacities that could be delivered to the fuel cell power plant. All targets must be met at the end of service life (approximately 1500 cycles or 5000 operation hours, equivalent of 150,000 miles).

[b] Capacities are defined as the usable quantity of hydrogen deliverable to the powerplant divided by the total mass/volume of the complete storage system, including all stored hydrogen, media, reactants (e.g., water for hydrolysis-based systems), and system components. Tank designs that are conformable and have the ability to be efficiently package onboard vehicles may be beneficial even if they do not meet the full volumetric capacity targets. Capacities must be met at end of service life.

[c] Hydrogen threshold cost is independent of pathway and is defined as the untaxed cost of hydrogen produced, delivered and dispensed to the vehicle. [http://hydrogen.energy.gov/pdfs/11007_h2_threshold_costs.pdf] For material-based storage technologies, the impact of the technology on the hydrogen threshold cost, e.g., off-board cooling, off-board regeneration of chemical hydrogen storage materials, etc., must be taken into account.

[d] Stated ambient temperature plus full solar load (i.e., full exposure to direct sunlight). No allowable performance degradation from –20 °C to 40 °C. Allowable degradation outside these limits is to be determined.

[e] Onboard efficiency is the energy efficiency for delivering hydrogen from the storage system to the fuel cell powerplant, i.e., accounting for any energy required for operating pumps, blowers, compressors, heating, etc. required for hydrogen release. Well-to-powerplant efficiency includes onboard efficiency plus off-board efficiency, i.e., accounting for the energy efficiency of hydrogen production, delivery, liquefaction, compression, dispensing, regeneration of chemical hydrogen storage materials, etc. as appropriate. H2A and HDSAM analyses should be used for projecting off-board efficiencies.

[f] Hydrogen storage systems must be able to deliver hydrogen meeting acceptable hydrogen quality standards for fuel cell vehicles (see SAE J2719 and ISO/PDTS 14687-2). Note that some storage technologies may produce contaminants for which effects are unknown and not addressed by the published standards; these will be addressed by system engineering design on a case-by-case basis as more information becomes available.

[g] Total hydrogen lost into the environment as H_2; relates to hydrogen accumulation in enclosed spaces. Storage system must comply with applicable standards for vehicular tanks including but not limited to SAE J2579 and the United Nations Global Technical Regulation. This includes any coating or enclosure that incorporates the envelope of the storage system.

[h] Total hydrogen lost from the storage system, including leaked or vented hydrogen; relates to loss of range.