


DOE Alternative Fuels and Feedstocks Office Program Record		
Record #: 25001	Date: 05/14/2026	
Title: 2030 Fuel Cell Stack Manufacturing Capacities		
Originator: Michael Ulsh, Eric White, Greg Kleen, William Gibbons		
Peer Reviewed by: Jennie Huya-Kouadio and Brian James (Strategic Analysis, Inc.), Karen Swider-Lyons (Plug Power), Scott Higgins (Nuvera), Narendra Deshpande (General Motors), Lee Sweetland (Ballard)		
Approved by: Dimitrios Papageorgopoulos	Date: 04/09/2026	

Item:

This record documents assumptions for achieving a manufacturing rate of 20,000 stacks/year for proton exchange membrane (PEM) fuel cells based on a case study for the manufacturing scale-up of industrial fuel cells with a variety of end uses—including providing stationary power for data centers. The manufacturing rate is a realistic near-term advancement of manufacturing capacity required for achieving the projected 2030 fuel cell system cost goal of \$80/kW (at a production volume of 100,000 fuel cell systems/year).^{1,2,3} This stack manufacturing rate translates to component level manufacturing capacity requirements for key stack components: membrane electrode assemblies (MEA), bipolar plate (BPP) assemblies (BPA), gas diffusion layers (GDL), membranes, and the catalysts as shown below.⁴ The current industrial manufacturing capacity baseline is <2,000 stacks/year at approximately \$120 per kW_{net}.

Table 1. Manufacturing rates commensurate with the 2030 manufacturing capacity target of 20,000 fuel cell stacks per year.

Component	Rate
Stacks	6 stacks/hour
MEAs	2,400 MEAs/hour
BPAs	2,400 BPAs/hour
GDLs	650,000 m ² /year
Membrane	370,000 m ² /year
Pt-based catalyst	1,300 kg Pt/year

¹ Hydrogen Class 8 Long Haul Truck Targets. 2019.

https://www.hydrogen.energy.gov/pdfs/19006_hydrogen_class8_long_haul_truck_targets.pdf

² DOE Hydrogen Program Record for Heavy-Duty Fuel Cell System Cost – 2022, Record #23002.

<https://www.hydrogen.energy.gov/docs/hydrogenprogramlibraries/pdfs/23002-hd-fuel-cell-system-cost-2022.pdf?Status=Master>

³ See Figure 5.4 Waterfall Chart in Hydrogen and Fuel Cell Technologies Office Multi-Year Program Plan, DOE/GO-102024-6266. May 2024. <https://www.energy.gov/sites/default/files/2024-05/hfto-mypp-2024.pdf>

⁴ Note: Manufacturing rates assume either a single manufacturing line or a system of a limited number of parallel lines for certain process steps, as opposed to an excess of parallel manufacturing lines to meet the targeted rates shown.

Rationale:

The U.S. Department of Energy (DOE) has supported extensive efforts to understand and improve fuel cell performance and durability for critical end uses, including stationary applications to support grid resiliency and onsite backup, hybrid, and behind-the-meter primary power for data centers, as well as for other applications including medium-duty and heavy-duty vehicle (HDV) applications. As a guide to these research, development, and demonstration (RD&D) efforts, as well as to manufacturing scale-up efforts, DOE has also supported an ongoing manufacturing cost analysis effort by Strategic Analysis, Inc. (SA). This analysis uses lab-demonstrated technology to evaluate the cost of fuel cell stacks and systems, including for HDVs, at varying production volumes, serving as a case study for industrial fuel cell manufacturing scale-up.⁵ This analysis provides a guideline for cost reduction pathways toward a 2030 HDV system cost target of \$80/kW (at a production volume of 100,000 systems per year).⁶ However, the analysis assumes manufacturing technology and enterprise advancements as production volume increases, though these future manufacturing states, including equipment and operating parameters, have not yet been demonstrated at scale for fuel cell materials.

This manufacturing capacity target therefore aims to help bridge the gap between the current low-volume U.S. fuel cell production status and the development and validation of the manufacturing capacities needed to begin to achieve economies of scale and thereby significantly reduce cost. To do so, the target capacity would ideally drive toward the knee of the fuel cell stack cost curve, shown in Figure 1, maximizing near-term cost reduction while minimizing the creation of unused manufacturing capacity. Based on these criteria, the manufacturing capacity target of 20,000 stacks/year was selected. This stack capacity, assuming an HDV fuel cell system comprising two 150 kW stacks, would equate to a system capacity of 10,000 per year, and generally aligns with the knee of the fuel cell stack cost curve. In addition, the modularity of the systems produced would have cross-cutting benefits for multiple applications, potentially addressing maritime and stationary (e.g., data center) power demands.

It is understood that driving toward increased stack capacity will also demand increases in manufacturing capacity of stack components. Thus, there is a need to understand how the stack-level target rolls down to implied requirements for components. To develop the target in a well-defined and justifiable way, DOE and SA performed a specialized analysis using the HDV manufacturing cost model. The SA model is based on a bottom-up cost analysis using a manufacturing process-based costing methodology, Design for Manufacture and Assembly (DFMA), that is well known and heavily used in automotive and other industries. SA's model estimates the direct material cost, manufacturing cost, assembly cost, and markup for each stack component by modeling each physical step of the manufacturing process. Price quotes are obtained for materials, tooling, and manufacturing equipment. Manufacturing cost is determined by the process cycle time combined with the machine rate (hourly cost based on amortization of equipment capital and operating costs). Markup is applied to components supplied by vendors as well as the fuel cell system manufacturer and powertrain system integrator to estimate the fuel

⁵ Mass Production Cost Estimation of Direct Hydrogen PEM Fuel Cell Systems for Transportation Applications: 2018 Update. <https://www.energy.gov/eere/fuelcells/articles/mass-production-cost-estimation-direct-h2-pem-fuel-cell-systems-7>

⁶ https://www.hydrogen.energy.gov/pdfs/19006_hydrogen_class8_long_haul_truck_targets.pdf

cell system cost to a vehicle original equipment manufacturer (OEM). Manufacturing yields are included but at projected optimized values. Key modeling assumptions for this specialized analysis are listed in Table 2, and provide the basis for the component level production rate calculations listed in Table 3 that are commensurate with the stack-level target.

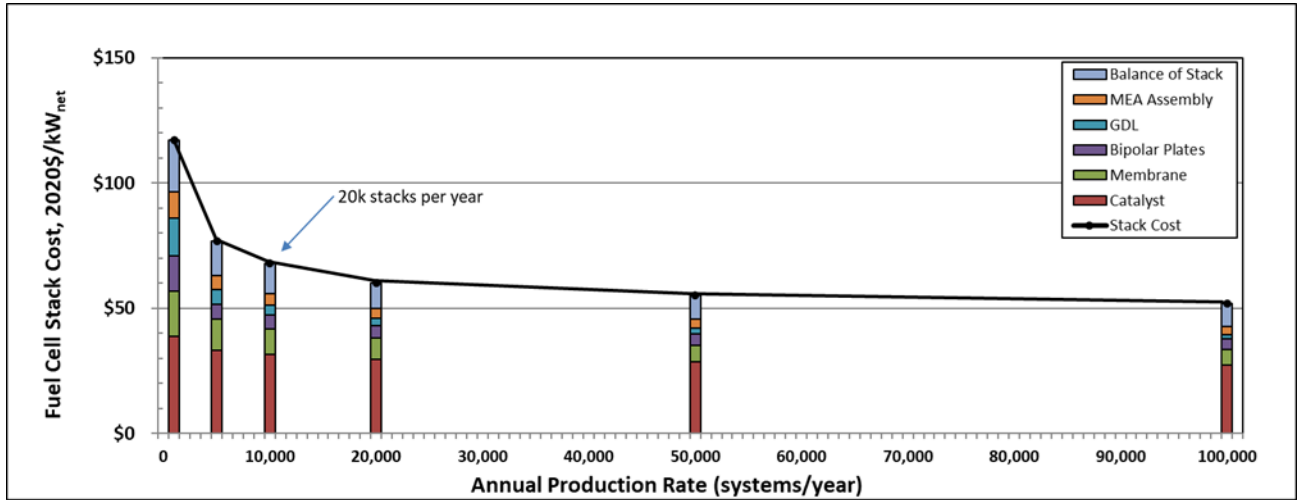


Figure 1. Modeled cost of a representative 300-kW_{net} PEM fuel cell system (2x150-kW stacks) based on 2024 technology.

Table 2. Modeling assumptions⁷ for 20,000 heavy-duty stacks per year manufacturing capacity target analysis

Parameter	Units	Value
Plant Operational Days per Year	days/year	240
Number of Shifts per Day	shifts/day	2
Productive Time per Shift	hours	7
Plant Operational Hours per Year	hours/year	3,360
Net Stack Power at EOL – 10% degradation from BOL	kW _{net}	150
Gross Stack Power at EOL	kW _{gross}	176
Cell Voltage at EOL – max continuous	V/cell	0.65
Minimum Current Density at EOL – max continuous	A/cm ²	1.692
Minimum Power Density at EOL – max continuous	mW/cm ²	1,100
Total Pt Loading	mgPt/cm ²	0.35
Cell Active Area	cm ²	400
Cell Total Area	cm ²	615
Total Stack Active Area	m ²	16
Total Stack Area	m ²	25
Repeat Cells per Stack (not to exceed 500)	cells/stack	400
Production Volume (150-kW_{net} stacks)	stacks/year	20,000
Total Stack Current (not to exceed 1,000 A)	A	675

Table 3. Component-level production rate calculations for the resulting rates shown in Table 1

Component	Rate
Stacks	20,000 stacks / 3,360 hours / 99% yield = ~6 stacks/hour
MEAs	20,000 stacks x 400 MEAs per stack / 3,360 hours / 99% yield = ~2,400 MEAs/hour
BPP Assemblies (BPAs)	20,000 stacks x 400 BPAs per stack / 3,360 hours / 99% yield = ~2,400 BPAs/hour
GDLs	20,000 stacks per year x 0.04 m ² per cell x 2 GDLs per cell x 400 cells per stack / 99% yield = ~650,000 m²/year
Membrane	20,000 stacks per year x 0.04 m ² per year x 1.10 additional membrane around border of active area x 400 cells per stack / 93% yield = ~370,000 m²/year
Pt-based Catalyst	0.00035 g Pt per cm ² / 1,000 g per kg x 400 cm ² active area per cell x 1.07 additional catalyzed area on border x 400 cells per stack x 20,000 stacks per year / 93% yield = ~1,300 kg Pt/year

⁷ Note that these assumptions are intended to be representative, not absolute. For example, it is acknowledged that there are other choices of operational tempo (operational days per year, shifts per day, hours per shift) that can still enable the accomplishment of the target annual production rates at the stack and component levels.