DOE Hydrogen and Fuel Cells Program Record	
Record #: 18001	**Date:** September 17, 2018
Title: FCTO FY18 Inputs and Assumptions for Program Analysis	
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Items:

To improve transparency and consistency for the DOE Fuel Cell Technologies Office (FCTO) analysis to support early stage R&D, a common set of assumptions and inputs will be used by FCTO to evaluate advanced technologies, compare lifecycle costs and energy use for technologies and pathways, and establish targets. This record documents the inputs and assumptions to be used for financial, hydrogen, fuel cell, and onboard storage analyses in FY18. The plan will be to update these inputs and assumptions on a 3–5 year basis and release updates through the FCTO data record process.

FCTO Assumption Summary:

The assumptions for general financial and technical analysis for hydrogen production and delivery, fuel cell, and onboard storage technologies will be the following.

General

Table 1. Assumptions used for standard analysis

Vehicle base model size	Mid size
Life of vehicle, miles	178,000 [3]
Dollar year for costs	2016$
Gasoline cost, $/gal (untaxed)	$2.50 [4]
Years between lab release to commercialization, yr	5
Vehicle range, miles	300
Gasoline ICEV on-road fuel economy (2030), mpg	35 [1]
Gasoline HEV on-road fuel economy (2035), mpg	53 [1]
2030 comparable vehicle	Conventional gasoline ICEV

Ultimate comparable vehicle	Gasoline HEV
Current FCEV on-road fuel economy, mpgge	62 [5][1]
FCEV on-road fuel economy (2030), mpgge	72 [5]
FCEV on-road fuel economy (2035), mpgge	87 [5]
Distance between hydrogen production facility and city gate, miles (km)[2]	200 (322 km) [6]
Current ICEV sales price (2013$), $	$21,380 [5]
Current HEV sales price (2013$), $	$26,600 [1]
Future ICEV sales price (2013$), $	$23,490 [1]
Future HEV sales price (2013$), $	$25,560 [1]
Future FCEV sales price (2013$), $	$30,260 [1]

Financial

Table 2. Assumptions used for financial analysis based on input from industry, peer reviewed publications, and to ensure consistency with other office analysis

Federal tax rate	21%
Vehicle ownership periods, years	5 (consumer payback) 15 (societal payback)
Fuel, untaxed	$2.50/gallon [4]
Model year	2030 (2025 lab demonstrated)
Real discount rate	8%[3] [8]
% equity financing	40%
After-tax IRR, %	10%[4]

[1] Note that commercially available vehicles (e.g., Toyota Mirai and Honda Clarity) achieve 66 mpgge but 62 mpgge is used because it is a modeled value based on a common set of parameters for comparative vehicle platforms.
[2] The delivery distance is defined as the distance to deliver hydrogen from the point of production to the hydrogen station.
[3] This rate of return is reflective of similar hydrogen production industries (Air Products and Praxair). It is similar to the OMB recommended rate of return (7%).
[4] This rate of return is reflective of similar hydrogen production industries (Air Products and Praxair).

Hydrogen

Table 3. Assumptions used for hydrogen production and delivery analysis

Current H_2 cost status (delivered) (2014\$), \$/gge (untaxed)	\$14 [9]
2025 H_2 cost target (delivered), \$/gge (untaxed) (2016\$)	\$7 [11]
Ultimate H_2 cost target (delivered), \$/gge (untaxed) (2016\$)	\$4 [11]
Utilization rate of stations	Achieve 80% utilization within 5 years[5]

Fuel Cells

Polymer Electrolyte Membrane Fuel Cell (PEMFC)

Table 4. Assumptions used for PEMFC analysis

Current (2017) cost status @ 500,000 units/yr (2017\$), \$/kW	\$45 [7]
Current (2017) cost status @ 100,000 units/yr (2017\$), \$/kW	\$50 [7]
Current (2017) cost status @ 10,000 units/yr (2017\$), \$/kW	\$79 [7]
2025 (lab demonstrated) cost target (2017\$), \$/kW	\$40 [13]
Ultimate cost target (2017\$), \$/kW	\$30 [13]
Current stack efficiency, %	52 [7]

[5] http://www.energy.ca.gov/2017publications/CEC-600-2017-011/CEC-600-2017-011.pdf

2025 fuel cell peak efficiency target, %	65 [13]
Ultimate fuel cell peak efficiency target, %	70 [13]
Current durability (2017), hours	4,100 [12]
2025 durability target, hours	5,000 [13]
Ultimate durability target, hours	8,000 [13]
Platinum cost, $/tr. oz.	$1,500
Current Pt loading (2017), mg_{Pt}/cm^2	0.125 [7]

Onboard Storage

Table 5. Assumptions used for onboard storage analysis

Current (2017) cost status @ 500,000 units/yr (2007$)[6], $/kWh	$15 [10]
Current (2017) cost status @ 100,000 units/yr (2007$)[6], $/kWh	$17 [10]
Current (2017) cost status @ 10,000 units/yr (2007$)[6], $/kWh	$24 [10]
2025 (lab demonstrated) cost target[7], $/kWh	$9 [10]
Ultimate cost target[7], $/kWh	$8 [10]
Current gravimetric capacity[6], kWh/kg_{system}	1.4 [10]
Gravimetric capacity (2025), kWh/kg_{system}	1.8 [10]
Ultimate gravimetric capacity, kWh/kg_{system}	2.2 [10]

[6] The status is based on 700 bar high pressure carbon composite tanks.
[7] The 2025 and Ultimate cost targets for onboard hydrogen storage is expressed in nominal dollars.

Current volumetric capacity[6], kWh/L_{system}	0.8 [10]
Volumetric capacity (2025), kWh/L_{system}	1.3 [10]
Ultimate volumetric capacity (2035), kWh/L_{system}	1.7 [10]

References:

[1] Elgowainy et al., 2016. *Cradle-to-Grave Lifecycle Analysis of U.S. Light Duty Vehicle-Fuel Pathways*. Argonne National Laboratory. https://greet.es.anl.gov/publication/c2g-2016-report.

[2] Islam et al., forthcoming. *An Extensive Study on Sizing, Energy Consumption, and Cost of Advanced Vehicle Technologies*. Argonne National Laboratory.

[3] NHTSA (National Highway Traffic Safety Administration), National Center for Statistics and Analaysis, 2006. *Vehicle Survivability and Travel Mileage Schedules*. http://www-nrd.nhtsa.dot.gov/Pubs/809952.pdf. (Note: the vehicle lifetime of 178,200 miles is still valid today.)

[4] EIA (Energy Information Agency), 2017. *Annual Energy Outlook 2017 with projections to 2040*.

[5] Moawad et al., 2016. *Assessment of Vehicle Sizing, Energy Consumption and Cost through Large Scale Simulation of Advanced Vehicle Technologies.* Report ANL/ESD-15/28. Argonne National Laboratory, Argonne, IL. http://www.autonomie.net/publications/fuel_economy_report.html.

[6] Wang et al., 2018. GREET® 2017 model. Available at: https://greet.es.anl.gov/index.php.

[7] U.S. Department of Energy Hydrogen and Fuel Cells Program, 2017. "Record 17007: Fuel Cell System Cost – 2017," https://www.hydrogen.energy.gov/program_records.html.

[8] OMB issues a circular annually, where they claim that "marginal pretax rate of return on an average investment in the private sector in recent years" is 7%. (https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/circulars/A94/a094.pdf)

[9] U.S. Department of Energy Hydrogen and Fuel Cells Program, "Record 15011: Low Volume Production and Delivery Cost – 2015," https://www.hydrogen.energy.gov/pdfs/15011_low_volume_production_delivery_cost.pdf.

[10] Storage team issued revised targets in 2017, corrections below reflect the newly revised targets. Targets posted here: https://www.energy.gov/eere/fuelcells/doe-technical-targets-onboard-hydrogen-storage-light-duty-vehicles. The current status values are based on the 2015 storage status record:

https://www.hydrogen.energy.gov/pdfs/15013_onboard_storage_performance_cost.pdf. Note, the storage state record is expected to be updated in 2018.

[11] The hydrogen R&D cost target was revised and issued in the DOE record 18004: "Hydrogen R&D Cost Target Calculation – 2018 Update," https://www.hydrogen.energy.gov/pdfs/18004_h2_cost_target_calculation_2018.pdf.

[12] Fuel cell team issued an updated status record of the on-road fuel cell stack durability in 2016. The updated status is posted here: https://www.hydrogen.energy.gov/pdfs/16019_fuel_cell_stack_durability_2016.pdf.

[13] DOE Fuel Cell Technologies Office MYRD&D plans. https://www.energy.gov/sites/prod/files/2017/05/f34/fcto_myrdd_fuel_cells.pdf.